



The Relationship of a Balanced Diet with Blood Pressure and Blood Sugar in Patients with type 2 Diabetes Mellitus in Urang agung Sidoarjo Village

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ABSTRACT: Type 2 diabetes mellitus (T2DM) causes metabolic disorders related to a pathological condition characterized by an increase in glucose concentration in the bloodstream beyond a set threshold (hyperglycemia). Hyperglycemia often accompanies metabolic syndrome especially involving hypertension which can worsen complications in people with diabetes. One effective way to control blood sugar and blood pressure levels is by implementing a balanced diet. There are 50 people with T2DM in the village of Urang Agung Sidoarjo with an increase of 1-3 people every month. The purpose of this study was to determine the relationship between a balanced diet with blood pressure and blood sugar levels measured by the GOD-POD method. This research is a quantitative study using chi-square analysis. The study sample of 44 people was taken with purposive sampling technique. The results showed that blood sugar levels were significantly associated with blood pressure, especially systole in patients with T2DM. In addition, a balanced diet was also found to be significantly related to blood sugar levels, but not significantly related to blood pressure.

KEYWORDS: Balanced Diet, Blood Sugar, Blood Pressure, T2DM

INTRODUCTION

Hypertension and diabetes mellitus are still major threats to public health in the world. The two diseases are even the leading cause of death in the world (Ruksakulpiwat et al., 2024). When these cardio-metabolic conditions coexist in a person's body, glycemic and cardiovascular disorders will occur (Alhassan et al., 2022). Both diseases even have relatively similar risk factors including dyslipidemia, family history, complications and lifestyle, especially a balanced diet. Recommendations for a balanced diet in patients with type 2 diabetes need to be based on personal choice, access to food and the patient's ability to make behavioral changes. This is because there is no single composition of carbohydrate, protein, and fat intake that is optimal for each patient. Instead, an individually selected balanced diet that emphasizes foods that have health benefits, minimizes foods that are proven to be harmful, and accommodates individual preferences with the goal of identifying viable healthy eating habits is highly recommended. Furthermore, a balanced diet also needs to be supported by fasting activities for patients treated with insulin, individualized education, and good medication management (Davies et al., 2022). There is ample evidence to suggest that diabetics with a healthy lifestyle, not smoking, limiting alcohol consumption, keeping fit, and eating a healthy diet can reduce the risk of hypertension and diabetes mellitus (Hu et al., 2022). Research in Australia shows that four key healthy lifestyle factors including not smoking, not drinking alcoholic beverages, a balanced healthy diet are associated with a reduced risk of hypertension (Nguyen et al., 2019). Similarly, research in China shows that adherence to a healthy lifestyle can reduce the risk of hypertension (Gao et al., 2022). Several studies in Indonesia also show that there is a significant relationship between a healthy lifestyle and blood sugar levels in patients with diabetes mellitus. In addition, a healthy diet, rest and exercise done in a balanced manner can control normal blood sugar levels (Rahmatiah & Yakub, 2022). Other studies have also shown that adherence to a diet program is one of the factors to stabilize blood sugar levels and to prevent complications (Aminah et al., 2021). Data from the International Diabetes Federation (IDF) shows that the number of people with diabetes in the world in 2021 reached 537 million. This figure is predicted to increase to 643 million by 2030 and 783 million by 2045. According to IDF, Indonesia is the fifth most diabetic country with 19.5 million people in 2021 and is predicted to reach 28.6 million by 2045 (Rokom, 2024). Almost all Indonesian provinces have experienced an increase in the number of people with diabetes mellitus, with East Java province occupying the fifth largest position with a percentage of 2.02%. Meanwhile, at the district and city level, Sidoarjo Regency contributed 7.8% to the number of people with diabetes mellitus in East Java (Budiarti et al., 2021). Data from the Sidoarjo District Health Office in 2022 shows that the number of people with hypertension and diabetes mellitus is still very high. One



empirical evidence shows that in Urang Agung Village, Sidoarjo Regency, there are 50 people with type 2 diabetes with an increase of 1-3 people every month in 2021. Various efforts from the government continue to be made by providing health services according to standards, which include blood pressure measurement, to education about lifestyle, especially on a balanced diet (Dinkes Sidoarjo, 2022). Therefore, based on theoretical phenomena and empirical data, this research is expected to be a reference study regarding the relationship between blood sugar levels, blood pressure, and a balanced diet in type 2 diabetes patients.

