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Relationship Between Nutrition Knowledge, Diet, Glycaemic Index with Blood Sugar Levels of Diabetes Mellitus Patients

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ABSTRACT

Diabetes Mellitus (DM) is one type of degenerative disease that has increased every year in countries around the world, including Indonesia. The purpose of this study was to determine the relationship between nutritional knowledge, diet and glycemic index status with blood sugar levels during type II DM patients at Pasar Ikan City Health Center. Bengkulu in 2024. Methods Analytic observation research with cross sectional design. 55 people with type II DM as a sample taken with simple random sampling technique. Nutritional knowledge was measured using a questionnaire, while diet and glycemic index status were measured using the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) form. Intermittent blood sugar levels were measured using the Nesco Multicheck tool. Univariate and bivariate data analysis was processed using SPSS software with chi square test with a significance value of $\alpha=0.05$. Results: There were 80% of respondents with poor knowledge, 89.5% with poor diet, and 82.1% with high glycemic index status. Conclusion: There is a relationship between nutritional knowledge, diet, glycemic index status, and the biggest influence is diet.

1. Introduction

In 2021, the International Diabetes Federation (IDF) recorded 537 million adults (aged 20-79 years) or 1 in 10 people living with DM worldwide. Diabetes Mellitus (DM) also causes 6.7 million deaths or 1 death every 5 seconds. Indonesia is in the fifth position with 19.47 million people with DM (Chole *et al.*, 2023). Diabetes mellitus is a non-communicable disease characterized by elevated sugar levels due to impaired insulin function. Risk factors of concern for diabetes mellitus are age, gender, decreased physical activity, obesity, hypertension and poor diet. Targeted lifestyle therapy has been shown to be clinically beneficial for the prevention and management of diabetes today (Sinisterra-Loaiza *et al.*, 2019).

Based on the results of the 2018 Riskesdas report, 0.91% of people with DM in Bengkulu Province were recorded. Precisely in Bengkulu City in 2018 as many as 1.28% (3,334 people) had DM sufferers. The highest prevalence of DM is in the age group 55-75 years. However, its development at a younger age - even in children and adolescents - is associated with a higher incidence of obesity, sedentary lifestyle, and unhealthy diet, It is characterized by a decrease in tissue sensitivity to insulin (insulin resistance), along with a decrease in pancreatic β -cell mass and function (IDF, 2021).

Diabetes mellitus is a metabolic disorder in which the body cannot produce or properly use insulin, a hormone needed to convert sugar, starch, and other foods into energy. The absence or reduction of insulin can lead to persistently high blood sugar levels and abnormal glucose tolerance. Diabetes mellitus is probably the oldest disease known to man and it is also called the black death of the 14th century (Musaiger, 2018). Diabetes mellitus is a chronic disease characterized by instant blood glucose levels of more than 200 mg/dL and fasting blood sugar levels of more than 126 mg/dL. Diabetes mellitus is known as the silent killer because often the sufferers are not aware of it and when it is known that there have been complications (Kementrian Kesehatan, 2022).

Glucose is one form of carbohydrate metabolism that serves as the main source of energy controlled by insulin. Excess glucose is converted into glycogen and then stored in the liver and muscles as a reserve if needed by the body . Blood glucose levels are influenced by endogenous and exogenous factors. Endogenous factors are humoral factors such as the hormones insulin, glucagon, cortisol, receptor systems in muscle and liver cells, while exogenous factors that influence are food intake (Tri *et al.*, 2023).

Patients' knowledge about diabetes mellitus (DM) is a crucial tool that helps them manage the condition throughout their lives. It enables patients to better understand their disease, the necessary behavior changes, and the reasons behind these changes. Knowledge about DM encompasses the four pillars of DM management: DM education, meal planning, physical exercise, and pharmacological therapy. Nutritional knowledge, a cognitive aspect, reflects an understanding of the science of nutrition, types of nutrients, and their interaction with nutritional and health status. A person's nutritional knowledge influences their attitudes and behaviors in choosing food, which determines how easily they can understand the benefits of the nutritional content they consume (Olatona, 2019).

