Cross Sectional Studies: the Relationship between Medication Adherence and Blood Sugar Levels of Type 2 Diabetes Mellitus Patients

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Abstract. Currently, non-communicable diseases are a fairly large public health problem in Indonesia, including diabetes mellitus. Diabetes Mellitus is a long-term metabolic disorder characterized by extremely high blood sugar content, insulin resistance, and relative lack of insulin. Blood sugar levels of people with diabetes mellitus need to be controlled by regularly taking medication. But there are still many people with diabetes mellitus who are less obedient to taking medicine. The purpose of this study was to determine the relationship between medication adherence and blood sugar levels in patients with Type 2 Diabetes Mellitus in the Working Area of Pucang Sewu Health Center Surabaya. The results of this study increase the awareness of Type 2 Diabetes Mellitus patients to be obedient to taking medication so that their blood sugar is controlled. Method: This research is a correlational analytical research with a cross-sectional approach. Data collection was carried out by interviews using questionnaires, measurement of random blood sugar levels, filling in the table of taking medication. Results: The results of the study proved a significant relationship between adherence to taking medication and blood sugar levels (p-value = 0.001<0.05). Conclusion : There is a significant relationship between medication adherence and blood sugar levels of Type 2 Diabetes Mellitus patients in the working area of Pucang Sewu Health Center, Surabaya city. Implication of this study is recommended that people with type 2 diabetes mellitus increase adherence to taking medication so that blood sugar levels remain controlled.

Keywords: Compliance, Taking Medications, Blood Sugar Levels, Type 2 Diabetes Mellitus.

T. Triwiyanto et al. (eds.), *Proceedings of the 6th International Conference of Health Polytechnic Surabaya (ICoHPS 2023)*, Advances in Health Sciences Research 72,
https://doi.org/10.2991/978-94-6463-324-5_47

1 Introduction

Diabetes Mellitus (DM) is a disease caused by increased blood sugar levels (hyperglycemia) due to the inability of the pancreas to produce insulin. Type I diabetes mellitus occurs when the body is unable to produce insulin, while type II diabetes mellitus occurs when the body cannot receive and process insulin effectively. According to a report from the International Diabetes Federation (IDF), in 2019, there were 463 million people or 9.3% of the world's population of people >20 years suffering from Diabetes Mellitus. In Asia and Australia (Western Pacific), the number of people with diabetes mellitus aged 20 years has reached 162.6 million with 1.2 million deaths. Indonesia is the 6th highest country with cases of people with diabetes mellitus, with the prevalence of diabetes mellitus based on a doctor's diagnosis for the age of 15 years is 2% [1]. Several methods are used to treat type 2 DM so that the patient's blood sugar levels are controlled, among others, by taking anti-diabetic drugs. However, there are still many people with type 2 diabetes who are less compliant in taking drugs so that blood sugar levels become uncontrolled. Currently, the prevalence of diabetes mellitus is dominated by the number of patients who are not detected and who do not take medication around 73% of the total DM sufferers in Indonesia [2]. Based on preliminary studies in the working area of Pucang Sewu Health Center Surabaya, medication adherence in diabetes mellitus patients with a high adherence rate obtained a percentage of 25%, moderate adherence of 12.5% and low adherence of 62.5%.

The increasing prevalence of diabetes mellitus, causing an increased risk of complications due to diabetes mellitus. Acute complications of type 2 diabetes mellitus (T2DM) include diabetic ketoacidosis, hyperglycemia, hyperosmolar states, and hypoglycemia. Meanwhile chronic complications consist of blindness, kidney failure, heart attack, stroke, and lower extremity amputation. Cardiovascular complications and stroke are the number one cause of type 2 diabetes mellitus morbidity worldwide, where there are 70% of deaths in diabetics. While in Asian countries, it is found that more than 50% of kidney failure is caused by diabetes mellitus [3]. The risk of these complications can be reduced by maintaining good blood sugar levels. It is the daily responsibility of diabetes mellitus patients in managing and controlling blood glucose levels to prevent complications [4].