METHODS

This study is a quantitative study to determine the relationship between blood sugar levels, blood pressure, and a balanced diet in patients with type 2 diabetes. This research was conducted from May to June 2024 in Urang Agung Village. Blood pressure examination was carried out at the time of sampling in Urang Agung Village, but the examination of blood glucose levels was carried out at the RA Basoeni Laboratory, Mojokerto Regency. The population of this study were residents of Urang Agung village who suffered from type 2 diabetes. The study sample of 44 people was taken by purposive sampling method with the criteria that elderly residents in Urang Agung Village who suffer from type 2 diabetes aged over 40 years. The variables analyzed were blood pressure, blood sugar levels, and a balanced diet. Blood pressure was measured with a digital tensimeter, while blood sugar was measured using a sample of blood sugar during which this study used 1 recipe with the endpoint method. Meanwhile, a balanced diet was measured using a questionnaire with answer options 1 (often), 2 (rarely), and 3 (never). The data were then statistically processed using chi-square analysis. Data processing was carried out using the SPSS 25.0 program. The results of the analysis are then determined based on the p-value, where if the resulting p-value is smaller than 0.05, it is concluded that there is a significant relationship between the analyzed variables (Ghozali, 2018).

RESULT AND DISCUSSION

Table 1. Profile of T2DM Patients

Characteristics	Total	
	N	%
Age		
40-60 years	23	52.3
61-80 years	21	47.7
Gender		
Male	7	15.9
Female	37	84.1
Systole		
Normal (< 130 mmHg)	5	11.4
High (> 130 mmHg)	39	88.6
Diastole		
Normal (< 85 mmHg)	20	45.5
High (> 85 mmHg)	24	54.5
Blood Sugar Levels		
Normal (< 200 mg/dl)	1	2.3
High (> 200 mg/dl)	43	97.7
Balanced Diet		
Often	3	6.8
Rarely	24	54.5
Never	17	38.6

The description of the research sample in Urang Agung Village showed that most of the samples were aged 40-60 years with a percentage of 52.3%, while the rest were aged 61-80 years (47.7%). When viewed in terms of gender, it is known that samples with female gender dominate as type 2 diabetes patients, with a percentage reaching 84.1%. The results of the health examination which includes checking systolic and diastolic blood pressure show that most diabetics have high blood pressure, namely 88.6% with high systolic blood pressure (>130 mmHg), and 54.5% with high diastolic blood pressure (>85 mmHg). The results of random sugar level examination showed that almost all patients with type 2 diabetes had high sugar levels (>200 mm/dl) with a percentage of 98%. In the next measurement, it can be seen that most patients with type 2 diabetes rarely apply a balanced diet (54.5%), while the rest show that they never apply a balanced diet (38.6%), and a small proportion often apply a balanced diet (6.8%). Based on the results of this description, an intervention is needed to provide education on the importance of a balanced diet to improve the health status of the community, especially for people with type 2 diabetes in Urang Agung Sidoarjo Village.

To get an overview of the data description of blood pressure and blood sugar levels of type 2 diabetics, Box-Plot was used. Box-Plot can provide a good visualization to summarize the distribution of data including also presenting measures of central tendency, measures of data spread, and identifying outliers (Mazarei et al., 2024)