Diet is one of the important factors that determine obesity and affect insulin resistance. The principles of eating for diabetics are almost the same as the dietary recommendations for the general public, which is to have a balanced diet according to the calorie and nutritional needs of each individual. Patients with diabetes must understand how to manage their daily diet properly. This includes a meal schedule, typically consisting of 6 meals a day, divided into 3 main meals and 3 snacks. Attention must be given to the type of food, as it determines the rate at which blood sugar levels rise. Proper food preparation, including the management of carbohydrate intake, is essential (Susanti & Nobel, 2018). Dietary intake is a major determinant of blood glucose levels; therefore, to achieve normal glucose levels, it is crucial to make food choices that induce a normal postprandial (post-meal) glycemic response (Zeevi *et al.*, 2021).

The glycemic index of a food indicates the potential of its available carbohydrates to raise blood sugar levels, ranking foods according to their effect on blood glucose levels. Consuming foods with a high glycemic index causes the release of large amounts of insulin due to the rapid and significant rise in blood sugar levels. This can lead to increased hunger after meals and fat accumulation in the body's adipose tissue (Wari *et al.*, 2023). So far, no research has analyzed the relationship between nutritional knowledge, dietary patterns, and the consumption of foods with different glycemic indices simultaneously.

2. Methods

The design of this study was cross-sectional and was conducted in May 2024. The inclusion criteria for the subjects were type II DM patients in the working area of the Pasar Ikan Health Center, Bengkulu City, who were willing to participate, physically and mentally healthy, having good awareness, and aged between 40 and 65 years. Exclusion criteria included being unable to attend the study, being physically ill and unable to participate, and being unwilling to become research respondents.

The independent variables consisted of nutrition knowledge, diet, and glycemic index status, while the dependent variable was type II diabetes mellitus. In the research method, a temporary blood sugar checking device (GDS) using Nesco Multicheck, made in Taiwan in 2010 and produced by PT. Djuniar & Djuniar, Jakarta-Indonesia, was used. (How to use: 1. Insert the test strip into the test strip slot; the meter automatically turns on. 2. Insert the sample and obtain a drop of blood using the sample collection procedure described above. 3. Read the result in 10 seconds. The result will be automatically stored. 4. Turn the meter off by removing the test strip). A nutrition knowledge questionnaire with 15 items made by Sundari (2020), which has been tested for validity, was used to measure nutrition knowledge with scores as follows: 1 = Poor (<60%), 2 = Medium (60-80%), 3 = Good (80%).

A Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) was used to determine the frequency and number of servings consumed by respondents in the last month to measure diet. The scoring for diet measurement was as follows: 1 = Poor (0-10) if the respondent's food consumption behavior does not align with the 3J principle (Schedule, Type, and Amount) and daily nutritional needs, 2 = Fair (11-20) if the respondent's behavior somewhat aligns with the 3J principle and daily nutritional needs, 3 = Good (21-30) if the respondent's behavior aligns with the 3J principle and daily nutritional needs (Marpaung *et al.*, 2022). The food consumption glycemic index status was measured with scores as follows: 1 = Low (<55) if a person rarely consumes carbohydrate-rich foods, 2 = Moderate (55-70) if a person's consumption of carbohydrate-rich foods is moderate, and 3 = High (>70) if a person often consumes carbohydrate-rich foods (Jennie, 2003).

The SQ-FFQ form was created by Dr. Meriwati, a lecturer in the Department of Nutrition at Poltekkes Kemenkes Bengkulu. This study was approved by the Ethics Committee of the Health Polytechnic of the Ministry of Health Bengkulu with No.KEPK.BKL/276/05/2024. It was conducted in the working area of the Pasar Ikan Health Center, Bengkulu City, in May 2024. A total of 55 respondents were selected using the purposive sampling method. The sample calculation, based on the Lemeshow 1990 formula, with an error rate (α) of 5% and power (β) of 10%, resulted in a total of 492 subjects. An additional 10% was added to account for potential loss of subjects or incomplete questionnaire data, bringing the minimum number of subjects to 55 people.

