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The Correlation between Diet Quality and Blood Glucose Levels in Type 2 Diabetes Mellitus Patients in Yogyakarta Municipality

Hubungan Kualitas Diet dengan Kadar Glukosa Darah pada Pasien Diabetes Mellitus Tipe 2 di Kota Yogyakarta

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ABSTRACT

Background: Diet quality is an important component in blood sugar regulation. Effective blood sugar regulation can effectively reduce the risk of developing additional complications and chronic diseases. The number of people suffering from type 2 diabetes mellitus (T2DM) in Yogyakarta City, Special Region of Yogyakarta (DIY) in 2021 will be 10,635 people and in 2022 it will be 15,588 people.

Objectives: This study aims to determine the correlation between diet quality and blood glucose levels in Type 2 Diabetes Mellitus patients living in Yogyakarta, Indonesia.

Methods: This research applied a cross-sectional design and is an analytical observational study. Purposive sampling was used to select participants, resulting in a sample size of 63 individuals. Blood glucose levels obtained from secondary sources at the Community Health Center were used as the dependent variable. The Diet Quality Index-International Questionnaire (DQI-I Q) and the Semi-Qualitative Food Frequency Questionnaire (SQ-FFQ) were used to assess the independent variables of food quality. The data was statistically analyzed using STATA version 14 and the Chi-Square test.

Results: 35.38% of respondents who reported eating healthy food had normal blood glucose levels (current blood glucose levels below 200 mg/dL), while 12.3% of respondents who reported eating poor food reported hyperglycemic blood glucose levels (current blood glucose levels exceeding 200 mg/dL). In T2DM patients, there was no association between dietary quality and blood glucose levels (p-value=0.397). However, correlations could be observed between blood glucose levels and DQI-I variation components (p-value=0.000) and overall balance (p-value=0.018).

Conclusions: In contrast to transient blood glucose levels, the overall component of variation and balance was related to diet quality.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder that causes non-communicable or degenerative diseases. It is characterized by insufficient insulin production by the pancreas or impaired utilization of insulin produced proteins by the body[1]. Diabetes mellitus consists of a group of metabolic disorders distinguished by hyperglycemia. Hyperglycemia is a pathological condition characterized by an increase in glucose concentration in the bloodstream beyond a set threshold. This condition arises due to dysfunction of the pancreas, which can lead to insufficient secretion of the insulin hormone[2].

In 2018, the incidence of diabetes mellitus in Indonesia rose to 2% from 1.5% in 2013[3]. With 2.6% of its population suffering from diabetes in 2018, DKI Jakarta is the province most responsible for the high diabetes rate. With a frequency of 2.4% in 2018 with 12,525 documented cases, the Special Region of Yogyakarta ranked second in Indonesia for all ages. occurred in 2018, with a peak incidence of 1.9% in urban areas[4].

The prevalence of diabetes mellitus in Yogyakarta Municipality based on the 2018 *Riskesdas* (Basic Health Research) results was 4.79% or around 15,540 people. The target prevalence of people with diabetes mellitus who receive health services according to established norms is 7.11% or 11,046 people[5]. About 10,635 people or 80.5% of the target prevalence will have diabetes mellitus and receive health services according to international standards in 2021[6]. The prevalence of people with diabetes mellitus has increased in 2022, which was 15,588 people[7].

The increasing incidence of diabetes mellitus (DM) is undoubtedly caused by dietary and lifestyle factors related to physical activity. It is known that unhealthy eating habits and lack of physical activity contribute significantly to the prevalence of diabetes

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mellitus. People are all aware that fast food has become the norm in today's culture as an easier and faster means of dieting. Fast food is detrimental to one's health due to its inclusion of sugar, fat, salt, and additives, such as artificial colours, flavours, and sweeteners[8].

The quality of one's diet is just one aspect of food control that is very important in the management of diabetes mellitus. The management of diabetes mellitus may be influenced by dietary factors other than sugar, fat, fiber, and antioxidants. An important part of controlling type 2 diabetes mellitus is dietary changes. The risk of developing diabetes mellitus increases when the consumption of foods containing carbohydrates, sugar, or glucose is low, and the intake of protein and fiber is low[9].