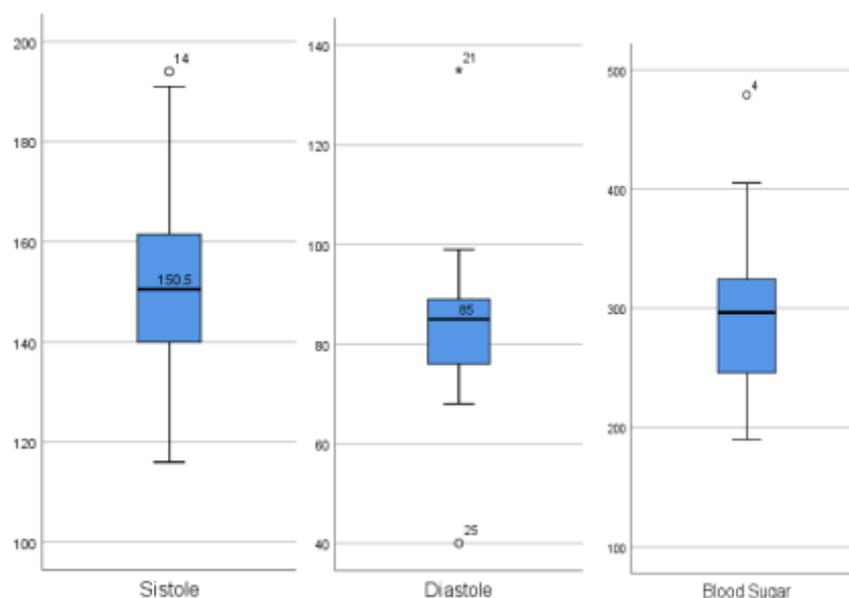


Figure 1. Boxplot of Blood Pressure and Blood Sugar of T2DM Patients

The median values of systolic and diastolic blood pressure of type 2 diabetics are 150.50 mmHg and 85 mmHg, respectively. These median values indicate that people with type 2 diabetes tend to have high blood pressure (hypertension). Meanwhile, the median value of the patient's blood sugar level is 296.5 mg/dl, which shows hyperglycemic symptoms in type 2 diabetics in this study. The systolic blood pressure distribution of the patients is between 116-194 mmHg, while the diastolic blood pressure is between 40-135 mmHg. Meanwhile, the patient's blood sugar level is between 190-479 mm/dl. When compared between the two types of blood pressure, it can be seen that systolic blood pressure has a larger data distribution when compared to diastolic. This is indicated by the Whisker line on systolic blood pressure which is wider than the diastolic blood pressure. Outlier detection through Box-Plot shows that there is 1 patient who has a systolic blood pressure very different from the average patient in general, which is 194 mmHg. Outliers in diastolic blood pressure data show that there are 2 patients who have diastolic blood pressure very different from the average of other patients, namely 40 mmHg and 135 mmHg. Meanwhile, in the blood sugar data, there is 1 patient with a sugar level of 479 mm/dl which is detected as an outlier. Chi-square analysis was used to determine the relationship between a balanced diet and blood pressure and blood sugar levels. If the resulting p-value <0.05 ($\alpha=5\%$), then there is a significant relationship between the two variables analyzed.



Table 2. The Relationship Between Blood Sugar and Blood Pressure in Patients with T2DM

		F	Blood Sugar		Total	P-Value
			Normal	Hyperglycemia		
Sistole	Normal	F	1	4	5	0.005
		%	20.0	80.0	100.0	
	High	F	0	39	39	
		%	0.0	100.0	100.0	
Total		F	1	43	44	
		%	2.3%	97.7	100.0	
Diastole	Normal	F	1	19	20	0.268
		%	5.0	95.0	100.0	
	High	F	0	24	24	
		%	0.0	100.0	100.0	
Total		F	1	43	44	
		%	2.3%	97.7	100.0	
Blood Pressure	Normal	F	1	5	6	0.011
		%	16.7	83.3	100.0	
	Hypertension	F	0	38	38	
		%	0.0	100.0	100.0	
Total		F	1	43	44	
		%	2.3%	97.7	100.0	