The sample size calculation uses the formula (Lemeshow 1990) if the population (N) is:

$$n = \frac{N \cdot z^2 \cdot 1 - \alpha / 2 \cdot p \cdot q}{d^2 \cdot (N - 1) + z^2 \cdot 1 - \alpha / 2 \cdot p \cdot q}$$

Note:

n = Minimum sample size required = degree of confidence

p = proportion = (0.2)

q = 1- p

d = limit of error or absolute precision (10%)

Z² 1- α/2= Z statistic (Z = 1.96 for α = 0.05)

N = Population Size

Then:

$$n = \frac{N \cdot z^2 \cdot 1 - \alpha/2 \cdot p \cdot q}{d^2 (N - 1) + z^2 \cdot 1 - \alpha/2 \cdot p \cdot q}$$

$$n = \frac{492 \cdot 1,96^2 \cdot 0,2 (1 - 0,2)}{(0,1)^2 (492 - 1) + 1,96^2 \cdot 0,2 (1 - 0,2)}$$

$$n = \frac{492 \cdot 3,8416 \cdot 0,2 \cdot 0,8}{0,01 \cdot (491) + 3,8416 \cdot 0,2 \cdot 0,8}$$

$$n = \frac{302,41}{5,52}$$

n = 55 Respondents

Based on the formula above, the sample for this study was 55 respondents.

3. Results and Discussion

The results of the research conducted obtained data on the characteristics of respondents (age and gender) in table 1.

Tabel 1. Respondent Characteristics I

Respondent Characteristics	n	%
Age		
40 – 55 years	34	61,8
56 – 65 years	21	38,2
Gender		
Famale	35	63,6
Male	20	36,4

Source : Research Results, 2024

Table 1 shows that in the age category of 40-55 years, there were 34 respondents (61.8%). In the gender category, most respondents were female, with 35 respondents (63.6%). This study indicates that the age of 40-55 years is considered middle age, a period characterized by significant physical and psychological changes. The body's ability gradually decreases during this time, leading to an increase in blood glucose levels. As a result, the prevalence of diabetes mellitus (DM) and impaired blood sugar tolerance increases with age (Kosegeran, 2017).

Table 1 also shows that the majority of respondents in this study were female, with 35 individuals (63.6%). This finding suggests that women have a higher risk of suffering from diabetic neuropathy complications related to parity and pregnancy, both of which are factors in the occurrence of diabetes mellitus (DM). The higher number of women affected by DM is partly because women have a life

expectancy nine years longer than men. Consequently, the greater number of elderly women leads to a higher prevalence of type 2 DM among women.

Table 2. Respondent Characteristics II

Respondent Characteristics		n (55)	%
Nutrition Knowledge	Less	30	54,5
	Medium	23	41,8
	Good	2	3,6
Diet	Bad	38	69,1
	Enough	16	29,1
	Good	1	1,8
Glycemic index status food consumption	Low	1	1,8
	Medium	15	27,3
	High	39	70,9
Current blood sugar	Abnormal	40	72,7
	al	15	27,3
	Normal		

Source: Research Results,2024

Table 2 shows that the nutritional knowledge of most respondents is less knowledgeable as many as 30 people (54.5%), in the dietary pattern variable most respondents have a poor diet, 38 people (69.1%), and the status of glycemic index food consumption has a high status as many as 39 people (70.9%), and respondents who have abnormal blood sugar levels as many as 40 respondents (72.7%).

Table 3. The relationship between nutritional knowledge and blood sugar levels in patients with type 2 diabetes

Nutrition Knowledge	Interval blood sugar levels				Total		<i>p-Value</i>
	Abnormal		Normal		n	%	
	n	%	n	%			
Less	24	80.0	6	20.0	30	100	0.044
Medium	16	69.9	7	30.4	23	100	
Good	0	0.0	2	100	2	100	
Total	40	72.7	15	27.3	55	100	

Source: Research Results,2024

Table 3 shows that among the 30 people suffering from type II DM, 24 respondents (80%) have insufficient knowledge, while among the 23 people with type II DM, 16 respondents (69.6%) have moderate knowledge. All type II DM patients with good knowledge (2 people) have normal blood sugar levels. The results of the Chi-Square test show a significant relationship between nutritional knowledge and blood sugar levels in type II DM patients, with a p-value of <0.044 (<0.05). This research indicates that, among the 55 respondents, better nutritional knowledge is associated with better blood sugar levels, and vice versa. Among the 40 respondents with insufficient knowledge, 24 had abnormal blood sugar levels. Of the 15 respondents with moderate knowledge, 7 had normal blood sugar levels, and the 2 respondents with good knowledge had normal blood sugar levels. This demonstrates that nutritional knowledge significantly influences blood sugar levels. Individuals with good knowledge can better control their blood sugar levels.

