

The Relationship Between Body Mass Index and Blood Sugar with Cognitive Function in Patients with Diabetes Mellitus

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Abstract

Impaired cognitive function is an individual's inability to perform daily functions and limits the quality of life. The prevalence of cognitive dysfunction in people in China, Spain, America, and Canada is 12.6%, 22.2%, and 16.8%. Cognitive impairment in Indonesia often increases, namely dementia, is 10%. Insulin resistance causes inflammation and mitochondrial dysfunction. The state of hyperglycemia occurs activation of pro-inflammatory cytokines that cause cognitive impairment. The study aims to determine the relationship between body mass index and blood glucose on cognitive function in patients with diabetes mellitus at the Gatak Sukoharjo Health Center, consisting of 36 patients—research using observational analytics with the Pearson test. The sample selection technique is purposive sampling. Based on the results of the Pearson test ($p = 0.043$), it means that there is a significant relationship. Furthermore, obtained ($p = 0.578$) means no significant relationship exists. The study concludes that there is a relationship between body mass index and cognitive function, but there is no relationship between transient blood sugar and cognitive function in patients with diabetes mellitus.

Keywords: Blood Sugar, Cognitive Function, Body Mass Index, Diabetes Mellitus.

Abstrak

Gangguan fungsi kognitif adalah ketidakmampuan individu dalam melakukan fungsi sehari-hari dan membatasi kualitas hidup. Prevalensi gangguan fungsi kognitif pada penduduk di Cina, Spanyol, Amerika, Kanada sebesar 12,6%, 22,2%, dan 16,8%. Prevalensi gangguan kognitif yang sering terjadi Indonesia yaitu demensia sebesar 10%. Resistensi insulin menyebabkan peradangan dan terjadi disfungsi mitokondria. Keadaan hiperglikemia terjadi aktivasi sitokin proinflamasi yang menyebabkan gangguan kognitif. Penelitian ini bertujuan untuk mengetahui hubungan indeks massa tubuh dan gula darah sewaktu terhadap fungsi kognitif pada pasien diabetes mellitus di Puskesmas Gatak Sukoharjo yang terdiri 36 prolans. Penelitian menggunakan observasional analitik dengan uji Pearson. Teknik pemilihan sampel dengan purposive sampling. Berdasarkan hasil penelitian dengan uji Pearson didapatkan ($p = 0,043$) artinya terdapat hubungan yang signifikan. Selanjutnya, didapatkan ($p = 0,578$) artinya tidak terdapat hubungan yang signifikan. Kesimpulan dari penelitian yaitu terdapat hubungan antara indeks massa tubuh dengan fungsi kognitif, tetapi tidak terdapat hubungan antara gula darah sewaktu dengan fungsi kognitif pada pasien diabetes mellitus.

Kata Kunci: Gula Darah Sewaktu, Fungsi Kognitif, Indeks Massa Tubuh, Diabetes Mellitus.

INTRODUCTION

Impaired cognitive function occurs due to the inability of an individual to perform daily functions and limits the quality of life. The prevalence of cognitive dysfunction in residents in China, Spain, America, and Canada is 12.6%, 22.2%, and 16.8%. Cognitive impairment in Indonesia often increases, namely dementia, is 10%. It does estimate that there were 35.6 million people with dementia in Indonesia in 2010^{9,14}.

Often cognitive impairment is associated with hyperglycemia. Hyperglycemia is common in people with diabetes mellitus. There are reports from the district health office diabetics in the Sukoharjo area were around 18,596 thousand sufferers in 2019. Hyperglycemia will worsen cognitive function if continuous chronic exposure occurs^{6,13}.

Obesity is the accumulation of excessive amounts of fat due to an imbalance in energy intake. According to the World Health Organization (WHO), obesity is declared a global epidemic. The prevalence of obesity is primarily found in adults, adolescents, and children. About 1.4 billion adults worldwide are obese. According to PERKENI, there is a classification of body mass index in obese people, including fat (weight), around 25.1-27.0 using body weight divided by the square of height^{1,10}.

In excess body mass index, there are obstacles in taking glucose into muscle and fat cells. Causes by glucose in the blood to increase. Diabetes mellitus patients are usually monitored by measuring blood sugar at any time to adjusting drug doses and determine if therapy has been successful. If therapy is not achieved, blood sugar may be ≥ 200 mg/dl. Exposure to continuous hyperglycemia will worsen cognitive function through mitochondrial dysfunction^{4,15}.