Based on Table 2, it can be seen that almost all patients with type 2 diabetes who became research samples had high blood sugar (hyperglycemia), as many as 43 people (97.7%). Table 2 shows that all patients who have high systolic blood pressure suffer from hyperglycemia, as many as 39 people (100%). Meanwhile, of the 5 people who had normal systolic blood pressure, 4 people (80%) of them suffered from hyperglycemia, while the remaining 20% had normal blood sugar. The resulting p-value of 0.005 (<0.05) indicates a significant relationship between systolic blood pressure and blood sugar levels, where patients who have high systolic blood pressure tend to experience hyperglycemia. Table 2 shows that all patients who have high diastolic blood pressure suffer from hyperglycemia, as many as 24 people (100%). Meanwhile, of the 20 people who had normal diastolic blood pressure, almost all of them also suffered from hyperglycemia, as many as 19 people (95%). The resulting p-value of 0.268 (>0.05) indicates no significant relationship between diastolic blood pressure and blood sugar levels, where both patients who have normal and high diastolic blood pressure tend to experience hyperglycemia. The overall test results regarding the relationship between blood pressure and blood sugar levels show a p-value of 0.011 (<0.05) which means there is a significant relationship between blood pressure and blood sugar levels in type 2 diabetes patients, where diabetics tend to have high blood pressure (hypertension). Blood pressure increases with age and the risk of hypertension in the elderly. Hypertension is the result of a complex interaction between genetic, metabolic and behavioral factors. In type 2 diabetes mellitus, insulin resistance occurs. Insulin resistance can trigger hypertension by activating the sympathetic nervous system and impairing the suppression of the renin-angiotensin system (RAS), thereby increasing sodium retention. Diabetes leads to increased vascular activity and vascular smooth muscle cell proliferation, which is thought to play an important role in the development of hypertension (Suharto & Nurseskasatmata, 2020). Patients with diabetes have higher coronary plaque atherosclerosis. Hyperglycemia is one of the important factors for coronary plaque atherosclerosis. Hyperglycemia alters vascular tissue at the molecular level by increasing oxidative stress and pro-inflammatory responses and increasing glycation end products (AGEs), and protein kinase C (PKC) activation, which together promote the development of atherosclerosis and coronary atherosclerosis plaques. This condition causes hypertension in patients with type 2 diabetes mellitus (Suharto & Nurseskasatmata, 2020). In hyperglycemia conditions, the oxidation process between blood sugar and proteins that occurs in blood vessels can increase glycation end products (AGEs). AGEs can then cause damage to the inside of the blood vessel wall and attract cholesterol to the blood vessel wall resulting in an inflammatory reaction that causes the blood vessels to become inelastic, and eventually blockage occurs resulting in hypertension (Roniawan et al., 2021).



The relationship between blood pressure and blood sugar levels emphasizes the importance for people with type 2 diabetes to monitor and control both to stay within normal limits. This control process has great benefits, especially in hypertensive patients who also have type 2 diabetes as it can reduce the risk of complications (Eliati & Fajarnita, 2024).

Table 3. The Relationship Between Balanced Diet and Blood Pressure in Patients with T2DM

		Blood Pressure		Total	P-Value	
		Normal	Hypertension			
Balanced Diet	Often	F	1	2	0.360	
		%	33.3	66.7		100.0
	Rarely	F	4	20		24
		%	16.7	83.3		100.0
	Never	F	1	16		17
		%	5.9	94.1		100.0
Total		F	6	38	44	
		%	13.6	86.4	100.0	

Table 3 shows that most of the type 2 diabetics in the study sample had hypertension, as many as 38 people (86.4%). Table 3 also shows that diabetics who often apply a balanced diet, 66.7% of them experience hypertension, while the rest have normal blood pressure. The same thing also happened to patients who rarely or never applied a balanced diet, where almost most of the diabetics experienced hypertension. The resulting p-value is 0.360 (>0.05) which indicates there is no significant relationship between a balanced diet and blood pressure, where patients who often, rarely, or never apply a balanced diet tend to experience hypertension.

