

The relationship of body mass index with fasting blood glucose in type-2 diabetes mellitus

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Abstract. Diabetes mellitus is a metabolic disorder caused by high blood sugar levels. Approximately 90% of diabetes cases are type 2. Indonesia ranks seventh globally with 10.7 million people affected. The increasing prevalence of diabetes mellitus is correlated with the increasing prevalence of overweight and obesity. Therefore, this research was conducted to investigate the relationship between body mass index (BMI) and fasting blood sugar (FBG) levels in type 2 diabetes patients at Umbulharjo 1 Public Health Center, Yogyakarta Province, Indonesia. Method: This research is an observational analytical study with a cross-sectional design. The sampling technique employed was purposive sampling. The total sample size for the study consisted of 325 type 2 Diabetes Mellitus patients at Umbulharjo 1 Public Health Center. Data analysis was performed using the Spearman's Rho correlation test. Result: The statistical test results indicate that the majority of type 2 diabetes mellitus patients have Obesity (55.4%) based on Body Mass Index (BMI) and diabetes (≥ 126) Fasting Blood Glucose (FBG) levels (99.1%). The research findings reveal no significant relationship between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) levels in type 2 diabetes mellitus patients at Umbulharjo 1 Public Health Center, with a two-tailed p-value of 0.338. The strength of the relationship is very weak, with a positive correlation of 0.053. Conclusion: We highlighted that there is no significant relationship between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) levels in type 2 diabetes mellitus patients at Umbulharjo 1 Public Health Center. Keywords: *Body Mass Index (BMI), Fasting Blood Glucose (FBG), Type 2 Diabetes mellitus*.

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1 Introduction

Diabetes mellitus is a metabolic disease caused by high blood sugar levels when the body cannot produce enough insulin hormone and cannot utilize the insulin hormone effectively. This insulin is produced in the pancreas and functions as a protein and fat metabolism [1]. According to the World Health Organization (WHO), diabetes mellitus is growing and endangering the world community. As many as 90% of diabetes sufferers are type II [2]. Indonesia occupies seventh position globally in terms of total diabetes mellitus patients, amounting to 10.7 million people. Data from Basic Health Research (RISKESDAS) in 2018 shows that the prevalence of diabetes mellitus based on doctor's diagnosis in the Indonesian population at various ages is 1.5% [3]. The increase in the prevalence of diabetes mellitus is in line with the increase in the prevalence of being overweight to 13.6% from 11.5% and obesity to 21.8% from 14.8% in 2013 to 2018 [4].

The city of Yogyakarta which were located in Indonesia is the second city that has the highest prevalence of diabetes mellitus in the population of each age according to province in 2018 [5]. Based on the provision of diabetes mellitus health services in Yogyakarta City in 2022, Umbulharjo 1 Community Health Centre has the highest diabetes mellitus service distribution target of 1,706 people and the highest achievement of diabetes mellitus service distribution is 1,716 people [6].

The relationship between obesity and diabetes was observed by Elliot P Joslin who showed that a 10% reduction in body weight could reduce clinical diabetes mellitus in obese individuals diagnosed with diabetes mellitus. These observations support the current belief that obesity causes Type-2 Diabetes Mellitus [7].

Obesity can be determined by anthropometric measurements, one of which is height and weight measurements which are included in the body mass index. Divide body weight (kg) by height (m^2) to determine status [8]. The risk of increased blood sugar levels in type-2 diabetes mellitus patients may increase if their body mass index is higher than average [9].

Fasting Blood Glucose is one of the tests to show a person's plasma blood sugar status, especially in people with type-2 diabetes mellitus. Fasting Blood Glucose test of ≥ 126 mg/dl with a fasting condition of at least 8 hours is more accurate [4]. Considering that type-2 diabetes mellitus will have an impact on the quality of human life, therefore, all parties are expected to participate in efforts to prevent and treat diabetes mellitus. Based on this description, this research aims to determine the relationship between body mass index (BMI) and fasting blood sugar (FBG) levels in type 2 diabetes mellitus patients. The aim of the current study is in line with the Sustainable Development Goals (SDGs) in the key field of communicable diseases, making this paper a potential solution for healthcare providers.

