LOMBOK HEALTH and SCIENCE JOURNAL
No. ISSN 2964-5239
https://journal.unram.ac.id/index.php/lhsj/index

Published in January 2026, included in Vol.1 (2026): LHSJ January 2026 (1-9)

The Relationship Between Body Mass Index, Physical Activity, and Depression Levels with Fasting Blood Glucose Levels in Patients with Type 2 Diabetes Mellitus at the Internal Medicine Clinic of Praya General Hospital

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ABSTRACT

Background: Diabetes mellitus is a health problem that accounts for more than 90% of cases in every country, and almost all diabetes mellitus is classified as type 2 diabetes. One of the districts in West Nusa Tenggara that has the second highest case of type 2 diabetes mellitus is Central Lombok Regency with 3,995 patients. Many factors influence blood glucose levels, particularly fasting blood glucose levels in individuals with type 2 diabetes mellitus, including body mass index, physical activity, and depression levels.
Objective: To determine the relationship between body mass index, physical activity, and depression levels with fasting blood glucose levels in patients with type 2 diabetes mellitus at the Internal Medicine Polyclinic of Praya Regional General Hospital.
Method: This study employed quantitative research methods with a cross-sectional design and purposive sampling techniques. The study was conducted at the Internal Medicine Polyclinic of Praya Regional General Hospital from September 8 to 23, 2023, with a total of 100 respondents. The data were analyzed using Spearman's Rank Correlation test with SPSS 25.

Results: There was a significant relationship between body mass index and fasting blood glucose levels with a p-value of 0.041. There was a significant relationship between physical activity and fasting blood glucose levels with a p-value of 0.008. There was no significant relationship between depression levels and fasting blood glucose levels with a p-value of 0.922.
Conclusion: There was a significant relationship between body mass index and physical activity with fasting blood glucose levels. However, there was no relationship between depression levels and fasting blood glucose levels in patients with type 2 diabetes mellitus.
Keywords: Activity, Diabetes Mellitus Type 2, Body Mass Index, Fasting Blood Glucose, depression levels.

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BACKGROUND

Diabetes mellitus (DM) is a group of metabolic disorders characterized by hyperglycemia resulting from abnormalities in insulin secretion, insulin action, or both (Soelistijo, 2021). *The American Diabetes Association* (2005) states that diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemia resulting from insulin deficiency. The most common symptoms include frequent hunger, excessive thirst, frequent urination in large volumes, and weight loss. Diabetes mellitus is classified into four types: type 1 diabetes mellitus, type 2 diabetes mellitus, gestational diabetes, and diabetes due to other causes.

The International Diabetes Federation (IDF) estimates that at least 463 million people aged 20–79 worldwide had diabetes in 2019, with projections of an increase to 578 million by 2030 and 700 million by 2045. In 2021, the IDF reported that 537 million adults (aged 20–79) or 1 in 10 people worldwide live with diabetes. Diabetes also causes 6.7 million deaths, or 1 person every 5 seconds (International Diabetes Federation, 2021). The International Diabetes Federation (IDF) Atlas 2021 states that Indonesia ranks fifth globally in terms of the highest number of diabetes patients. Indonesia is in fifth place with 19.47 million diabetes patients (10.6%).

The 2018 Riskesdas results show that West Nusa Tenggara ranks 22nd out of 34 provinces with 36,486 cases of type 2 diabetes mellitus (1.2%). The number of diabetes mellitus patients is distributed across 10 districts in West Nusa Tenggara Province. One of the districts in West Nusa Tenggara with the second-highest number of type 2 diabetes cases is Central Lombok District, with 3,995 patients. The 2021 Health Department profile of Central Lombok District notes that the number of diabetes cases has continued to rise year after year. Praya, one of the sub-districts in Central Lombok District, has 920 diabetes cases (Central Lombok, 2021). Praya General Hospital reported 503 patients with type 2 diabetes mellitus at its Internal Medicine Clinic in 2022, with 201 males and 302 females (Praya General Hospital, 2022).

