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Risk factor analysis and preventive health behavior in the control of blood glucose among patients with type II diabetes mellitus: A community-based cross-sectional study

Panondang N. Panjaitan[1]*, Pius Weraman, Apris A. Adu
[1] *Public Health Science Study Program, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, 85228, Indonesia.*
*Correspondence: panondangpanjaitan00@gmail.com

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ABSTRACT

Background: Diabetes Mellitus (DM) Disease is rapidly increasing in Indonesia. This disease is defined as either our random blood glucose level >200 mg/dL or fasting blood glucose level >126 mg/dL. Maintaining a controllable blood glucose level (either less than 200 mg/dL for random blood glucose level or less than 126 mg/dL for fasting blood glucose level) in Type II DM patients is obviously playing an important role to avoid any complications such as stroke disease, heart disease and kidney failure. The purpose of this research is to analyze the risk factors contributing to uncontrolled blood glucose in Type II DM patients who come to visit Alak Public Health Centre, city of Kupang. **Methods:** This research is a quantitative analytic study with cross sectional method, with a total sample of 68 respondents. The statistical analysis carried out by Computer Program is univariate, bivariate and multivariate analysis. **Findings:** The result of this research shows significant factors contributing to uncontrolled blood glucose level are Body Mass Index (BMI) p value=0.003, patients compliance (p value=0.003), Knowledge of DM (p value=0.011), Regular Physical Activity (p value=0.000), Food Order (p value=0.024), Smoking (p value=0.524) and family support (p value=0.077). The dominant factor which has more significant effect on uncontrolled blood glucose level in Type II DM patients is regular physical activity (p value=0.001). **Conclusion:** Uncontrolled blood glucose in Type II DM patients is strongly influenced by multiple behavioral and lifestyle factors, with regular physical activity being the most dominant. Strengthening patient education, compliance, and health promotion at the primary care level is essential to improve glycemic control and prevent complications. **Novelty/Originality of this article:** In order to maintain controlled blood glucose level in Type II DM patients it is suggested that all health workers in public health centre pay more promotive measure to risk factors affecting the bllood glucose in Type II DM patients with effective medias and methods.

KEYWORDS: BMI; blood glucose level; care; DM patients; patient compliance.

1. Introduction

Diabetes Mellitus (DM) or diabetes is a chronic or chronic metabolic disorder characterized by chronic hyperglycemia or high blood sugar levels. Blood sugar levels in DM patients when fasting are above 126 mg/dL or when blood sugar levels are above 200 mg/dL (Perkeni, 2020). DM disease is one of the non-communicable diseases (NCD) which is quite high in Indonesia after high blood pressure or hypertension. Based on the results of riskesdas data conducted in 2018, it was found that the prevalence of Diabetes Mellitus in

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people aged over 15 years in Indonesia increased to 10.9% in 2018 from 6.9% in 2013 (Riskesdas 2018; Hans, 2017). There was an increase of 5% in five years in the prevalence of DM in Indonesia. Many DM patients do not routinely go to health facilities, either Community Health Centers or hospitals to monitor their blood sugar levels. Controlled sugar levels can reduce or reduce the impact and risk of complications of DM such as stroke, kidney failure, heart disease which can cause death (Ministry of Health, 2021). Diabetes Mellitus patients are a group that is vulnerable to the risk of infections such as Tuberculosis (TB). DM patients whose blood sugar levels are uncontrolled are a group that is very vulnerable to serious complications and death from Covid-19 infection. According to the latest research conducted by Tim

Based on data from the Ministry of Health, 35% of Covid deaths had comorbid DM disease whose blood sugar levels were not controlled and had not been vaccinated. Maintaining blood sugar levels in DM patients is very important to reduce complications that will occur in DM patients. The number of DM patients handled by the Alak Community Health Center in the January-December 2023 period was 233 DM patients, of which only 42 DM patients at the Alak Community Health Center or 18% were DM patients whose blood sugar levels were controlled, while almost 82% of DM patients had uncontrolled blood sugar levels (Report PTM Pusk Alak, 2023).

The number of DM patients handled by the Alak Community Health Center in the January-December 2023 period was 233 DM patients, of which only 42 DM patients at the Alak Community Health Center or 18% were DM patients whose blood sugar levels were controlled, while almost 82% of DM patients had uncontrolled blood sugar levels (Kupang City Health Service, 2023). Diabetes mellitus cases in Indonesia experience an increase in cases every year. Based on the results of the 2018 riskesdas in NTT province, around 0.57% of the Indonesian population experienced Diabetes Mellitus, where in Kupang City, 1.01% of the population of Kupang City experienced DM (East Nusa Tenggara Provincial Health Service, 2018). Handling DM patients according to standards with the aim of controlling blood sugar levels must be a guideline in the management of DM patients. DM patients with controlled blood sugar levels will have a positive impact on the health of DM patients in the form of reducing the risk of DM complications they experience. Reducing the risk of complications will improve the quality of life of DM patients and have a positive impact on families and society. DM patients whose blood sugar levels are controlled reduces the economic burden and complications of the disease.