2 Material and Methods

Method used in this research is observational analytics with a cross-sectional approach. The sampling technique used is purposive sampling where samples are taken by determining certain characteristics. The inclusion criteria for the study were type-2 diabetes mellitus patients with examination and age 40-70 years. The exclusion criteria for the study were patients who did not have complete data and were not compliant with taking medication. This research was carried out at Umbulharjo Community Health Centre 1, Umbulharjo subdistrict, Yogyakarta city from September 4 to September 17, 2023, with the number of the ethical approval (012307156). Data collected from medical record then entered and processed in data processing software using a computer program (Microsoft Excel version 16.02 and SPSS version 27). The data analysis used in the research is univariate and bivariate analysis. Univariate analysis to describe subject characteristics data. Bivariate analysis is used to determine the relationship between the independent variables and the dependent variable,

using the Kolmogorov-Smirnov test to determine the normality of the data. In this study, the data was not normally distributed (Sig <0.05), so it was continued using the Spearman's Rho correlation test.

3 Results and Discussion

3.1 Characteristics of Research Subjects

Table 1. Frequency Distribution of Patient Data Based on Gender, Age and Family history of DM

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	128	39.4
Female	197	60.6
Age		
40-44 Years	15	4.6
45-49 Years	36	11.1
50-54 Years	44	13.5
55-59 Years	75	23.1
60-64 Years	89	27.4
65-69 Years	65	20.0
70 Years	1	0.3
DM famiy history		
With	51	15.7
Without	274	84.83
Total	325	100.0

Table 1 shows that there are 325 samples suffering from type-2 diabetes mellitus, with 128 samples male (39.4%) and 197 samples (60.6%) female, with 15 samples aged 40-44 years (4.6%).), 45-49 years old as many as 36 samples (11.1%), aged 50-54 years as many as 44 samples (13.5%), aged 55-59 years as many as 75 samples (23.1%), aged 60-89 samples (24.7%) aged 64 years, 65 samples (20.0%) aged 65-69 years and 1 sample (0.3%) aged 70 years, with 51 samples (15.7%) with a family history of DM and no family history DM was 274 samples (84.83%).

3.2 Body Mass Index (BMI) data

Table 2. Frequency Distribution of Patient Data Based on Body Mass Index

BMI	Frequency (n)	Percentage (%)
Normal	81	24.9
Overweight	64	19.7
Obese	180	55.4
Total	325	100.0

Table 2 shows that there were 325 samples with a normal BMI of 81 samples (24.9%), an overweight BMI of 64 samples (19.7%) and an obese BMI of 180 samples (55.4%).

3.3 Data on Fasting Blood Glucose (FBG)

Table 3. Frequency Distribution of Patient Data on Fasting Blood Glucose

FBG Levels	Frequency (n)	Percentage (%)
Diabetes	322	99.1
Prediabetes	3	0.9
Total	325	100.0

Table 3 shows that there were 325 samples, with 322 samples (99.1%) of diabetes fasting blood glucose and 3 samples (0.9%) of prediabetes fasting blood glucose.

3.4 Bivariate Analysis

Table 4. Kolmogorov-Smirnov Z-Normality Test

		Unstandardized Residual
N		325
Normal Parameters	Mean	.00000000
	Std. Deviation	68.58350003
Most Extreme Differences	Absolute	.122
	Positive	.122
	Negative	-.099
Kolmogorov-Smirnov Z		2.194
Asymp. Sig. (2-tailed)		.000

Table 4 shows that the normality test results show the Sig value. (2-tailed) is 0.00, because the Sig value. (2-tailed) $0.00 < 0.05$, it can be concluded that the residual value is not normally distributed. Furthermore, using the Spearman's Rho correlation test is a method for guessing whether there is a relationship between variables and the ordinal data scale.

Table 5. Relationship between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) Levels in type 2 diabetes mellitus patients at Umbulharjo 1 Community Health Center.

			Body Massa Index	Fasting Blood Sugar
Spearman's rho	Body Massa Index	Correlation Coefficient	1.000	.053
		Sig. (2-tailed)		.338
		N	325	325
	Fasting Blood Sugar	Correlation Coefficient	.053	1.000
		Sig. (2-tailed)	.338	
		N	325	325

Table 5 shows that the Sig value. (2-tailed) is 0.338, because the Sig value. (2-tailed) $0.338 > 0.05$, it can be concluded that in this study there is no relationship between Body Mass Index BMI) with Fasting Blood Glucose (FBG) Levels in type 2 diabetes mellitus patients at Umbulharjo 1 Community Health Center, then a correlation coefficient of 0.053 indicates the strength of the relationship, so it is said that the strength of this correlation is very weak with a positive (unidirectional) correlation value. The higher the body mass index, the higher the blood sugar content.

