

## The Relationship between Stress Levels and Body Mass Index on Blood Sugar Levels in Type 2 Diabetes Mellitus Patients in The Working Area of Puskesmas Gemarang

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### Abstract

**Background:** Diabetes Mellitus (DM) is a disease that experiences chronic metabolic disorders as evidenced by an increase in blood glucose (hyperglycemia). This condition results in changes or disorders, both physical and psychological, in each sufferer. DM sufferers must depend on the diabetes therapy process. This results in problems, for example people suffering from DM are required to limit their diet, this makes people feel weak, every health problem can result in stressors. The factors that can influence the increase in DM, namely obesity or weight gain, are one of the symptoms of T2DM patients.

**Aims:** The aim of this study was to analyze the relationship between stress levels and body mass index with blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area.

**Methods:** The research method used is descriptive analytic with a cross sectional approach design. The sampling technique in this research was purposive sampling with a total of 47 samples.

**Results:** The results of research using Spearman's rho test analysis show that there is a relationship between stress levels and blood sugar levels ( $p$  value = 0.009), and there is a relationship between body mass index and blood sugar levels ( $p$  value = 0.005).

**Conclusion:** The conclusion is that there is a relationship between stress levels and body mass index and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area.

**Keywords:** *Diabetes Mellitus, Body Mass Index, Blood Sugar Levels, Stress Levels*

### INTRODUCTION

Diabetes Mellitus (DM) is a disease that experiences chronic metabolic disorders as evidenced by an increase in blood glucose (hyperglycemia), due to an imbalance between supply and demand which facilitates the entry of glucose into cells. Decreased or unavailability of insulin can cause glucose to remain in the blood, which can result in an increase in blood sugar, so that cells become deficient in glucose which is really needed for cell function (Adam & Tomayahu, 2019).

According to the World Health Organization (2022), it estimates that there will be an increase in DM sufferers in

Indonesia of around 21.3 million in 2030, this high incidence makes Indonesia rank 4th. According to Riskesdas (2018), the prevalence of DM in Indonesia ranks 4th. 7 with a total of 8.5 million DM sufferers including China, India, the United States, Brazil, Russia and Mexico. The prevalence of DM has increased from 6.9% in 2013 to 10.9% in 2018 for a total population of 250 million people. Based on the prevalence of DM sufferers in East Java Province, it is 6.8% of sufferers. Based on data from the Ngawi District Health Service, the prevalence of DM in 2018 was 6.9%. The number of sufferers of type 2 diabetes mellitus has increased over the past 3 years, as evidenced by data on DM sufferers of 38,159 cases in 2016, 43,279 cases in 2017,

and 57,085 cases in 2018 (Ngawi District Health Service, 2018).

DM has 2 types, including type I and type II. People who experience DMT 1 need an external supply of insulin (exogenous insulin), a kind of injection to maintain the life of DM sufferers. Without insulin, DM sufferers will experience diabetic ketoacidosis, which is a life-threatening condition resulting from metabolic acidosis. People with DMT 2 are insulin resistant, where the body or body tissues do not respond to the action of insulin. People with DMT 2 are required to maintain their diet, in order to prevent hypoglycemia or hyperglycemia. If the sufferer does not maintain their diet, this condition will continue throughout their life (Adam & Tomayahu, 2019).

The increasing number of DM sufferers is caused by risk factors including hereditary/genetic factors, obesity, lifestyle, diet, medication, lack of physical activity, the aging process, pregnancy, smoking habits and stress (Derek et al., 2017). This condition results in changes or disorders, both physical and psychological, in each sufferer. DM sufferers must depend on the diabetes therapy process. This results in problems, for example people suffering from DM are required to limit their diet, this makes people feel weak, every health problem can result in stressors (Adam & Tomayahu, 2019)

Stress is a non-specific body response when bodily functions are disrupted. Stress can cause excessive production of cortisol, cortisol is a hormone that opposes the effects of insulin and can cause blood sugar levels to increase. A person who experiences severe stress produces more and more cortisol in the body. This will reduce the body's sensitivity to insulin. The higher the level of stress experienced can cause blood sugar levels to increase, and

can make the situation worse (Suhandi et al., 2020).

The factors that can influence the increase in DM, namely obesity or weight gain, are one of the symptoms of DMT 2 patients. Body mass index (BMI) is used as a measurement of nutritional status which is influenced by a person's body weight. Nutritional status that is more than normal can result in insulin resistance, this has a big impact on increasing blood sugar levels and can worsen tissue and can cause complications (Suryanti et al., 2019). Adults with a BMI between 25 and 29.9 kg/m<sup>2</sup> are categorized as overweight and those with a BMI > 30 kg/m<sup>2</sup> are categorized as obese (Hanum et al., 2020). The risk of developing DM increases with increasing BMI above normal (Arif et al., 2017). Being overweight can make body cells insensitive to insulin (insulin resistance) (Isnaini & Hikmawati, 2016).