Diet quality may be affected by unhealthy eating habits or overeating. To avoid non-communicable diseases (NCDs), a healthy diet should include foods that are varied, contain sufficient micronutrients, and adhere to World Health Organization (WHO) guidelines[10]. Controlling blood glucose levels and avoiding other problems may be greatly helped by a high-quality diet[11]. According to the results of the Study of Total Diet (SDT) in 2014, the Special Region of Yogyakarta showed that on average, urban residents consumed 302.6 g of carbohydrates per day, higher than rural areas which only consumed 262.0 g per day. Protein averaged 70.8 g per day for men and 72 g per day for women. For fat, the average was 81.1 g per day. Sodium intake averaged 1,554 mg per day. The average sugar consumption always increases with age, the average in urban areas is 28.4 g per day[12]. Experts at *Puskesmas* (Primary Health Center) Sumbang 2 Banyumas observed a statistically significant correlation between dietary quality and fasting blood glucose levels in patients with type 2 diabetes mellitus. The same correlation was observed for total cholesterol levels.

An unhealthy diet, namely one that is high in glucose, is a modifiable risk factor for DM, as it can raise the likelihood of developing the condition. In addition, one of the managements of DM can be done by paying attention to diet or food intake consumed which is commonly referred to as medical nutrition therapy. A person's calorie and nutrient needs, as well as their preferred eating habits, are the guiding principles of the diet, which emphasizes on the "3Js" (quantity, type, and timing)[13]. Obediently and actively following the prescribed dietary rules characterizes the diet or eating patterns of people with DM. A person's diet may reflect their eating habits if they have diabetes, which can lead to uncontrolled blood glucose levels. Food quality criteria may help to give an idea of what people with DM eat. Consumption of energy, carbohydrate, fat, protein, and fiber all play a role in metabolic disorders, such as glucose and lipid metabolism in people with diabetes, therefore it is important to eat a healthy diet. The effect increases in proportion to the quality of the food. In addition to blood sugar levels.

In accordance with the above contextual information, the researchers were motivated to investigate the relationship between the quality of dietary intake and glycemic control in individuals residing in the city of Yogyakarta with type 2 diabetes mellitus. By 2022, the number of people with type 2 diabetes mellitus increased to 15,588 people from 10,635 people in 2021, as reported by a profile source affiliated with the Yogyakarta City Regional Health Office.

METHODS

The study aimed at identifying correlations between risk factors and their impacts necessitates the use of quantitative methodology in analytical observational research. This study employed a cross-sectional research design, wherein multiple variables were measured simultaneously. A team of researchers in Yogyakarta, Indonesia, used this approach to investigate the correlation between blood glucose levels and food quality in individuals diagnosed with type 2 diabetes mellitus. In this study, purposive sampling was used as the sampling method. May to June 2023 was the study period.

The population in this study were all patients with diabetes mellitus in Yogyakarta Municipality, totaling 63 respondents. The sampling location includes 2 *Puskesmas* (primary health center) in Yogyakarta Municipality, namely Umbulharjo 1 Primary Health Center and Tegalrejo Primary Health Center. This study was calculated using the *Lemeshow* formula. Inclusion criteria such as age 20-59 years, long suffering from DM, outpatients at the Yogyakarta City Health Center, suffering from type 2 DM that has been diagnosed by a doctor, GDS > 200mg/dL or GDP > 126 mg/dL, and patients. The second criterion was exclusion such as incomplete data and patients who were on a special diet or diet other than DM (Mayo and Keto).

The instruments in this study were respondent characteristics, DQI-I *(*Diet Quality Index-International) questionnaire and SQ-FFQ (Semi Quantitative- Food Frequency Questionnaire) questionnaire. Data on respondent characteristics consisted of age, duration of diabetes mellitus, family history, and education level. The SQ-FFQ (Semi Quantitative- Food Frequency Questionnaire) questionnaire is one of the components used to assess diet quality. The SQ-FFQ (Semi Quantitative- Food Frequency Questionnaire) questionnaire has been designed as a questionnaire to ascertain the eating habits of study participants, with adjustments made based on the type of food and location of the study. The aim was to evaluate daily consumption by averaging consumption over the past 30 days. By evaluating four main components-variety, appropriateness, size, and overall balance-the food quality questionnaire (DQI-I) can ascertain total food balance.