Table 4. The Relationship Between Balanced Diet and Blood Sugar of Patients with T2DM

		Blood Sugar		Total	P-Value	
		Normal	Hyperglycemia			
Balanced Diet	Often	F	1	2	0.001	
		%	33.3	66.7		100.0
	Rarely	F	0	24		24
		%	0.0	100.0		100.0
	Never	F	0	17		17
		%	0.0	100.0		100.0
Total		F	1	43	44	
		%	2.3	97.7	100.0	

Based on Table 4, it can be seen that almost all patients with type 2 diabetes who became the research sample experienced hyperglycemia, namely 43 people (97.7%). Table 4 shows that all type 2 diabetics who rarely or never apply a balanced diet, namely 24 people and 17 people respectively, experience hyperglycemia. Meanwhile, of all type 2 diabetics who often apply a balanced diet, 66.7% of them experience hyperglycemia and the remaining 33.3% have normal blood sugar. The resulting p-value is 0.001 (<0.05) which indicates a significant relationship between a balanced diet and blood sugar levels, where type 2 diabetics who are further away from a balanced diet behavior, tend to experience hyperglycemia. Dietary management of patients with diabetes mellitus is aimed at minimizing the intake of sugar and fat which can reduce the intake of glucose in the body, so that the use of energy in the body can draw on stored energy reserves. If glucose is converted into energy, it can reduce blood glucose levels (Ardiani et al., 2021). In addition, a balanced diet allows patients to regulate the amount and type of food intake into the



body, because if you put too much food into the body, glucose will be difficult to enter the cells so that it can increase blood glucose levels (Ritonga & Ritonga, 2020).

CONCLUSIONS

The results of data analysis and discussion provide conclusions that blood pressure is significantly related to blood sugar with type 2 diabetes, where the higher the blood pressure of diabetics, it will be followed by high blood sugar levels. Another thing that can be concluded is that a balanced diet is not significantly related to blood pressure, but is significantly related to blood sugar levels. This study is a cross-sectional study so it cannot be widely generalized. Second, in addition to the limited number of samples, in this study the measurement of blood pressure, blood sugar, and a balanced diet was carried out at one time so that this study could not determine the fluctuations in measurement results at different time points to get more consistent results.

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APPENDIX

Usia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	40-45 tahun	23	52.3	52.3	52.3
	46-50 tahun	21	47.7	47.7	100.0
	Total	44	100.0	100.0	

Jenis Kelamin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Pria	7	15.9	15.9	15.9
	Wanita	37	84.1	84.1	100.0
	Total	44	100.0	100.0	

Sistole

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	5	11.4	11.4	11.4
	Tinggi	39	88.6	88.6	100.0
	Total	44	100.0	100.0	

Diastole

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	20	45.5	45.5	45.5
	Tinggi	24	54.5	54.5	100.0
	Total	44	100.0	100.0	



Gula Darah

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	1	2.3	2.3	2.3
	Hiperglikemia	43	97.7	97.7	100.0
	Total	44	100.0	100.0	

Descriptives

		Statistic	Std. Error
Sistole	Mean	150.75	2.563
	95% Confidence Interval for Lower Bound		145.58
	Mean Upper Bound		155.92
	5% Trimmed Mean	150.28	
	Median	150.50	
	Variance	289.076	
	Std. Deviation	17.002	
	Minimum	116	
	Maximum	194	
	Range	78	
	Interquartile Range	22	
	Skewness	.239	.357
Kurtosis	.412	.702	
Diastole	Mean	83.82	1.957
	95% Confidence Interval for Lower Bound		79.87
	Mean Upper Bound		87.77
	5% Trimmed Mean	83.65	
	Median	85.00	
	Variance	168.571	
	Std. Deviation	12.983	
	Minimum	40	
	Maximum	135	
	Range	95	
	Interquartile Range	14	
	Skewness	.495	.357
Kurtosis	7.079	.702	
Gula Darah	Mean	292.25	8.536
	95% Confidence Interval for Lower Bound		275.04
	Mean Upper Bound		309.46
	5% Trimmed Mean	289.18	
	Median	296.50	
	Variance	3206.099	
	Std. Deviation	56.622	
	Minimum	190	
	Maximum	479	