Based on a preliminary study conducted on November 30 2022 in the Gamarang Community Health Center working area, it was found that 10 people suffering from DMT 2 said they were stressed when their blood sugar levels rose because of the many rules so that blood sugar could be controlled. Based on the results of a preliminary study, 10 respondents were divided into 2 groups, 5 people filled out the stress level questionnaire, the results showed that 5 respondents experienced moderate stress, and 5 people with BMI measurements obtained results of 23.5 - 25.0, which could be categorized as overweight and obese. Some respondents said they did not know how to diet/manage the correct eating patterns and the average age of T2DM sufferers in the Gamarang Community Health Center working area was 40-70 years.

Based on the description above, seeing the large number of DM sufferers who experience stress and the large number of

DM patients who cannot maintain their lifestyle, the author wants to know whether there is a "Relationship between Stress Levels and Body Mass Index with Blood Sugar Levels in Type 2 Diabetes Mellitus Patients in the Community Health Center Working Area Gemarang."

## METHOD

This type of research uses quantitative research with analytical observational methods. The research design uses descriptive analytics using a Cross Sectional approach design.

The instruments used in this research were the DASS 42 questionnaire, Scales, Meters, and GCU.

### Sample

The sample in this study was 47 respondents in the Gemarang health center working area. This research was conducted on April 30 2023 in the Gemarang Community Health Center area.

### Design

Data analysis by hypothesis testing uses Spearman Rank to determine the relationship between independent and dependent variables with ordinal and ordinal data scales (Sopiyudin Dahlan, 2014).

## RESULTS

The results obtained in this research are:

**Table 1.** Distribution of respondents based on respondent age (n: 47)

| Age          | Frequency | Persentase (%) |
|--------------|-----------|----------------|
| 36 – 45      | 4         | 8,5            |
| 46 – 55      | 22        | 46,8           |
| 56 – 65      | 21        | 44,7           |
| <b>Total</b> | <b>47</b> | <b>100</b>     |

Source: Primary Data (2023)

From the results of this research, it was found that the majority of respondents were aged 46 - 55 years, with 22 respondents (46.8%). This research is in line with research by Saputra & Muflihatin, (2020) explaining that the majority of respondents aged > 40 years were 35 respondents (38.9%).

**Table 2.** Distribution of Respondents Based on Gender (n: 47)

| Gender       | Frequency | Persentase (%) |
|--------------|-----------|----------------|
| male         | 18        | 38,3           |
| Female       | 29        | 61,7           |
| <b>Total</b> | <b>47</b> | <b>100</b>     |

Source: Primary Data (2023)

The research results showed that 29 respondents (61.7%) were female. This research is in line with research by Masi & Mulyadi, (2017) explaining that the majority of patients who experience type 2 diabetes mellitus are female, 48 respondents (64.0%).

**Table 3.** Distribution of Respondents Based on Length of Suffering from DM (n: 47)

| Duration Of Diabetes Mellitus (Years) | Frequency | Persentase (%) |
|---------------------------------------|-----------|----------------|
| 1 – 5                                 | 13        | 27,7           |
| > 5                                   | 34        | 72,3           |
| <b>Total</b>                          | <b>47</b> | <b>100</b>     |

Source: Primary Data (2023)

The results of this study showed that 34 respondents (72.3%) had been suffering from DMT 2 > 5 years. This research is in line with research by Meidikayanti & Wahyuni, (2017) explaining that the majority of respondents who experienced DM for  $\geq 3$  years were 27 respondents (54%).

**Table 4.** Distribution of Respondents Based on Education (n: 47)

| Education    | Frequency | Persentase (%) |
|--------------|-----------|----------------|
| SD           | 30        | 63,8           |
| SMP          | 9         | 19,1           |
| SMA          | 5         | 10,6           |
| Sarjana      | 3         | 6,4            |
| <b>Total</b> | <b>47</b> | <b>100</b>     |

Source: Primary Data (2023)

The results of this research show that the highest level of education is elementary school with 30 respondents (63.8%). The results of this research are in line with Pahlawati & Nugroho, (2020) research, which showed that the highest education results were elementary school with 40 respondents, 36.0%.

**Table 5.** Distribution of Respondents Based on Occupation (n: 47)

| Work          | Frequency | Presentase (%) |
|---------------|-----------|----------------|
| Laborer       | 17        | 35,2           |
| IRT           | 20        | 42,6           |
| PNS           | 4         | 8,5            |
| Self-Employed | 6         | 12,8           |
| <b>Total</b>  | <b>47</b> | <b>100</b>     |

Source: Primary Data (2023)

The results of this research show that the majority are housewives with 20 respondents, 42.6%. This research is in line with research by Masi & Mulyadi, (2017), which showed that the largest number of respondents were housewives with 22 respondents (59.5%).