The number of questions on the DQI-I questionnaire is 17 questions. The dietary variety component has 2 questions that can be evaluated in two ways, namely the balance of the whole diet and the variety of protein sources. The adequacy component has 8 questions that are evaluated from nutritional elements that must be met in the diet, such as rice group, vegetable group, fruit group, fiber, protein, iron, vitamin C and calcium. The measure component has 5 questions that

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can be evaluated from elements related to chronic diseases and their restrictions. Fatty acids in healthy people are required in greater quantities than those with a history of chronic disease, as is the case with sodium intake. The fourth component, overall balance, has 2 questions that can be evaluated by comparing total energy intake (macronutrient ratio) with total fatty acid intake (fat ratio). The variation component is said to be good if the average score meets half of the total score of 20, the adequacy component is said to be good if the average score meets half of the total score of 40, the third component is the size which is said to be good if the average score meets half of the total score of 30, and the last component is the overall balance which is said to be good if the average score meets half of the total score of 10.

The patient's glucose level was the dependent variable in this study, while diet quality was the independent variable. The variable of diet quality was measured by diet quality questionnaire (DQI-I questionnaire), with interview method and ordinal measuring scale, while the result was the diet quality was said to be low or poor if the total score was ≤ 60, and the diet quality was said to be high or good if the total score was > 60. The variable of blood glucose level was the glucose level in the direction of either during or fasting measured by medical personnel. This variable is measured with a glucometer using the respondent's medical record data and an ordinal measuring scale, while the results are at the current blood glucose level said to be normal if < 200 mg/dl and said to be hyperglycemia if > 200 mg/dl, while at the fasting blood glucose level said to be normal if 70-99 mg/dl and said to be hyperglycemia if > 126 mg/dl.

Before the data collection process was taken for the SQ-FFQ (Semi Quantitative-Food Frequency Questionnaire) questionnaire, expert judgment or validation was carried out to experienced experts with the aim of knowing that the questionnaire used was suitable for use as a research instrument. The ethical number in this study is No.2705/KEP-UNISA/III/2023. For primary data in the form of respondents' food intake, while for secondary data in the form of the results of respondents' blood glucose levels.

Univariate and bivariate analysis were the data analysis methods used. Each item in the DQI-I (Diet Quality Index-International) questionnaire was analyzed univariately, while the Chi Square test and Fisher Exact test were used for bivariate analysis. The Chi Square test relies on the following conditions: There were no zero frequency values in any cell; in the case that the shape of the contingency table was 2x2, no cell could have a value below five; and if the shape of the table exceeded 2x2, the number of frequency cells that had values decreased. Five should not exceed twenty percent of the total compartment area. The relationship between blood glucose levels and food quality was ascertained through the use of bivariate analysis.

RESULTS AND DISCUSSION

Respondent Characteristics

The criteria for respondents in this study are age 20-59 years, long suffering from DM, outpatients at the Yogyakarta City Health Center, suffering from type 2 DM that has been diagnosed by a doctor, GDS> 200mg/dL or GDP> 126 mg/dL, and no mental health problems, and patients are able to communicate well.

Table 1. Respondent characteristics

Characteristics	Total	
	n	%
Age	0	0
20 - 29	3	4.62
30 - 39	11	16.92
40 - 49	51	78.46
50 - 59		
Duration of DM	53	81.54
> 1 year	12	18.46
≤ 1 year		
History from family	56	86.15
Yes	9	13.85
None		
Education Level	11	16.92
Out of school and primary school	38	58.46
Junior high school and senior high school	16	24.62
Higher education (D3, D4, S1, and S2)		
Blood Glucose Levels	40	61.54
Normal glucose levels	25	38.46
Hyperglycemia		

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Characteristics	Total	
	n	%
Drug Consumption	55	84.61
Compliant		
Non-compliant	10	15.38

Based on table 1, it is known that the age group 30-39 years has the lowest incidence of diabetes mellitus as many as 3 people (4.62%), while the largest prevalence is in the age group 50-59 years as many as 51 people (78.46%). Age is one of the risk factors for diabetes mellitus, because among other things it causes resistant problems that cause an imbalance in blood sugar levels with age[14]. Insulin resistance is a physiological state characterized by the inability of muscle cells to receive signals caused by insulin to remove glucose from circulation[15]. This is due to the fact that insulin affects and alters carbohydrate metabolism with age, leading to changes in insulin release in response to blood glucose levels and inhibition of glucose release into cells caused by insulin. Additional research shows that those over the age of 45 have a higher chance of developing diabetes mellitus. This reinforces the idea that the likelihood of contracting diabetes mellitus increases with each passing year. Glucose intolerance, which occurs when the body's ability to metabolize glucose is impaired, is more common with age[16]. The World Health Organization reports that, starting at age 40, fasting blood glucose levels increase by 1-2 mg% and will increase by 5.6% to 13.0% within 2 hours of eating. Diabetes is more common in elderly people. Type 2 diabetes is numerous. Age is associated with an increased risk of developing type 2 diabetes mellitus, according to many studies[17].