Range	289	
Interquartile Range	79	
Skewness	.775	.357
Kurtosis	1.372	.702

Crosstab

		Gula Darah		Total	
		Normal	Hiperglikemia		
Sistole	Normal	Count	1	4	5
		% within Sistole	20.0%	80.0%	100.0%
Tinggi		Count	0	39	39
		% within Sistole	0.0%	100.0%	100.0%
Total		Count	1	43	44
		% within Sistole	2.3%	97.7%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (1-sided)	(2-Exact sided)	Sig. (2-Exact sided)	Sig. (1-sided)
Pearson Chi-Square	7.981 ^a	1	.005			
Continuity Correction ^b	1.517	1	.218			
Likelihood Ratio	4.541	1	.033			
Fisher's Exact Test				.114		.114
Linear-by-Linear Association	7.800	1	.005			
N of Valid Cases	44					

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,11.

b. Computed only for a 2x2 table

Crosstab

		Gula Darah		Total	
		Normal	Hiperglikemia		
Diastole	Normal	Count	1	19	20
		% within Diastole	5.0%	95.0%	100.0%
Tinggi		Count	0	24	24
		% within Diastole	0.0%	100.0%	100.0%
Total		Count	1	43	44
		% within Diastole	2.3%	97.7%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (1-sided)	(2-Exact sided)	Sig. (2-Exact sided)	Sig. (1-sided)
Pearson Chi-Square	1.228 ^a	1	.268			
Continuity Correction ^b	.009	1	.926			
Likelihood Ratio	1.605	1	.205			



Fisher's Exact Test				.455	.455
Linear-by-Linear Association	1.200	1	.273		
N of Valid Cases	44				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,45.

b. Computed only for a 2x2 table

Tekanan Darah * Gula Darah Crosstabulation

		Gula Darah		Total	
		Normal	Hiperglikemia		
Tekanan Darah	Normal	Count	1	5	6
		% within Tekanan Darah	16.7%	83.3%	100.0%
Hipertensi	Count	0	38	38	
		% within Tekanan Darah	0.0%	100.0%	100.0%
Total	Count	1	43	44	
		% within Tekanan Darah	2.3%	97.7%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Sig. (2-Exact sided)	Sig. (1-sided)
Pearson Chi-Square	6.481 ^a	1	.011		
Continuity Correction ^b	1.149	1	.284		
Likelihood Ratio	4.139	1	.042		
Fisher's Exact Test				.136	.136
Linear-by-Linear Association	6.333	1	.012		
N of Valid Cases	44				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,14.

b. Computed only for a 2x2 table

Pola Makan Seimbang * Tekanan Darah Crosstabulation

		Tekanan Darah		Total	
		Normal	Hipertensi		
Pola Makan Seimbang	Sering	Count	1	2	3
		% within Pola Makan Seimbang	33.3%	66.7%	100.0%
Jarang	Count	4	20	24	
		% within Pola Makan Seimbang	16.7%	83.3%	100.0%
Tidak pernah	Count	1	16	17	
		% within Pola Makan Seimbang	5.9%	94.1%	100.0%
Total	Count	6	38	44	
		% within Pola Makan Seimbang	13.6%	86.4%	100.0%



Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.043 ^a	2	.360
Likelihood Ratio	1.999	2	.368
Linear-by-Linear Association	1.946	1	.163
N of Valid Cases	44		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .41.

Pola Makan Seimbang * Gula Darah Crosstabulation

		Gula Darah		Total	
		Normal	Hiperglikemia		
Pola Makan Seimbang	Sering	Count	1	2	3
		% within Pola Makan Seimbang	33.3%	66.7%	100.0%
	Jarang	Count	0	24	24
		% within Pola Makan Seimbang	0.0%	100.0%	100.0%
	Tidak pernah	Count	0	17	17
		% within Pola Makan Seimbang	0.0%	100.0%	100.0%
Total	Count	1	43	44	
	% within Pola Makan Seimbang	2.3%	97.7%	100.0%	

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.984 ^a	2	.001
Likelihood Ratio	5.726	2	.057
Linear-by-Linear Association	4.918	1	.027
N of Valid Cases	44		

a. 4 cells (66,7%) have expected count less than 5. The minimum expected count is ,07.

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