DM is a lifestyle-related disease, so the success or failure of DM management depends on the patient himself in changing his behavior. Rosyida et al. (2015) in Handayani et al (2019), stated that non-adherence to undergoing medication therapy is one of the Drug Therapy Problems (DTP) that needs special attention. Meanwhile, previous research showed that 70% of diabetes mellitus patients do not comply with taking medication because they forget or are lazy [5]. There are several types of anti-diabetic drugs with different clinical effects, including reducing liver gluconeogenesis, stimulates the pancreas to secrete insulin, increases the sensitivity of peripheral tissues to insulin provides insulin exogenously [6]. The role of health workers in efforts to handle diabetes mellitus can be done with an approach through providing motivation, checking blood sugar levels at least once a month and providing education to families to play a role in reminding patients to be obedient to taking medication.

The purpose of this study was to determine the relationship between medication adherence and blood sugar levels in patients with Type 2 Diabetes Mellitus in the Working Area of Pucang Sewu Health Center Surabaya. People with type 2 diabetes must consume anti-diabetic drugs regularly and regularly so that blood sugar levels are controlled. The results of this study can be used as educational material in increasing knowledge and increasing patient insight into the importance of taking medication and then will be obedient to taking medication so that blood sugar levels are con-trolled.

2 Materials and Method

This study uses a correlational research design that explains a relationship, estimates, and tests based on existing theories. The approach used is cross-sectional where the measurement / observation of independent and dependent variable data is only once at a time [7]. This study aimed to reveal the correlative relationship between adherence to taking diabetes medication with blood sugar levels in Type 2 Diabetes Mellitus patients. The respondents were Type 2 Diabetes Mellitus patients in the Pucang Sewu Pusk-esmas Working Area Surabaya, both men and women aged ≥ 26 years as many as 100 people. Data collection was carried out by interviews using questionnaires, measurement of random blood sugar levels, and filling in sheets of medication tables. Data analysis using spearman rank test to determine the relationship between adherence to taking diabetes medication and blood sugar levels in Type 2 Diabetes Mellitus patients.

3 Result

3.1 Characteristics of Respondents

Table 1. Characteristics of Type 2 Diabetes Mellitus Patiens in the Working Area of Pucang Sewu Health Center Surabaya in June 2023.

No.	Characteristics	Category	Frequency	Percentage (%)
1.	Age	26 – 45 Years	6	6
		46 – 55 Years	24	24
		> 56 Years	70	70
		Total	**100**	**100**
2.	Gender	Male	30	30
		Women	70	70
		Total	**100**	**100**
3.	Last Education	Not Schooling	2	2
		Elementary school	30	30
		Junior high school	28	28
		Senior High School	28	28
		College	12	12
		Total	**100**	**100**
4.	Jobs	Private	9	9

No.	Characteristics	Category	Frequency	Percentage (%)
		Entrepreneur	3	3
		Traders	12	12
		Household Assistant	1	1
		Retired	9	9
		Housewives	54	54
		Not Working	12	12
		Total	**100**	**100**
5.	Length of Suffering	0 – 5 Years	38	38
		6 – 10 Years	40	40
		> 10 Years	22	22
		Total	**100**	**100**
6.	Duration of drug Consumption	0 – 5 Years	39	39
		6 – 10 Years	43	43
		> 10 Years	18	18
		Total	**100**	**100**

Table 1 shows the distribution of most (70%) respondents in the elderly age range (>56 years), most (70%) women, and almost half (30%) have a primary school education. Most (54%) respondents are housewives, almost half (40%) have had diabetes mellitus for 6 – 10 years, and almost half (43%) have been taking medication for 6 – 10 years.

3.2 The Relationship Between Adherence to Taking Medication and Blood Sugar Levels of Type 2 Diabetes Mellitus Patients

Table 2. Adherence to Taking Medication of Type 2 Diabetes Mellitus Patients in the Work Area of the Pucang Sewu Health Center in Surabaya in June 2023.

Medication Adherence	Frequency (F)	Percentage (%)
Low Adherence	55	55
Moderate Adherence	22	22
High Adherence	23	23
Total	**100**	**100**

Table 2 shows the adherence rate of medication in patients with type 2 diabetes mellitus mostly in the low category.

Table 3. Blood Sugar Levels of Type 2 Diabetes Mellitus Patients in the Work Area of the Pucang Sewu Health Center in Surabaya in June 2023.