Diabetes mellitus occurs due to high levels of glucose in the blood. One of the most accurate tests for determining whether someone has diabetes mellitus is fasting blood glucose levels. Elevated fasting blood glucose levels in patients with type 2 diabetes mellitus are influenced by various factors, including internal and external factors. Internal factors that influence blood glucose levels include depression, stress, race, genetics, and body mass index (obesity). External factors include physical activity, education, knowledge, and diet (S & Kusuma, 2019).

Obesity is one of the internal factors influencing the onset of type 2 diabetes mellitus. According to data from the World Health Organization Europe, obesity is estimated to be responsible for 65-80% of new cases of type 2 diabetes mellitus. The prevalence of obesity among adults with type 2 diabetes mellitus from 2007 to 2018 reached 21.8% (Riskesdas NTB, 2018). Excessive fat accumulation in the body of a diabetes mellitus patient can affect blood sugar levels and cause cells to become insensitive to insulin (insulin resistance). In obese individuals, leptin levels in the body increase. Leptin is a hormone produced by fat cells (adipocytes) and plays a role in regulating appetite, energy metabolism, and body fat distribution. Leptin is a hormone produced by fat cells in the body and plays a role in regulating appetite and energy metabolism. This hormone sends signals to the brain to tell the body when to feel full and when to stop eating. In some people, especially those who are obese, leptin levels in the blood can be very high due to excessive body fat. Increased

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leptin can disrupt insulin response, causing body cells to not respond well to insulin, which ultimately leads to elevated blood glucose levels (Nababan et al., 2020).

Research conducted by Sagita et al. (2020) states that there is a relationship between body mass index and blood sugar levels in patients with type 2 diabetes mellitus (Sagita et al., 2020). A body mass index above the threshold can cause an increase in insulin resistance, thereby triggering an increase in the prevalence of type 2 diabetes mellitus (Rita, 2018). However, this study contradicts the findings of Azizah (2020), who reported no association between BMI and fasting blood glucose levels in patients with type 2 diabetes mellitus, as BMI alone does not specifically indicate body fat levels that could eventually lead to diabetes (Indeks et al., 2018).

Another factor contributing to the occurrence of diabetes mellitus is physical activity, which falls under external factors. Low physical activity is one of the risk factors for uncontrolled blood sugar levels in patients with type 2 diabetes mellitus (Nurayati & Adriani, 2017). Physical activity is any bodily movement aimed at increasing and expending energy (Anggraeni & Alfarisi, 2018). Physical activity plays a role in controlling blood sugar levels by converting glucose into energy. Low physical activity and a sedentary lifestyle can lead to uncontrolled blood sugar levels in type 2 diabetes mellitus patients and increase the risk of developing diabetes mellitus by 1.64 times (Nurayati & Adriani, 2017).

Previous research conducted by Rachmawati et al (2019) showed that individuals with type 2 diabetes mellitus who engage in light physical activity are 7.15 times more likely to have uncontrolled blood sugar levels. This aligns with the findings of Dolongseda et al (2017), who reported that 93.3% of type 2 diabetes mellitus patients at the Internal Medicine Clinic of Pancaran Kasih Hospital in Manado had low physical activity levels and high blood sugar levels.

Depression is an internal factor contributing to uncontrolled blood glucose levels in patients with type 2 diabetes mellitus. Depression is defined as a common mental disorder. Individuals with depression exhibit symptoms such as loss of interest in activities that were once enjoyable (anhedonia), fatigue and rapid exhaustion (anergy), and feelings of sadness (depressive affect). Depression is often associated with long-term stressors, which lead to excessive production of the hormone cortisol. Cortisol counteracts the effects of insulin. If someone experiences depression, the cortisol levels in their body will increase. This reduces the body's sensitivity to insulin and leads to high blood glucose levels (Saputro et al., 2022).