Based on this, the authors studied the relationship between body mass index and blood sugar on cognitive function in patients with diabetes mellitus.

METHODS

The research type used will be analytic observational with a cross-sectional approach. The research time is around June to September 2022. The place for conducting the research is Gatak 1 District, Sukoharjo Regency, Central Java. The independent variable is body mass index and blood sugar, while the dependent variable is cognitive function. This study uses a sample of all patients that fulfill the inclusion criteria and exclusion criteria. The sample selection technique was carried out through purposive sampling (16). The instruments used in this study were the Mini-Mental State Examination (MMSE) questionnaire, questionnaires, body scales, microtome, and glucometers. Data analysis was performed using the Statistical Program for Social Science (SPSS). The

univariate analysis described each research variable using a single variate analysis. The bivariate analysis assesses whether the independent and dependent variables have a significant relationship. This study was tested with the Pearson test.

RESULTS

The sample selection technique was carried out using purposive sampling. The number of samples obtained was 36 people. The results of the analysis of the characteristics of the respondents are as follows:

Based on age characteristics, most respondents were aged > 60 years, with a frequency of 20 people or 55.6%. The least number of respondents found in this study were aged between 40-60 years, with a frequency of 16 people or 44.4%.

Based on gender characteristics, the majority of respondents who were most often found were male with a frequency of 7 people or 19.4%. The fewest respondents in this study were female, with a frequency of 29 people or 80.6%.

Based on the characteristics of body mass index, the majority of respondents were most often found with a body mass index between 18.5 – 24.9 kg/m², which is said to be expected, with a frequency of 28 people or 77.8%. The least number of respondents found in this study had a body mass index of more than 25.0 kg/m²; that is, they were said to be obese with a frequency of 8 people or 22.2%.

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Based on the characteristics of body mass index, the majority of respondents were most often found with a Body Mass Index (BMI) between 18.5 – 24.9 kg/m², which is said to be expected, with a frequency of 28 people or 77.8%. The least number of respondents found in this study had a body mass index of more than 25.0 kg/m²; that is, they were said to be obese with a frequency of 8 people or 22.2%.

Based on the characteristics of blood sugar at any time, most respondents were found to have blood sugar at < 200 mg/dL, which is said to be regular, with a frequency of 21 people or 58.3%. Respondents who were the least found in this study had blood sugar when > 200 mg/dL, which is said to be high with a frequency of 15 people or 41.7%.

Tabel 1. Univariate Analysis Results

Variable	Frequency (n)	Persentase (%)
	Mean age \pm SD	
Age	61,89 \pm 10,045	
40-60 year	16	44,4%
>60 year	20	55,6 %
Gender	1,81 \pm 0,401	
Male	7	19,4 %
Female	29	80,6 %
Body Mass Index	203,22 \pm 78,687	
Normal	28	77,8 %
Fat	8	22,2 %
Blood Sugar	175,81 \pm 86,354	
< 200 mg/dl	21	58,3 %
\geq 200 mg/dl	15	41,7 %
Cognitive Function	26,05 \pm 4,592	
Normal	27	41,5 %
Probable	6	9,2 %
Definite	3	4,6 %

The characteristics of using the Mini-Mental State Examination (MMSE) for cognitive function assessed, respondents who were most often found with MMSE scores between 24-30 which is said category normal with a frequency of 27 people or 41.5% and followed by respondents who have an MMSE score between 0-16, which is said category definite with a frequency of 6 people or 9.2%. The least number of respondents found in this study had an MMSE score between 17-23, which is said category probable with a frequency of 3 people or 4.6%.

The results of bivariate analysis it is known that are as follows in table 2. Based on the bivariate analysis table with the Pearson test, a significant value of Sig. (2-tailed) The relationship between body mass index and cognitive function in patients with diabetes mellitus is $p = 0.043$ (<0.05), meaning there is a significant relationship between body mass index and cognitive function in patients with diabetes mellitus.

Based on the bivariate analysis table with the Pearson test, a significant value of Sig. (2-tailed) on the relationship between random blood sugar and cognitive function in patients with diabetes mellitus was $p = 0.578$ (<0.05), meaning that there was no significant relationship between temporary blood sugar and cognitive function in patients with diabetes mellitus.