Blood Sugar Levels	Frequency (F)	Percentage (%)
Abnormal	63	63
Normal	37	37
Total	**100**	**100**

Table 3 shows most (63%) respondents had abnormal blood sugar levels.

Table 4. Correlation Compliance with Taking Medication and Blood Sugar Levels in Patients with Type 2 Diabetes Mellitus in the Working Area of the Pucang Sewu Health Center in Surabaya in 2023.

Medication Adherence	Blood Sugar Levels				Total		*P* Value
	Abnormal		Normal				
	F	%	F	%	F	%	
Low Adherence	48	87,3%	7	12,7%	55	100%	0,000
High Adherence	2	8,7%	21	91,3%	23	100%	
Moderate Adherence	13	59%	9	41%	22	100%	
Total	63	63%	37	37%	100	100%	

Table 4 shows the results of the spearman rank test with a sig value of 0.000 (< 0.05) which means that there is a significant relationship between medication adherence and blood sugar levels of patients with type 2 Diabetes Mellitus in the working area of Pucang Sewu Health Center, Surabaya city.

4 Discussion

4.1 Medication Compliance Level in Patients with Type 2 Diabetes Mellitus

The results showed that out of 100 people with type 2 diabetes mellitus, it was found that most (55%) people with type 2 diabetes mellitus had a low level of adherence to taking medication, a small proportion (23%) of patients with type 2 diabetes mellitus had a high level of adherence to taking medication, a small proportion (22%) of patients with type 2 diabetes mellitus had a moderate level of adherence to taking medication.

The results of the same study were shown by research conducted by Misra, et al, that is, most patients did not adhere to taking antidiabetic drugs. Research conducted in India concluded that there is a relationship between medication adherence and quality of life of patients with type 2 diabetes mellitus [8]. While the study conducted by Achappa S showed different results from the study where patients with good health as much as 80% and poor adherence as much as 20%. However, this study showed that most of the results of random blood sugar levels of diabetes mellitus patients were not controlled [9]. Different results were also shown in a study conducted by Eliza, et al, where high adherence was 37.8% while medium and low adherence were 31.1% respectively. Although adherence to taking medication high, medium and low drugs, showed an insignificant difference, the results of this study concluded a relationship between medication adherence and blood sugar levels but there was no relationship between medication adherence and the quality of life of diabetes mellitus patients [10]. However, there are studies that show results that are not much different from this study, namely most (74.62%) diabetes mellitus patients do not take medication for different reasons. Most said that they did not take medicine because they for-

got, some said because they felt healthy, did not have a s upply of medicine at home, because they were busy and did not want to depend on medicine [11].

Treatment adherence is taking medication as advised by a doctor or injected by the patient within a certain period of time or at least 80% of the amount of medication prescribed by the doctor at the same time. Treatment adherence is an important factor that affects good metabolic rate, quality of life, and reduced hospitalization costs [12]. Adherence to taking medication in patients with diabetes mellitus is influenced by several factors. The first factor relates to himself. A person who is obedient to taking medicine comes from his own self-awareness and feels that taking medicine is his need. The second factor relates to interpersonal and organization. Someone obedient or disobedient to take medication because of the presence or absence of support from people around including family support and co-workers. The third factor relates to the community in which the patient lives. Patient adherence to taking medication is accompanied by concerns about discrimination from society that makes patients not comply with taking medicine [13].

There are still many people with type 2 diabetes mellitus who still have low medica-tion adherence due to age. Based on the data obtained, most of them are in the elderly age range (> 56 years), old age or the elderly have the opportunity to be disobedient with respect to memory. In addition, the drugs consumed cause side effects that make patients uncomfortable, especially when taking metformin. The results of the questionnaire obtained many who felt uncomfortable when using the drug. Saturation or boredom can also affect adherence, especially for patients who have had diabetes mellitus for a long time and are taking medication. Based on the data obtained, almost half have diabetes mellitus for 6-10 years and have been taking drugs for 6-10 years. However, there are some people with type 2 diabetes mellitus who have high medication adherence.