**Table 6.** Relationship between Stress Levels and Blood Sugar Levels in Type 2 Diabetes Mellitus Patients in the Gemarang Community Health Center working area

| Variable                              | Koeffiensi korelasi (r) | P Value |
|---------------------------------------|-------------------------|---------|
| Stress Levels with Blood Sugar Levels | 0,375                   | 0,009   |

Source: Primary Data (2023)

The research results stated that the Spearman's rho test showed a p value of 0.009 ( $< 0.05$ ). This can be interpreted as meaning that there is a significant relationship between stress levels and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a correlation value for the two variables, namely 0.375.

**Table 7.** Relationship between Body Mass Index and Blood Sugar Levels in Type 2 Diabetes Mellitus Patients in the Gemarang Community Health Center working area

| Variable                                | Koeffiensi korelasi (r) | P Value |
|-----------------------------------------|-------------------------|---------|
| Body Mass Index with Blood Sugar Levels | 0,399                   | 0,005   |

Source: Primary Data (2023)

The research results stated that the Spearman's rho test showed a p value of 0.005 ( $< 0.05$ ). This can be interpreted as meaning that there is a significant relationship between body mass index and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a correlation value for the two variables, namely 0.399.

## DISCUSSION

Table 1 was found that the majority of respondents were aged 46 - 55 years, with 22 respondents (46.8%). This research is in line with research by Saputra & Muflihatin, (2020) explaining that the majority of respondents aged  $> 40$  years were 35 respondents (38.9%).

The risk factor for DMT 2 is age over 30 years, this is due to anatomical, physiological and biochemical decline, where changes start at the cellular level, and continue at the tissue level and end at the organ level, this can cause hemostasis. The chairman of the Indonesian Diabetes Association explained that DMT 2 is often found in adults aged over 40 years (Masi & Mulyadi, 2017).

Based on the results above, the researchers assumed that people suffering from DMT2 in this study were mostly aged  $> 45$  years. This is because increasing age will cause a decrease in the function of the body's organs, this can cause an increase in sugar levels above normal.

Table 2 showed that 29 respondents (61.7%) were female. This research is in line with research by Masi & Mulyadi, (2017) explaining that the majority of patients who experience type 2 diabetes mellitus are female, 48 respondents (64.0%).

According to Masruroh, (2018) explained that DM is more common in women than men. This is because women have higher levels of bad cholesterol compared to men and there are also differences in carrying out daily activities and lifestyle, besides that women have higher levels of lipids (blood fat) than men, so women have a higher tendency to experience increased blood sugar levels than men.

Based on the results above, researchers assume that DMT 2 is more common in women because women have a greater chance of experiencing DMT 2 due to the large amount of bad cholesterol and high lipid levels, lack of activity and hormonal processes which can cause an increase in blood sugar levels above normal.

Table 3 showed that 34 respondents (72.3%) had been suffering from DMT 2 > 5 years. This research is in line with research by Masi & Mulyadi, (2017) explaining that the majority of respondents who experienced DM for  $\geq 3$  years were 27 respondents (54%).

The duration of the disease is closely related to the age at which DM was first diagnosed. The younger the patient is diagnosed with DM, the longer the patient experiences DM and the greater the chance of suffering from chronic hyperglycemia which will cause DM complications in the form of retinopathy, nephropathy, CHD and diabetic ulcers. This is because the long duration of DM will cause a state of hyperglycemia which continuously initiates hyperglycolia, namely where the cells are

mostly glucose. Chronic hyperglycosis will change the biochemical homeostasis of cells which has the potential to experience basic changes in the formation of chronic complications in DM sufferers (Suryanti et al., 2019).

Based on the results above, researchers assume that the duration of suffering from DM depends on how a person regulates their diet so that blood sugar levels can be controlled and how a person can improve their quality of life so that they can maintain their life by controlling their sugar levels every month.

Table 4 showed that the highest level of education is elementary school with 30 respondents (63.8%). The results of this research are in line with Pahlawati & Nugroho, (2020) research, which showed that the highest education results were elementary school with 40 respondents, 36.0%.