In this study, 53 participants (81.54%) had diabetes mellitus for more than one year, while 12 participants (18.46%) had diabetes mellitus for less than one year. The majority of participants had the condition for more than one year. This happens because respondents have a strong desire to get a better life due to their long-term illness. The likelihood of problems increases when diabetes continues for a longer period of time. Various studies have shown a correlation between the length of DM disease and the development of various problems[18].

Based on family history, it was seen that the incidence of type 2 diabetes mellitus was higher in those with a history of the disease (56 cases, or 86.15% of the total) than those without a history of the disease (only 9 cases, or 13.55% of the total). As a genetic disorder, diabetes mellitus increases the chances of one's children also developing type 2 diabetes mellitus if one of the parents has a family history of the disease. This is because their shared genetic makeup makes diagnosis of type 2 diabetes mellitus faster. Having a close relative with type 2 diabetes mellitus increases one's risk of developing the disease, according to several studies[19,20]. Type 2 diabetes mellitus is 10.938 times more likely to occur in someone whose family has the disease than in someone whose family has never had the disease.

Of all the respondents, 38 people (or 58.46%) had their last certificate from junior secondary school or senior secondary school, while 11 people (16.92%) had their last certificate from primary school. Education level refers to the respondent's formal education level. This study classified participants' education level into low (no schooling or elementary school), medium (junior secondary school and senior secondary school) or high (university). People who have completed a longer period of schooling tend to be better informed about health issues and aware of the need to take care of themselves, making it easier for them to accept a diagnosis of a disease when they experience symptoms associated with the disease. Various studies have shown that compared to those with lower education levels, those with higher education levels are less likely to develop type 2 diabetes mellitus.

Table 1 shows that 50 participants (61.54%) had normal blood glucose levels, while 25 participants (38.56%) had hyperglycemia. Every cell and tissue in your body uses glucose, a type of sugar, as an energy source. The amount of glucose in your blood is measured by your blood glucose level. A blood glucose level that is considered normal should be less than or equal to 200 mg/dL.

Diet Quality Overview

Food quality is a measure that can explain the relationship between a person's calorie intake, fat consumption, protein consumption, and fiber consumption; these factors impact the body's metabolic state, such as glucose and lipid metabolism in diabetes. Restoring normal metabolic activity during sugar processing requires careful monitoring of one's diet or eating habits.[2]. The better the diet quality, the better the HbA1c of patients with diabetes mellitus[21]. According to the Diet Quality Index International (DQI-I), the four components of nutritional quality are diversity, adequacy, moderation and overall balance. A score below 60 indicates poor dietary quality, while a higher number indicates poor dietary quality. a rating of 60 indicates that the dish is of moderate quality[22]. The size component is evaluated from elements related to chronic diseases and their restrictions. Fatty acids in healthy people are required in greater quantities than those with a history of chronic disease, as is sodium intake. The overall balance is evaluated from the ratio of total energy intake (macronutrient ratio) to total fatty acid intake (fat ratio). The scoring classification on the variety component is said to be good if the average score is above the median (10) of a total score of 20, the adequacy component is said to be good if the average score is above the median (20) of a total score of 40, the third component is the size which

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is said to be good if the average score is above the median (15) of a total score of 30, and the last component is the overall balance which is said to be good if the average score is above the median (5) of a total score of 10[23].