Tabel 2. Results of Bivariate Analysis

Variable	Correlations	
	Body Mass Index	Cognitive Function
Body Mass Index		
Correlation Coefficient	1,000	0,339
Sig. (2-tailed)		0,043
N	36	36
Cognitive Function		
Correlation Coefficient	0,339	1,000
Sig. (2-tailed)	0,043	
N	36	36
Variabel	Blood Sugar	Cognitive Function
Blood Sugar		
Correlation Coefficient	1.000	-0,096
Sig. (2-tailed)		0,578
N	36	36
Cognitive Function		
Correlation Coefficient	-0,096	1.000
Sig. (2-tailed)	0,578	
N	36	36

DISCUSSION

The results of this study follow research conducted by Sari¹⁶, who found a significant relationship between Body Mass Index (BMI) and cognitive function in diabetes mellitus patients in the inpatient room of dr. Loekmonohadi Kudus with a value of Sig. (2-tailed), which obtained $p = 0.007$. Based on Pradini's research¹⁷ found that there was a significant relationship between abdominal circumference and cognitive function in patients with type 2 diabetes mellitus with Sig. (2-tailed), which obtained $p = 0.033$. This is related to obesity which causes poor memory function due to disruption of HDL lipoprotein metabolism, which causes inflammation in neurons. Obesity causes low adiponectin levels, associated with decreased insulin sensitivity, atherogenic plasma lipid profile, and increased body mass index.

In obesity, excessive adipose tissue can disrupt metabolism and cause insulin resistance mechanisms³. Insulin resistance causes chronic inflammation that

causes changes in the release of adipokines and cytokines. Then there is central inflammation, microglia cells which can turn into reactive microglia and damage local nerve tissue (including apoptotic effects) by releasing cytotoxic cytokines⁴. The combination of increased proinflammatory cytokine expression in the hippocampus, hypothalamus, and other cerebral areas, including intensification of amyloid- β production, oxidative stress, and endoplasmic reticulum stress, can lead to impaired cognitive function in obesity⁵.

There are research results that are not following the study of transient blood sugar with cognitive function conducted by Faishal⁷, who found that there was a significant relationship between blood sugar status and the incidence of cognitive dysfunction in diabetes mellitus patients at the internal medicine clinic of Dr. Soedarso Pontianak with a value of Sig. (2-tailed), which obtained $p = 0.000$. According to the theory, it is said that blood sugar is an indicator that therapy has been achieved and to adjust drug doses¹⁵. In diabetes mellitus patients with transient blood sugar levels > 200 mg/dL caused by insulin resistance, insulin cannot work optimally in muscle, fat, and liver cells, forcing the pancreas to compensate to produce more insulin. Due to increased blood sugar and hyperglycemia, proinflammatory cytokines will be activated. NF- κ B is a modulator for ROS that regulates the expression of TNF and interleukins, which have a significant role in inflammation. TNF upregulation can inhibit of insulin signaling, which leads to increased generation of ROS and causes cognitive impairment¹³. So the results of the research that have examined have not been able to prove that there is a relationship between transient blood sugar and cognitive function in patients with diabetes mellitus.

There is research that follows research conducted by Manoppo, which found no significant relationship between blood sugar levels and cognitive function in patients with type 2 diabetes mellitus who received the DSME program with a Sig. (2-tailed), which obtained $p = 0.137$. In this study, blood sugar levels were measured using random blood sugar. They showed the discussion results, which stated that uncontrolled blood sugar levels could interfere with cognitive function. However, blood sugar examination was not a determinant of cognitive function in patients with diabetes mellitus. Other factors can affect blood sugar levels, such as insulin use, infection, disease, and stress. Because blood sugar checks are only done at that time and ignore other factors that can affect blood sugar levels when. It may be necessary to check other blood sugar levels, such as fasting blood sugar, HbA1C, and post-prandial¹¹.

The majority of respondents in this study had a cognitive function in the normal category, with a percentage of 41.5%. This is because the patient has a relatively stable cognitive function. So the results of the research that I have examined cannot prove that there is

a relationship between body mass index and cognitive function in patients with diabetes mellitus.

CONCLUSION

The analysis based of the study above, it can be concluded that there is a significant relationship between body mass index and cognitive function. However, there is no significant relationship between random blood sugar and cognitive function in patients with diabetes mellitus.

ETHICAL APPLICATION

This research obtained permission from the Health Research Ethics Commission of RSUD Dr. Moewardi Number: 1.396 / XI / HREC / 2022.

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