2. Methods

This research is an analytical observational study with a cross sectional approach (Sugiyono, 2009). The population in this study was 233 patients suffering from Type II Diabetes Mellitus, both with controlled and uncontrolled blood sugar levels. There are 42 controlled type II DM patients while the remaining 191 DM patients whose blood sugar levels are not controlled are in the Alak Community Health Center working area who have been undergoing treatment for type II DM for more than a year.

The sample in this study was 68 type II DM patients, both with controlled and uncontrolled blood sugar levels. This research was carried out in the work area of the Alak Health Center, Kupang City, where the research time in the form of data collection and data processing will be carried out within one month after the letter of approval for conducting research and research ethics letters as well as all necessary administration have been issued by Nusa Cendana University. The dependent variable in this research is blood sugar levels Meanwhile, the independent variables in this study are Body Mass Index (BMI), 3 Patient Compliance, Patient Knowledge, Physical Activity, Adjusting Diet, Smoking, Stress and Family Support.

3. Result and Discussion

3.1 Body mass index (BMI)

From the Table 1, the percentage of normal BMI whose blood sugar levels are controlled is 33.3%, while normal BMI which is not controlled is 66.7%. The percentage of excess BMI whose blood sugar levels are controlled is 5.3%, while those with excess BMI whose blood sugar levels are uncontrolled is 94.7%. From the results of the analysis, we got p value=0.003 or (<0.05) which indicates that there is a significant relationship or correlation between BMI (Body Mass Index) and whether blood sugar levels are controlled or not in Type II DM patients.

Table 1. Analysis of the effect of body mass index (BMI) on uncontrolled blood sugar levels in DM patients

BMI	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Normal BMI	10	33.3	20	66.7	30	100	0.003
Excessive BMI	2	5.3	36	94.7	38	100	0.003
Total	12	17.6	56	82.4	68	100	0.003

Obesity or being overweight is a risk factor for diabetes in humans, however, disruption of insulin production in the body results in glycogenogenesis which causes DM patients who were previously fat to experience weight loss as if they were normal weight or thin is the result of the weight loss experienced by DM patients. BMI is a description of body weight and a person's height status, where the risk of being overweight or obese with the accumulation of fat that occurs in the body results in metabolic disorders in the body so that these metabolic disorders result in damage to the insulin hormone in the body. The ideal BMI is 18-24, where with a normal BMI the metabolism in the body will function well.

3.1.2 Adherence to taking anti-diabetes medication

From the Tabel 2, the percentage of regularly taking medication with controlled blood sugar levels is 37.5%, while the percentage of routinely taking medication with uncontrolled blood sugar levels is 62.5%. The percentage who do not routinely take medication for controlled blood sugar levels is 6.8%, while the percentage who do not routinely take medication for uncontrolled blood sugar levels is 93.2%. From the results of this study, it was found that p value=0.003 (<0.005) where there was a significant relationship with regularly taking anti-diabetic medication and controlled blood sugar levels in type II DM patients.

Table 2. Distribution of respondents routinely taking medication with blood sugar levels in type II DM patients

BMI	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Take Medicine Routinely	9	37.5	15	62.5	24	100	0.003
Not Taking Medicine Routinely	3	6.8	41	93.2	44	100	0.003
Total	12	17.6	56	82.4	68	100	0.003

The results of this study are in line with research conducted by Sendekie et al (2021) entitled Medication adherence and its impact on glycemic control in type 2 diabetes mellitus patients in Northwest Ethiopia. It was found that p value=0.002 where patients with high adherence to taking diabetes medication then their blood sugar levels are more controlled than patients with low levels of medication adherence. Apart from the knowledge of health workers in administering diabetes medication at the right dose, patient compliance in taking

the medication can have a significant impact on controlling blood sugar levels in DM patients. Research conducted at the Alak Community Health Center found that patients diagnosed with DM had complied with taking medication so their blood sugar levels could be controlled.

3.1.3 Patient knowledge regarding DM

From the table below, the percentage of good knowledge with controlled blood sugar levels is 29.4% and good knowledge with uncontrolled blood sugar levels is 70.6%. The percentage of insufficient knowledge of controlled h=blood sugar levels was 5.8%, while insufficient knowledge of uncontrolled blood sugar levels was 94.2%. From the p value we see a result of 0.012, namely p <0.05, meaning there is a relationship or correlation between the patient's knowledge about DM and blood sugar levels being controlled or not.