Patients' knowledge about DM is a crucial tool for managing the disease throughout their lives, helping them understand their condition. DM knowledge includes the four pillars of DM management: education, meal planning, physical exercise, and pharmacological therapy (Sundari, 2020). There is an important correlation between good nutritional knowledge and improved blood glucose control compared to those with moderate or poor scores (Ahmed et al., 2024).

Patient knowledge about diabetes mellitus is essential for a smooth healing process. Individuals with high knowledge are more successful in managing their condition, preventing uncontrolled diabetes and complications (Sami et al., 2020). This data highlights the importance of specific, targeted knowledge in changing attitudes and encouraging a family approach to lifestyle change. Such information is critical when formulating behavior change strategies (Waidyatilaki, 2019). Nutrition knowledge and skills enable individuals with type 2 diabetes (T2DM) to make informed food choices that optimize metabolic self-management and quality of life. Improving patients' knowledge of the disease and its complications significantly benefits adherence to treatment and reduces complications associated with the disease (Fanny et al., 2021).

Table 4. The relationship between diet and blood sugar levels in patients with type 2 diabetes

Diet	Interval blood sugar levels				Total		p-Value
	Abnormal		Normal				
	n	%	n	%	n	%	
Low	36	89.5	4	10.5	1	100	0.000
Enough	4	37.5	10	62.5	15	100	
Good	0	0.0	1	100	39	100	
Total	40	72.7	15	27.3	55	100	

Source: Research Results, 2024

Table 4 shows that of the 38 people with type II DM, 34 respondents (89.5%) had a poor diet. Among the 16 people with type II DM, 10 respondents (62.5%) had a moderate diet, and one respondent (100%) had a good diet. The results of the Chi-Square test show a significant relationship between diet and blood sugar levels in type II DM patients, with a p-value of <0.000 (<0.05). This research indicates that among the 55 respondents, a better diet is associated with better blood sugar levels, and vice versa. Specifically, of the 40 respondents with a poor diet, 34 had abnormal blood sugar levels. Among the 15 respondents with a moderate diet, 10 had normal blood sugar levels, and the single respondent with a good diet had normal blood sugar levels. This shows that diet significantly influences blood sugar levels in the body.

Based on interviews with respondents about their diets, it was found that poor dietary habits were due to a lack of knowledge about proper portion sizes and timing, leading to large portion sizes and continued consumption of sugar and white rice instead of substituting with brown rice. Diet compliance involves adhering to dietary guidelines emphasizing the "3J" principles: the right time, the right type, and the right amount (Wahyuni et al., 2023).

A person's calorie and nutrient needs, as well as their preferred eating habits, should follow dietary guidelines that emphasize the "3J" principles. Adhering to these dietary rules reflects good dietary habits, which are crucial for controlling blood glucose levels (Zulkarnaina et al., 2022).

Diet quality can be affected by unhealthy eating habits or overeating. To avoid non-communicable diseases (NCDs), a healthy diet should include a variety of foods containing sufficient micronutrients and adhere to World Health Organization (WHO) guidelines. A high-quality diet can help control blood glucose levels and prevent other complications (Cheung et al., 2018). A sensible or healthy diet, characterized by high consumption of vegetables, fruits, fish, poultry, and whole grains, is associated

with a reduced risk of diabetes. The protective effect of fruits and vegetables on the development of diabetes could be attributed to antioxidants (Yu *et al.*, 2011).

Table 5. Relationship between glycemic index status food consumption and blood sugar levels in patients with type 2 diabetes

Glycemic index status food consumption	Interval blood sugar levels				Total		<i>p-Value</i>
	Abnormal		Normal		n	%	
	n	%	n	%			
Low	1	100	0	0	1	100	0,027
Medium	7	46,7	8	53,3	15	100	
High	32	82,1	7	17,9	39	100	
Jumlah	40	72,7	15	27,3	55	100	

Source: Research Results,2024

Table 5 shows that of the 39 people with type II DM, 32 respondents (82.1%) have a high glycemic index status. Among the 15 people with type II DM, 8 respondents (53.3%) have a moderate glycemic index status, and one respondent (100%) has a low glycemic index status. The results of the Chi-Square test showed a significant relationship between food consumption with glycemic index status and blood sugar levels in type II DM patients, with a p-value of <0.027 (<0.05). This research indicates that of the 40 respondents with a low glycemic index status, only 1 had abnormal blood sugar levels. Of the 15 respondents with a moderate glycemic index status, 8 had normal blood sugar levels. Of the 39 respondents with a high glycemic index status, 32 had abnormal blood sugar levels. This shows that a low glycemic index (GI) status significantly affects blood sugar levels, and vice versa.