Table 2. Distribution of diet quality

Component	Score	$\bar{X}$ ± SD
Total DQI-I	0 - 100	62.84 ± 6.28
Variations	0 - 20	18.53 ± 2.37
Sufficiency	0 - 40	24.50 ± 5.13
Size	0 - 30	18.13 ± 3.91
Overall Balance	0 - 10	1.66 ± 2.13

Notes:
$\bar{X}$ ± SD = Average

Table 3. Average DQI-I score

Components	Score	Scoring Criteria	Mean ± SD
Total DQI-I	0 – 100	-	62.84 ± 6.28
Variation	0 – 20	-	18.53 ± 2.37
All food variation	0 – 15	≥1 serving in a food group/day = 15 1 food group not served/day = 12 2 food groups not served/day = 9 3 food groups not served/day = 6 ≥4 servings in a food group/day = 3 None at all = 0	14.4 ± 1.2
Variation among groups for protein sources	0 – 5	≥3 different sources/day = 5 2 different sources/day = 3 1 different source/day = 1 No protein source = 0	4.13 ± 1.36
Adequacy	0 – 30	-	24.50 ± 5.13
Vegetable group	0 – 5	≥3 – 5 servings/day = 5; 0 servings/day = 0	4.7 ± 0.93
Fruit group	0 – 5	≥2 – 4 servings/day = 5; 0 servings/day = 0	4.4 ± 1.35
Cereal group	0 – 5	≥6 – 11 servings/day = 5; 0 servings/day = 0	1.03 ± 0.24
Fiber	0 – 5	≥20 – 30 servings/day = 5; 0 servings/day = 0	1.73 ± 1.25
Proteins	0 – 5	≥10% energy/day = 5; 0% energy/day = 0	3.09 ± 1.29
Iron	0 – 5	≥100% AI/day = 5; 0% AI/day = 0	3.95 ± 1.37
Calcium	0 – 5	≥10% AI /day = 5; 0% AI/day = 0	1.73 ± 1.25
Vitamin C	0 – 5	≥100% RDA/day = 5; 0% RDA/day = 0	3.84 ± 1.49
Size	0 – 30	-	18.13 ± 3.91
Total fat	0 – 6	≤20% of total energy/day = 6 >20-30% of total energy/day = 3 >30% of total energy/day = 0	0.27 ± 1.15
Saturated fat	0 – 6	≤7% of total energy/day = 6 >7-10% of total energy/day = 3 >10% of total energy/day = 0	0.96 ± 2.06
Cholesterol	0 – 6	≤300 mg/day = 6 >300-400 mg/day = 3 >400 mg/day = 0	5.53 ± 1.52
Sodium	0 – 6	≤2,400 mg/day = 6 >2,400-3,400 mg/day = 3 >3,400 mg/day = 0	6 ± 0
Food calories	0 – 6	≤3% of total energy/day = 6 >3-10% of total energy/day = 3 >10% of total energy/day = 0	5.35 ± 1.45
Total Balance	0 – 10	-	1.66 ± 2.13
Macronutrient Ratios (Kh : P : L)	0 – 6	55-65 : 10-25 : 15-25 = 6 52-68 : 9-16 : 13-27 = 4	0. 73 ± 1.71

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Components	Score	Scoring Criteria	Mean ± SD
Fatty acid ratios (PUFA : MUFA : SFA)	0 – 4	50-70 : 8-17 : 12-30 = 2 Other comparisons = 0 P/S = 1-1.5 and M/S = 1-1.5 = 4 Others If P/S = 0.8-1.7 and M/S = 0.8-1.7 = 2 Other comparisons = 0	0.92 ± 1.27

Based on table 2, the total DQI-I score obtained was 62.84 ± 6.28 or > 60 which is included in the good diet quality category. The majority of participants scored poorly on the general balance measurement component. The variation component had a good average score of 18.53 out of a possible 20 points. In fact, based on the SQ-FFQ questionnaire, respondents have not met their daily needs for all food groups, especially those containing animal protein. The average adequacy score is 24.50 out of a total score of 40, this means that the adequacy component is good even though there are still several food groups and nutrients that are not maximally fulfilled per day. The adequacy score for the vegetable and fruit group shows good results (sufficient) but the fulfillment of fiber adequacy is relatively low, it is possible that the amount of fiber contained in the vegetables and fruit consumed is not enough to produce a high fiber score. The food groups and nutrients that are lacking when viewed from the SQ-FFQ questionnaire and Nutrisurvey results are grains, protein, calcium. The foods frequently consumed by respondents are market snacks, ready-to-eat foods and fried foods, where most of these foods do not contain good nutrition, this is what makes the respondents' score on the size or moderation component an average of 18.13 out of a total score of 30. In Overall balance obtained an average score of 1.66 out of a total score of 10, this is caused by consuming carbohydrates at sufficient levels but not yet reaching the recommended daily protein and fat adequacy, resulting in a very low ratio.