A person's level of education can influence a person's level of knowledge in knowing new things (Saputra & Muflihatin, 2020). The higher the level of education, the more knowledge they will have about health. With this knowledge, they will have awareness of maintaining health. Increasing the level of education will influence the level of awareness of healthy living and paying attention to lifestyle and eating patterns (Pahlawati & Nugroho, 2020)

Based on the results above, the researcher assumes that the level of education has an important role in a person's response to something that originates from outside, high levels of low education cause low levels of knowledge, this can influence wrong diet patterns which can cause obesity and because of a lack of knowledge can cause lack of treatment for DM, it is hoped that the family can motivate them so that blood sugar levels can be controlled and prevent complications.

Table 5 showed that the majority are housewives with 20 respondents, 42.6%. This research is in line with research by Masi & Mulyadi, (2017), which showed that the largest number of respondents were housewives with 22 respondents (59.5%).

Sukmaningsih, (2016) stated that the type of work has an important role in the occurrence of disease through the presence or absence of physical activity at work, so it can be stated that a person's type of work can influence their level of physical activity. According to Arimbi et al., (2020) explained that housewives carry out activities at home such as washing, cooking and cleaning the house, and other activities. Physical activity will have an effect on increasing insulin, this will lead to a reduction in blood sugar levels. If insulin is not sufficient to convert glucose into energy, it will cause DM 2. The work of housewives is light activity so housewives are more susceptible to DM.

Based on the results above, researchers assume that the type of work has a close relationship with the incidence of DMT2. Based on the data above, many housewives experience DMT2 due to lack of activity where insulin cannot convert glucose into energy, this causes blood sugar levels to be unstable.

Table 6 was stated that the Spearman's rho test showed a p value of 0.009 ( $< 0.05$ ). This can be interpreted as meaning that there is a significant relationship between stress levels and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a correlation value for the two variables, namely 0.375.

Based on research by Nursucita & Handayani, (2021) stress is a factor that can influence blood sugar levels in DMT 2 patients. High levels of stress and lack of

control over stress levels can result in DMT 2 sufferers finding it difficult to control blood sugar levels. Stress in DM patients is caused by the many rules for a healthy life. DM sufferers must follow different new rules and routines, such as maintaining a diet and doing physical activity so that blood sugar levels can be stable (Nurzani et al., 2020).

Based on the results of the analysis above, researchers assume that stress is a factor that causes blood sugar levels to rise above normal, stress is caused by the many rules that patients must follow and the many problems that come from various factors including environmental factors, thoughts and oneself. This can cause patients to be unable to control their diet and lifestyle, resulting in uncontrolled sugar levels and causing hyperglycemia.

Table 7 was stated that the Spearman's rho test showed a p value of 0.005 ( $< 0.05$ ). This can be interpreted as meaning that there is a significant relationship between body mass index and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a correlation value for the two variables, namely 0.399.

Risk factors for DM are due to lack of physical activity and high consumption of carbohydrates, protein and fat, this can lead to obesity. Obesity causes an increase in fatty acids, high free fat deposits can cause increased cell uptake of free fatty acids and cause fat oxidation which will inhibit the use of glucose in the blood (Komariah & Rahayu, 2020). Obesity has a risk of developing DMT2 which is 4 times greater than people who have normal nutritional status (Pangestika et al., 2022).

Based on the results of the analysis above, the researcher assumes that someone who has a BMI more than normal will be more at risk of developing DMT2, this is due to

lack of activity and a large amount of food intake that is not excreted, resulting in fat accumulation in the body, this can cause insulin resistance resulting in can increase blood sugar levels above normal.

## CONCLUSION

There is a relationship between stress levels and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a p-value of 0.009 ( $p < 0.05$ ) with a correlation value between variables of 0.375.

There is a relationship between body mass index and blood sugar levels in type 2 diabetes mellitus patients in the Gemarang Community Health Center working area with a p-value of 0.005 ( $p < 0.05$ ) with a correlation value between variables of 0.399.

## Abbreviations

WHO: World Health Organization; DM: Diabetes Mellitus; DMT 1: Type 1 Diabetes Mellitus; DMT 2: Type 2 Diabetes Mellitus; BMI: Body mass index.

## Declarations

1. This research has received ethical approval with NO 371/ III/ HREC/ 2023 and has been approved by respondents using informed consent.
2. This research does not conflict with anyone's interests
3. In this research there is availability of respondents
4. In this research the researcher contributed with a research assistant
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- f. Respondents who have participated in helping the research complete the research

## Ethics Approval and Consent Participant

Before the research is carried out, the researcher determines where the research will be carried out, and when the researcher invites respondents, the researcher explains the purpose of this research.

## Conflict of Interest

In this research there are no other interests besides research, and there are no problems in this research.

## Availability of Data and Materials

Research tools and materials are provided by researchers.

## Authors' Contribution

Pratiwi conceptualized the study; Pratiwi created the methodology; Pratiwi wrote,

reviewed, and edited the manuscript; Pratiwi wrote the original draft.

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