Patient compliance is a behavior that must be carried out by people with type 2 diabetes mellitus to carry out their obligations to take medication regularly. Based on the data, it was found that a small proportion (23%) had a high level of adherence to taking medication. This is important for type 2 diabetes mellitus patients to achieve treatment goals and be effective in preventing some complications of diabetes mellitus, where good and correct medication adherence will be very beneficial for the patient, both in terms of health or recovery from the disease they are suffering from. The method used by people with type 2 diabetes mellitus to support the treatment of diabetes mellitus is by taking medication as recommended. High medication adherence needs to be supported by the role of the family by always supervising and reminding patients to take medication regularly. In addition, the role of health workers is needed to provide information to patients about the importance of adherence in treatment so that there is no sudden increase in blood sugar levels and interfere with health conditions for activities.

4.2 Blood Sugar Levels in Type 2 Diabetes Mellitus Patients

The results showed that out of 100 people with type 2 diabetes mellitus, it was found that the majority (63%) of people with type 2 diabetes mellitus had abnormal blood

sugar and almost half (37%) of people with type 2 diabetes mellitus had normal blood sugar.

Similar results to this study were shown by Haase C which obtained the results of half of diabetic patients achieving good blood sugar control, increasing chronic complications and mortality and reducing the quality of life of diabetes mellitus patients [14]. Other studies showed different results to this study where the overall prevalence of diabetes mellitus patients with high blood sugar levels was 45.2%. In this study there are several factors that affect the poor control of blood sugar levels, including the consumption of antidiabetic drugs with insulin, the level of understanding of patients the practice of taking inappropriate patient drugs [15]. Another study on blood sugar control in patients with type 2 diabetes mellitus, showed that most DM patients (54.8%) had uncontrolled blood sugar levels. A study conducted on 957 Type 2 diabetes mellitus patients in Northern Thailand also concluded that forgetting to take antidiabetic drugs is one of the things associated with uncontrolled blood sugar levels in DM patients [16].

Type 2 Diabetes Mellitus (DMT2) is characterized by blood glucose that continues to rise. Several factors can increase a person's blood sugar levels, both internal and external factors. External factors include a person's diet and lifestyle while internal factors are related to the function of the hormones glucagon, ephineprin and cortisol. Glucose is an element used by all cells especially glucose-dependent cells including red, white, blood cells, and renal papilla cells. Management of T2DM is leading to improvements in blood sugar level control [17]. Uncontrolled blood sugar levels in type 2 DM patients are also associated with several disorders including blood disorders that cause vascular complications. Hematological changes encountered in T2DM patients include changes in the function, structure, and metabolism of red blood cells, white blood cells, platelets, and coagulation systems, Anemia is a common hematological change in patients with T2DM with varying prevalence and often undetected. Another mechanism for uncontrolled blood sugar levels is insulin resistance, which is associated with endothelial dysfunction, an increase in inflammation levels that accelerates vascular complications in T2DM [18]. The success of diabetes mellitus management is monitoring blood sugar levels of diabetes mellitus patients. Achieving and maintaining controlled blood sugar levels is essential in preventing acute and chronic complications. Self-monitoring of blood sugar is important to optimize diabetes therapy in individuals with diabetes, especially those who depend on insulin therapy and anti-diabetic drugs. By monitoring blood sugar independently, diabetes mellitus patients can find out their blood sugar levels [19].

Patients with type 2 diabetes mellitus who have abnormal blood sugar levels can be caused by other factors such as stress. In stressed people, the sympathetic nervous system activates and causes various changes that occur in the body, one of which is the process of gluconeogenesis, namely the breakdown of glucogen into glucose into the blood, so that it can increase blood glucose levels. Stress causes excessive cortisol production. Cortisol is a hormone that inhibits insulin action which causes high blood glucose in the body. High stress levels will trigger blood glucose levels to increase. However, there are some people with type 2 diabetes mellitus who have normal blood

sugar levels. This can be caused by physical activity factors such as walking and participating in gymnastics.

How to control/reduce blood sugar levels in patients with type 2 diabetes mellitus apart from adhering to taking medication regularly also needs to control body weight through exercise, reducing excess stress and a healthy diet by reducing consumption of sugar and fatty foods.