Putri *et al*. (2018) found a correlation between depression levels and blood glucose levels in patients with type 2 diabetes mellitus (Ludiana et al., 2022; M. K. Putri et al., 2018). This aligns with the study conducted by Vina et al. in 2021, which stated that depression is associated with fasting blood glucose levels in patients with type 2 diabetes mellitus. In patients with depression who have type 2 diabetes mellitus, it can worsen glycemic and metabolic control. Additionally, depression accelerates the onset of complications and doubles the risk of morbidity (Vina *et al.*, 2021). However, this finding is inconsistent with the study by S & Kusuma in 2019, which reported no association between depression levels and fasting blood glucose levels in patients with type 2 diabetes mellitus. S & Kusuma (2019) explained that this was due to the lack of a clear relationship between depression levels and blood glucose levels, which have different regulatory systems within the body (S & Kusuma, 2019).

Praya General Hospital is a hospital located in Central Lombok Regency. Based on surveillance from Praya General Hospital, diabetes mellitus is among the 10 most prevalent diseases with 503 cases in 2022. This number is certainly high and will cause problems if not handled properly. A survey of type 2 diabetes

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mellitus patients at Praya General Hospital revealed that most patients were obese, leading to reduced physical activity and complaints indicative of depression due to prolonged medication use. This issue has not yet received special attention at Praya General Hospital (RSUD Praya, 2022).

Based on the above findings, the incidence of diabetes mellitus continues to rise over time and requires greater attention in its management. The results of the survey and the differences in previous research findings serve as the main points for the researcher to conduct a study on "The Relationship between Body Mass Index, Physical Activity, and Depression Levels with Fasting Blood Glucose Levels in Type 2 Diabetes Mellitus Patients at the Internal Medicine Outpatient Clinic of Praya General Hospital."

RESEARCH METHOD

The type of research used is an observational analytical study employing *a cross-sectional study* design. The study was conducted at the Internal Medicine Outpatient Clinic of Praya General Hospital. The research period and data collection took place from September 8 to 23, 2023. The study population consisted of patients with type 2 diabetes mellitus who were receiving outpatient treatment at the Internal Medicine Clinic of Praya General Hospital. The sample size was determined using the Slovin formula, with a total of 100 participants. The sampling technique used was purposive sampling.

The research instruments used were the *Beck Depression Inventory-II* questionnaire, which has been validated as a tool to measure depression levels, *the Short-International Physical Activity Questionnaire* (IPAQ-SF) to measure physical activity, a digital scale and microtoise as tools to measure Body Mass Index (BMI), and patients' medical records to determine fasting blood glucose levels. The research data obtained were analyzed using *Spearman's Rank Correlation* test.

RESULTS AND DISCUSSION

Respondent Characteristics

Table 1.
Distribution of Respondents by Gender

Gender	Number (n)	Percentage
Male	36	36
Female	64	64
Total	100	10

Table 1 shows the data analysis of 100 respondents, indicating that the majority of type 2 diabetes mellitus patients are female, with 64 respondents (64%).

Table 2
Distribution of Respondents by Age

Age	Number (n)	Percentage
20	1	1
31-40	4	4
41-50	30	30
51-60	36	36
>60	29	29
Total	10	100

Table 2 shows that the age group 51–60 years is the most common age group with 36 respondents (36%). The age group 20–30 years has the lowest distribution with 1 respondent (1%).

Table 3.
Distribution of Respondents Based on Occupation

Occupation	Number (n)	Percentage
Housewife	4	47
Private Sector Workers	9	9
Civil Servants	3	3
Civil servant retirement	8	8
Farmers	3	30
Driver	3	3
Total	10	100

The distribution of respondents based on occupation in Table 3 shows that housewives (IRT) constitute the highest percentage of respondents, with 47 respondents (47%). Private sector workers numbered 9 respondents (9%),

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civil servants (ASN) numbered 3 respondents (3%), retired civil servants numbered 8 respondents (8%), farmers numbered 30 respondents (30%), and drivers numbered 3 respondents (3%).