Interviews conducted by researchers revealed that not only nutritional knowledge and diet but also food consumption and glycemic index status affect the control of blood sugar levels. Consuming foods high in carbohydrates continuously can increase blood sugar levels. Examples of commonly consumed foods with a high glycemic index include rice, carrots, bananas, and sugar. Consuming these foods in large quantities, beyond recommended levels, can cause an increase in blood sugar levels, making it difficult for the pancreas to convert glucose into energy and inhibiting insulin production in the body.

According to the International Diabetes Federation, type 2 diabetes (T2D) is a significant and growing problem, with high and rising costs to society. Modifiable lifestyle choices affecting one's risk include being overweight or obese (especially central obesity), smoking, low physical activity, and consumption of a diet rich in refined grains and alcohol and low in dietary fiber and whole grains. Diets with a high glycemic index (GI) have also been reported to increase the risk of metabolic conditions (Livesey, 2019).

Foods with a high glycemic index are commonly found in sugary foods and drinks because they contain very high levels of glucose. Foods high in carbohydrates, such as rice, potatoes, and bread, are quickly digested and absorbed, leading to rapid increases in blood glucose levels (Papanikolaou, 2018).

Carbohydrates in foods that break down quickly during digestion have a high glycemic index. Conversely, if carbohydrates are broken down slowly, releasing glucose into the blood gradually, the glycemic index will be low. Frequent consumption of foods with a high glycemic index (GI) is positively associated with an increased risk of diabetes mellitus (Geil, 2004).

One factor affecting carbohydrate metabolism is the glycemic index. Low insulin receptors and high carbohydrate intake can cause increased glucose levels in the blood due to the metabolism of consumed carbohydrates (Lilmawawti *et al.*, 2022). Consuming foods with a high GI value leads to the storage of some carbohydrates as glycogen, with the rest converted into body fat and protein, resulting in significant fat accumulation if repeated over a long period. This accumulation can cause central obesity (Wari *et al.*, 2023).

Evaluating food quality and recognizing appropriate indices for better glycemic control and improved lipid profiles can be used to present effective nutritional recommendations to address existing nutritional problems (Ziaee *et al.*, 2021). Glycemic status, adjusted for age, gender, diabetes duration, and insulin use as covariates, shows that age and gender are associated with hedonic hunger, while diabetes duration and insulin use affect body weight and appetite (Cheung *et al.*, 2018).

The use of glycemic index (GI) and glycemic load (GL) to rank dietary carbohydrates according to their effect on glycemia remains a concern for diabetics and those at risk for diabetes. As defined by Brand-Miller, "GI provides a summary measure of postprandial glycemia. It predicts peak (or near-peak) responses, maximum glucose fluctuations, and other response attributes" (Evert *et al.*, 2019).

Table 6. The relationship between nutritional knowledge, diet and food consumption with glycemic index status and blood sugar levels in patients with type 2 diabetes

Variabel	<i>p-valuee</i>
Nutrition Knowledge	0,471
Glycemic index status food consumption	0,337
Diet *	0,005

Description: * The most related logistic regression.

Table 6 shows that variables with p -value <0.05 include GDS, nutritional knowledge, diet, and food consumption of glycemic index status. Diet is the most significant factor associated with blood sugar levels in patients with diabetes mellitus, according to multivariate logistic regression analysis shows that the most dominant factor associated with blood sugar levels in patients with type II diabetes mellitus is diet, with a p -value of 0.0005.

4. Conclusions

Based on the research data collected through field interviews, it can be concluded that almost all respondents have poor nutritional knowledge, as the community remains indifferent to the diseases they suffer. The data also indicate that almost all respondents have poor dietary habits, consuming food that does not align with the 3J principles (schedule, type, and amount). Additionally, the research shows that nearly all respondents consume foods with a high glycemic index (such as rice, carrots, bananas, and granulated sugar). If these foods are consumed continuously and in large portions, they will increase sugar levels in the body.

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