Relationship Between Diet Quality and Blood Glucose Levels

One bivariate test is the chi-square test, which looks for a correlation between food quality and blood glucose levels. The diet quality criteria used were good and bad diet quality for DM sufferers, while glucose levels were based on the criteria for hyperglycemia and normal glucose levels. The criteria for diet quality are based on the questionnaire used, while the criteria for glucose levels are based on blood glucose level examination data carried out by respondents.

Table 4. Bivariate chi square test of the relationship between diet quality and blood glucose levels

Diet Quality	Blood Glucose Levels				95% CI	p value (< 0,05)
	Hyperglycemia		Normal			
	n	%	n	%		
Poor Diet Quality	8	12.3	17	26.15	0.716	0.397
Good Diet Quality	17	26.15	23	35.38		

Based on table 3, the data obtained shows that 61.53% of respondents reported a healthy diet, while 38.46% reported a bad diet. This research was conducted on diabetes mellitus sufferers who underwent outpatient examinations at 2 City Health Centers in the Yogyakarta area. The results of the research showed that good quality diets tended to have more blood glucose levels in the normal category, namely 23 people (35.38%) compared to blood glucose levels in the hyperglycemia category, namely 17 people (26.15%). Meanwhile, the results of poor diet quality on blood glucose levels in the normal category tend to be higher, namely 17 people (26.15%) compared to blood glucose levels in the hyperglycemia category, namely 8 people (12.3%).

If you look at the SQ-FFQ and Nutrisurvey questionnaires, there are still many respondents whose food intake is not good enough. This is because many respondents consume foods that are high in sugar, high in fat and low in protein. The carbohydrates consumed by respondents consisted of various types, such as white rice, cassava, sweet potatoes, corn and taro. Apart from that, respondents also consumed a lot of ready-to-eat food such as fried chicken, meatballs, chicken noodles, satay, donuts. Meanwhile, protein consumption is still quite lacking, respondents tend to consume vegetable protein sources rather than animal protein[24].

Medication treatment (drug use) is another consideration. The results of this study showed that the majority of people who participated took their diabetes medication as prescribed. For this medication to help avoid further problems, patients must take it as prescribed. Basically, the magnitude of uncontrolled blood glucose levels is directly proportional to the level of drug use[25]. Education, income or income, and changing eating patterns can be influenced[26,27].

This is influenced by various variables including money and education, as well as changes in eating habits; several additional studies reached similar conclusions, namely that there is no substantial relationship between the quality of a person's diet and blood glucose levels. Apart from that, research by Sepandi et al., 2022 found that blood glucose levels and food quality were not significantly correlated, according to the data; However, food quality is the main risk factor for type 2 diabetes mellitus. Research conducted by Sepandi et al., 2022 was influenced by education, where the prevalence of DM2 was higher in research subjects with a low level of education. So, the low level of education regarding

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nutritional recommendations is directly related to the low quality of the diet. In addition, costs related to diet and food prices also influence diversity in food choices, consuming less diverse foods can cause a decrease in food quality. So, low-income levels are also related to low food quality.

Additionally, researchers in this study evaluated food quality questionnaire items that were associated with blood glucose levels; Overall, individual food quality did not show a statistically significant correlation with either measure. Many food quality factors are significantly correlated with blood glucose levels. Diversity and overall balance are components of this.

Table 5. Bivariate Chi Square Test of Variation Components with Blood Glucose Levels

Components	Blood Glucose Levels				95% CI	p value (< 0,05)
	Normal		Hyperglycemia			
	n	%	n	%		
Variation[A]						
Not good	0	0%	0	0%	0.000	0.000
Good	40	61.53%	25	38.46%		
Adequacy[B]						
Not good	8	12.3%	5	7.69%	0.000	1.000*
Good	32	49.23%	20	30.76%		
Size[A]						
Not good	10	15.38%	3	4.61%	1.625	0.202
Good	30	46.15%	22	33.84%		
Overall Balance[A]						
Not good	39	60%	20	30.76%	5.623	0.018*
Good	1	1.53%	5	7.69%		

[A]Chi-Square test
[B]Fisher Exact test
*p value (< 0,05)

Table 4 shows the results of the Chi-Square test, which shows a statistically significant relationship between blood glucose levels and total and balance variation components. At the same time, there is no correlation between blood glucose levels and the size or adequacy of the components.