Bivariate Analysis

The Relationship Between Body Mass Index and Fasting Blood Glucose Levels in Type 2 Diabetes Mellitus Patients

The statistical test using *Spearman's Rank Correlation* showed a p-value of 0.041 (p-value < 0.05). This means that H1 is accepted and Ho is rejected. The statistical test results indicate a significant relationship between Body Mass Index (BMI) and fasting blood glucose levels in patients with type 2 diabetes mellitus. The strength of the relationship is evident from the correlation coefficient value of 0.205, indicating a low level of relationship between BMI and fasting blood glucose levels with a positive direction, meaning that the higher the BMI of patients with type 2 diabetes mellitus, the higher their fasting blood glucose levels.

Obesity and type 2 diabetes mellitus are closely related. Obesity is a major risk factor for the development of type 2 diabetes mellitus. When someone is obese, especially if fat is concentrated around the abdomen, their body cells can become more resistant to insulin. Insulin resistance causes the body to require more insulin to process glucose. However, when the pancreas cannot produce enough insulin to overcome this resistance, blood glucose levels can rise (Komariah & Rahayu, 2020). When fasting blood glucose levels are high (blood glucose levels when someone has fasted or not eaten for 8–12 hours), this can be a sign of type 2 diabetes mellitus. People with obesity are at a higher risk of developing insulin resistance. As a result, they have a higher risk of elevated blood glucose levels. If left untreated, this can lead to type 2 diabetes mellitus (Paramita & Lestari, 2019).

Nababan *et al* (2020) also stated the same thing, that there is a relationship between age, gender, and body mass index with fasting blood glucose levels in patients with type 2 diabetes mellitus. The same was found by Miftahul Adnan et al (2013), who stated that there is a relationship between body mass index and fasting blood glucose levels in patients with type 2 diabetes mellitus. Miftahul Adnan et al. (2013) used the Chi-square method and obtained a p-value of 0.00 ≤ 0.05, indicating a significant relationship between body mass index and fasting blood glucose levels in patients with type 2 diabetes mellitus. Miftahul Adnan et al. stated that a body mass index above the threshold can cause massive fat accumulation in the body. Most patients with type 2 diabetes mellitus were found to have poor and excessive eating patterns, leading to obesity. Obesity is known to be one of the internal factors that increase the risk of uncontrolled blood glucose levels. Uncontrolled blood glucose levels can cause an increase in leptin hormone levels. Leptin hormone is known to inhibit insulin's role in converting glucose into glycogen. This condition leads to insulin resistance, which can result in type 2 diabetes mellitus.

The Relationship Between Physical Activity and Fasting Blood Glucose Levels in Type 2 Diabetes Mellitus Patients

The results of the *Spearman's Rank Correlation* statistical test showed a p-value of 0.008 (p-value < 0.05). This means that H1 is accepted and Ho is rejected. The statistical test results indicate a significant relationship between physical activity and fasting blood glucose levels in patients with type 2 diabetes mellitus. The strength of the relationship is evident from the correlation coefficient value of -0.263, indicating a low level of relationship between physical activity and fasting blood glucose levels with a negative direction, meaning that the lower the physical activity of patients with type 2 diabetes mellitus, the higher their fasting blood glucose levels.

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The main issue in patients with type 2 diabetes mellitus is insulin resistance, which prevents glucose from entering cells and converting into energy and glycogen, thereby halting the glycolysis process. When someone engages in physical activity, muscle contraction occurs, which facilitates glucose entry into cells. This means that when someone engages in physical activity, insulin resistance decreases, ultimately lowering blood glucose levels. Therefore, physical activity has a very strong correlation with high fasting blood glucose levels in individuals with type 2 diabetes mellitus. The lower the physical activity level, the greater the likelihood of uncontrolled fasting blood glucose levels. Physical activity is closely related to the control of blood glucose levels, particularly fasting blood glucose levels. Low-intensity and moderate-intensity physical activity leads to uncontrolled fasting blood glucose levels. Based on the research conducted, respondents tended to engage in low-intensity and moderate-intensity physical activities such as sweeping and relaxing compared to more vigorous activities like exercising and others. Since most respondents reported no longer engaging in physically demanding work after being diagnosed with diabetes mellitus and experiencing a decline in their ability to perform strenuous activities, individuals with type 2 diabetes mellitus have high and uncontrolled blood glucose levels (Nurayati & Adriani, 2017).