4.3 The Relationship of Adherence to Taking Medications with Blood Sugar Levels of People with Type 2 DM

The results showed $p = 0.000 < \alpha = 0.05$, meaning that there was a significant relationship between medication adherence to blood sugar levels in individuals with type 2 diabetes mellitus in the Pucang Sewu Health Center Surabaya Working Area.

Out of 100 people with type 2 diabetes mellitus, there were 55 people with type 2 diabetes mellitus who had a low level of adherence to taking medication including almost all (87.3%) people with type 2 diabetes mellitus had abnormal blood sugar and a small proportion (12.7%) people with type 2 diabetes mellitus had normal blood sugar. There were 23 people with type 2 diabetes mellitus who had a high level of adherence to taking medication, including almost all (91.3%) people with type 2 diabetes mellitus had normal blood sugar and a small proportion (8.7%) of people with type 2 diabetes mellitus had abnormal blood sugar. There were 22 type 2 diabetes mellitus patients who had a moderate level of adherence to taking medication, of which most (59%) type 2 diabetes mellitus patients had abnormal blood sugar and almost half (41%) type 2 diabetes mellitus patients had normal blood sugar.

The same results were shown by the Ethiopian State study which concluded that medication adherence was significantly related to patients' blood sugar levels. The study also found medical expenses, monthly income, independent blood sugar levels, and medical conditions had significant associations with medication adherence [20]. Meanwhile, Nuari, et al in their research on diabetes compliance showed the same results as this study. Diabetes adherence in question includes dietary adherence, exercise adherence, medication adherence, and adherence to monitoring blood sugar levels independently [21]. Different results were shown in other studies, where the factor of non-adherence to the diabetes mellitus treatment program did not affect the instability of blood sugar levels of diabetes mellitus patients [22].

The results of this study are supported by the theory that blood sugar levels are affected by the use of oral hypoglycemia drugs and insulin. Mechanisms of action of drugs to lower blood sugar levels include stimulating the pancreas gland to increase insulin production, reducing glucose production in the liver, and inhibiting the digestion of carbohydrates so as to reduce glucose absorption and stimulate receptors [23]. Well-controlled blood glucose is influenced by several factors including adherence to diit, physical activity, adherence to taking medication, lifestyle and anxiety levels. Adherence to medication is important because it depends on the awareness of the patient himself. Diabetes self management is an important program for patient in maintaining their blood sugar levels [24]. The main goal of treatment of diabetic patients is to maintain blood sugar levels and prevent diabetes-related complications,

reduce morbidity and mortality. However, many patients are less than optimal in the treatment program, causing treatment failure. To prevent complications of diabetes requires monitoring blood sugar levels. lifestyle modification and medication adherence. Non-adherence to treatment continues to be a barrier so that treatment results become ineffective. risk of hospitalization, increased morbidity and mortality in patients with type 2 diabetes mellitus [25].

Patients with type 2 diabetes mellitus who have a low level of adherence have abnormal blood sugar levels. This can happen because it is related to memory, so they forget to take medication or cause side effects that make the patient uncomfortable. In addition, feeling bored or bored can also affect adherence, especially for patients who have had diabetes mellitus for a long time and are taking medication. Based on the data obtained, almost half have diabetes mellitus for 6-10 years and have been taking drugs for 6-10 years. Compliance with taking medication is one of the factors related to controlling blood sugar levels in type 2 diabetes mellitus patients where patients with low levels of adherence to taking medication have poor blood sugar control.

The weakness of this study is that it did not identify the type of diabetes medication taken and blood sugar levels were only categorized as normal and abnormal. For the next study, it is expected to identify the type of diabetes mellitus drugs consumed and blood sugar levels are classified quantitatively (using numbers).

5 Conclusion

The conclusion in this study was that there was a significant association between medication adherence and and blood sugar levels in patients with type 2 diabetes mellitus. The findings in this study were that patients with high medication adherence tended to have normal sugar levels, while patients with low medication adherence had abnormal sugar levels. Based on this, patients with type 2 diabetes mellitus are advised to be obedient to taking medication so that blood sugar levels are controlled. In future studies it is expected to identify the type of drugs taken, identify other methods in the management of diabetes mellitus including diit patterns, physical activity. The category of blood sugar levels is recommended to use data in the form of numbers from measuring blood sugar levels.

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