3.5 Characteristics

Most patients with type 2 diabetes mellitus at Umbulharjo 1 Health Centre were female, totalling 197 samples (60.6%). The same results from research by Komariah and Rahayu show that the highest number of sufferers of type 2 diabetes mellitus are women at 60.4% [10]. Premenstrual syndrome causes the distribution of body fat to accumulate more easily due to changes in hormones. This increases a woman's risk of developing type 2 diabetes mellitus [11].

The majority of people with type 2 diabetes mellitus at Umbulharjo 1 Health Centre were aged 60-64 years, totalling 89 samples (27.4%). The same results from research by Milita et al. which stated that type-2 diabetes mellitus patients were more commonly found at the age of 60-64 years (8%) [12]. According to research by Amalia RF the risk of type 2 DM in the late elderly (56-65 years) is 2.28 times higher than in the elderly (≥ 65 years) [14]. This is also caused by lack of physical activity, increased body weight, and reduced muscle mass [13].

Most type-2 diabetes mellitus sufferers at Umbulharjo 1 Community Health Center did not have a family history of DM, 274 people (84.83%). The same results from research by Makful which stated that individuals with type 2 diabetes mellitus most often do not have a family history of DM is 80.4% [14]. Children who have both parents with diabetes will also suffer from diabetes, as long as they can maintain and avoid other risk factors [15].

Most type-2 diabetes mellitus sufferers at Umbulharjo 1 Community Health Centre had an obese BMI of 180 samples (55.4%). The same results from research by Adnan et al., (2014) which stated that people with type 2 diabetes mellitus most often have an obese BMI of 51.4% [16]. Obesity causes metabolic disorders as indicated by increased mRNA and TNF- γ factors induced by lipopolysaccharides (LPS) protein levels. The expression of TNF- γ , IL-6, and MCP-1 is controlled by LITAF, which causes insulin resistance [17].

Most people with type-2 diabetes mellitus at Umbulharjo 1 Community Health Centre had diabetes GDP (≥ 126) with 322 samples (99.1%). The same results from research by Hasanah et al (2021) which shows that people with type 2 diabetes mellitus have FBG levels above normal (≥ 126 mg/dl) as much as (81.8%) [18]. FBG levels indicate a person's blood glucose condition, especially people with type 2 diabetes, and are determined by the hormones glucagon and insulin which increase and decrease blood glucose. It is important for people with type 2 diabetes to understand and prevent factors that have the potential to impact their GDP levels [19].

3.6 Relationship between body mass index (BMI) and fasting blood glucose (FBG) level

The results were obtained based on analysis carried out on 325 patient samples who met the criteria for this study using the Spearman's Rho Sig correlation test. (2-tailed) is 0.338, because the Sig value. (2-tailed) $0.338 > 0.05$. Thus, it can be concluded that in type-2 diabetes mellitus patients at Umbulharjo 1 Health Center there is no significant relationship between Body Mass Index (BMI) and Fasting Blood Glucose (FBG).

The results of this research are in accordance with previous research conducted by Suryanti et al. with the title "The relationship of body mass index and fasting blood glucose levels in patients with type-2 diabetes mellitus" shows that there is no relationship and it was found that with obese BMI more people suffer from type-2 diabetes [20]. There are several factors that could cause this study to find no relationship, such as body fat levels. One of the anthropometric measures most commonly used to measure a person's nutritional status in relation to disease risk is Body Mass Index (BMI). However, BMI has the disadvantage that it only shows the amount of fat but does not show the distribution of body fat. The use of

BMI is also inappropriate because every person with muscles and bones and elderly people have different levels of fat and muscle mass [21].

This study only used the method of measuring body mass index from height and weight, did not measure waist circumference and abdominal circumference so it could not describe the distribution of body fat. Abdominal circumference measurement can provide higher accuracy for determining visceral or central obesity. Therefore, this study can be used as a reference source for early prevention of obesity and type-2 diabetes mellitus such as controlling lifestyle, regulating diet and adequate physical activity.

4 Conclusion

Our study showed that there is no significant relationship or correlation between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) levels in type 2 diabetes mellitus patients at Umbulharjo Community Health Center 1. In addition type 2 diabetes mellitus patients showed that the majority had an obese BMI. This means that lack of physical activity and consuming more energy and fat causes fat to accumulate in the body and causes insulin resistance. Furthermore, type 2 diabetes mellitus patients at Umbulharjo 1 Community Health Center showed that the majority had diabetes FBG levels (≥ 126).

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Author contribution

Rimadhani, E.T conceived and designed the study. Mawardi, F revised the manuscript. Dewi, F.P approved the manuscript. Purwanta, B.D approved the manuscript. Sholikah, A approved the manuscript. Hutomo, M.A approved the manuscript. All authors have read and made significant contributions to this study.

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