First, the p value = 0.000 (p<0.05) indicates a significant relationship between the variation components and blood glucose levels in the Chi-Square analysis carried out on the variation components. Carbohydrates, protein from plants, protein from animals, fruit and vegetables are the five categories of food that form components of variation. Dietary carbohydrates, lipids, and proteins all play a role in regulating blood glucose levels. Higher carbohydrate intake is associated with a higher risk of developing diabetes mellitus. The breakdown and absorption of carbohydrates into monosaccharides, especially sugar, is a process where carbohydrate consumption is related to the occurrence of diabetes mellitus. Blood sugar levels increase and insulin production increases due to the absorption of this sugar. Protein functions as a source of energy, so if consumed in excess of the body's needs it can have an impact on blood sugar levels. When other energy sources such as carbohydrates and fat are not available, the glyconeogenesis process will use protein as an energy source. However, the use of too much protein can lead to excessive degradation of amino acids, which in turn can be precursors to energy sources such as glucose and acetyl-KoA[28]. In addition to providing energy, fat helps with the absorption of vitamins A, D, E, and K. A condition known as insulin resistance and excess body fat can be triggered by consuming excessive amounts of fat. Fat cells in obese people secrete various chemicals that belong to the adipocytokine family. These chemicals make the body less responsive to insulin, which makes it difficult for glucose from the blood to enter cells and causes hyperglycemia, which is an increase in blood sugar levels[29].

Based on the results of the chi-square test (p <0.05), there is a statistically significant correlation between blood glucose levels and overall balance components (p = 0.018). Macronutrient ratios—carbohydrates, proteins, and fats are included in these components. According to Nutrisurvey, the macronutrient to carbohydrate ratio is at the recommended level; However, protein and fat consumption is still insufficient, causing the KH:P:L ratio to be poor. This could be caused by the respondent's poor food intake, in this study respondents tended to consume more carbohydrate and fat sources than protein. Carbohydrates that are often consumed include rice, cassava, taro and sweet potatoes. The protein consumed tends to be mostly vegetable protein in the form of tofu.

In accordance with research by Cheung et al., 2018, this may be caused by confounding variables that influence food quality, but these findings indicate a modest relationship between obesity and type 2 diabetes mellitus in individuals in China. Lifestyle, physical activity level and body weight play a role in this[30]. Dietary quality was significantly associated with fasting blood glucose levels, according to comparable previous studies on cholesterol-related diabetes mellitus. Using a cross-sectional design and the same instruments—SQ-FFQ and DQI-I—both studies are similar to the above studies in that they examine food frequency and nutrients.

The findings of this study suggest that the quality of diabetes patients' diet has no effect on how well their

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blood glucose levels are managed, as the researchers found no correlation between the two variables. Factors such as income, lifestyle and changes in eating habits are among the factors that may cause this. However, there are several components that have a relationship with temporary blood glucose levels, namely the variation component and the overall balance component. Sufferers need to pay attention to some of these components because they can help keep blood glucose levels under control within the normal range. An important component in normalizing metabolic function during sugar processing is diet or diet control, remembering that diet is a factor that can be modified in management of DM[2].

The advantage of this research is that it examines the quality of diet in diabetes mellitus patients, because not many people have studied diet quality using the Diet Quality Index-International (DQI-I) survey. Apart from that, you can also observe the diet of patients suffering from diabetes mellitus. One potential obstacle in this research is the absence of supporting sources that use the DQI-I (Dietary Quality Index-International) questionnaire.

CONCLUSIONS

Patients with type 2 diabetes mellitus did not show a statistically significant correlation between food quality and blood glucose levels, according to the Chi Square test (p value > 0.05). However, blood glucose levels are influenced by a number of dietary quality factors, including overall balance and variety.

Diabetes mellitus sufferers can be given nutritional education and information regarding appropriate eating patterns for diabetes mellitus sufferers so that they can increase knowledge in maintaining a healthy quality of life. Diabetes mellitus sufferers are advised to consume food in accordance with the 3J principles (*Jadwal* - meal schedule, *Jenis* - type and *Jumlah* - amount). Diabetes mellitus sufferers must consider dietary patterns seriously in relation to the components of variation and overall balance, in order to help keep blood glucose levels under control within the normal range. These food groups are carbohydrates, fats and proteins (animal protein). Apart from that, there is another factor, namely that compliance with medication consumption is very important to increase the effectiveness of preventing other complications. In other words, the lower the level of medication consumption, the more uncontrolled blood glucose levels will be.

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