The results of this study align with Sipa's (2018) research, which stated that the Chi-Square test yielded a p-value of $0.00 \leq 0.05$ with an OR value of 6.245 (95% CI: 2.78–14.01). This indicates a significant association between physical activity and the occurrence of type 2 diabetes mellitus. Sipa states that light and moderate physical activity have a 6.2 times higher risk of developing type 2 diabetes mellitus compared to heavy physical activity. Individuals with low physical activity levels tend to experience fat accumulation, where fat that should be used for physical activity accumulates and leads to insulin resistance. Insulin resistance occurs when body cells do not respond properly to insulin, resulting in elevated blood glucose levels.

The Relationship Between Depression Levels and Fasting Blood Glucose Levels in Type 2 Diabetes Mellitus Patients

The results of the *Spearman's Rank Correlation* statistical test showed a p-value of 0.922 (p-value > 0.05), meaning that H1 was rejected and Ho was accepted. The statistical test results indicated no significant relationship between depression levels and fasting blood glucose levels in patients with type 2 diabetes mellitus. The strength of the relationship is evident from the correlation coefficient value of -0.010, indicating a very low level of relationship between depression levels and fasting blood glucose levels, with a negative direction, meaning that as depression levels decrease in patients with type 2 diabetes mellitus, fasting blood glucose levels increase.

This study shows that there is no relationship between depression levels and fasting blood glucose levels in patients with type 2 diabetes mellitus. Fasting blood glucose levels in patients with type 2 diabetes mellitus tend to vary over time. The depression found at the time of the study showed insignificant results with the actual condition, and the majority of respondents were aware of their psychological condition and controlled their stress. Some respondents who concealed their condition were evident from their gestures while speaking and in their responses to the researcher's questions. These results indicate that managing type 2 diabetes mellitus is a complex issue, and psychological factors such as depression do not have a direct impact on fasting blood glucose control. Other factors such as diet, physical activity levels, and measurement timing can influence blood glucose levels. Therefore, identifying a direct relationship between depression and fasting blood glucose levels can be challenging due to these confounding factors (S & Kusuma, 2019).

The results of this study align with those of Mutiara Kartiko Putri (2018), who found no

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association between depression levels and fasting blood glucose levels in type 2 diabetes patients in Bandar Lampung. Mutiara Kartiko Putri (2018) used the same questionnaire as the researcher, the Beck Depression Inventory-II. Data analysis used the Chi-square test with a p-value of 0.406 > 0.05, indicating no significant relationship between depression levels and fasting blood glucose levels in patients with type 2 diabetes mellitus. Mutiara Kartiko Putri stated that the regulation between stressors in depressed individuals and insulin resistance in patients with type 2 diabetes mellitus differs. Each individual has a different response to depression and diabetes. Some people with depression may not experience a significant increase in their blood glucose levels.

CONCLUSION

Based on the research findings, it can be concluded that the characteristics of the respondents were predominantly female, aged 51–60 years, with a body mass index in the obese category, totaling 54 respondents (54%). Most respondents engaged in moderate-intensity physical activity, with 45 respondents (45%). Most respondents had moderate depression, with 34 respondents (34%). Based on fasting blood glucose levels, most respondents had high fasting blood glucose levels, with 89 respondents (89%). There is a significant relationship between body mass index and fasting blood glucose levels with a p-value of 0.041. There is a significant relationship between physical activity and fasting blood glucose levels with a p-value of 0.008. There is no significant relationship between depression levels and fasting blood glucose levels with a p-value of 0.922.

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