Table 3. Knowledge distribution of patients with blood sugar levels of type II DM patients

DM Knowledge	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Good Knowledge	10	29.4	24	70.6	34	100	0.012
Lack of Knowledge	2	5.8	32	94.2	34	100	0.012
Total	12	17.6	56	82.4	68	100	0.012

Respondents who have uncontrolled blood sugar levels tend to have less knowledge about the disease they are experiencing. Patients' knowledge of DM is influenced by educational factors as well as adequate health information from doctors or health workers who provide services. So, with sufficient knowledge regarding the course of the patient's DM disease, the patient's attitudes and behavioral changes will emerge, which will have a significant impact on controlling the patient's blood sugar levels. So the hope for controlled blood sugar levels in DM patients is very good in controlling complications from this DM disease which cannot yet be cured but blood sugar levels can be controlled. The results of this study are in line with research conducted by Velázquez López et al (2023) entitled Inadequate Diabetes Knowledge is Associated with Poor Glycemic Control in patients with type 2 Diabetes Level to Clinical Outcome Type 2 DM with p value=0.016. The results of this study are also in line with the results of research by Yuliawati et al. (2022) entitled Knowledge and Quality of Life in Type 2 DM patients with a p value of 0.01. Research was also conducted by Nurasyifa et al (2021) entitled Relationship between Knowledge to Type 2 DM Patients where p value=0.000.

3.1.4 Effect of regular physical activity/exercise on blood sugar levels

In the table below, the percentage of routine exercise with controlled blood sugar levels is 53.3%, while routine exercise with uncontrolled blood sugar levels is 46.7%, while the percentage of non-routine exercise with controlled blood sugar levels is 7.6%, regular exercise with uncontrolled blood sugar levels of 92.4%.

Table 4. Distribution of exercise routine with blood sugar levels in DM patients

Sports/Physical Activity	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Exercise Routine	8	53.3	7	46.7	15	100	0.000
Not Exercising Regularly	4	7.6	49	92.7	53	100	0.000
Total	12	17.6	56	82.4	68	100	0.000

From the table above, it appears that uncontrolled blood sugar levels were more common in DM patients who did not exercise regularly or as many as 49 patients or 72.1%, while patients who exercised regularly had their blood sugar levels under control in 8

people or 11.8%. From the research results, it was found that p value=0.000, where if p value <0.005 then there is a significant correlation or relationship between patients who exercise regularly and controlled blood sugar levels in DM patients.

3.1.5 Dietary regulation on blood sugar levels in type II DM patients

It can be seen in the table that the percentage of managing a diet with controlled blood sugar levels is 32%, while regulating a diet with uncontrolled blood sugar levels is 68%. The percentage of not controlling their diet with controlled blood sugar levels was 9.3%, while the percentage of not controlling their diet with uncontrolled blood sugar levels was 90.7%. Patients who regulate their diet in the form of the amount and type of food in the body according to the body's metabolic needs will control the blood sugar levels in the DM patient's body by 32 percent, while patients who do not regulate their diet or diet will have uncontrolled blood sugar levels. From p value <0 .05, then there is a relationship between dietary regulation and blood sugar levels in DM patients.

Table 5. Distribution of regulating eating patterns with blood sugar levels in DM patients

Dietary Habit	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Managing Eating Patterns	8	32	17	68	25	100	0.022
Not Regulating Eating Patterns	4	9.3	39	90.7	43	100	0.022
Total	12	17.6	56	82.4	68	100	0.022

3.1.6 The influence of smoking habits on blood sugar levels in DM patients

From the research table above, it is found that the percentage of non-smokers with controlled blood sugar levels is 17.7% and the percentage of non-smokers with uncontrolled blood sugar levels is 82.3%. The percentage of smoking with controlled blood sugar levels was 16.7%, while smoking with uncontrolled blood sugar levels was 83.3%.

Table 6. Distribution of smoking habits and blood sugar levels in DM patients

Smoke	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Do Not Smoke	11	17.7	51	82.3	62	100	0.947
Smoke	1	16.7	5	83.3	5	100	0.947
Total	12	17.6	56	82.4	68	100	0.947

From the results of the analysis, it was found that the p value was >0.05, namely, p value=0.947, so there was no significant correlation between smoking and the causes of high or uncontrolled blood sugar levels in diabetes patients. In the sample in this study there were more women who, culturally speaking, the habit of smoking is not commonly found in women. Cigarette smoke can increase blood sugar levels, where cigarettes stimulate the adrenal glands and can increase glucose levels. Smoking is a risk factor that causes insulin resistance which is a precursor to type II DM.

3.1.7 The relationship between adequate rest and blood sugar levels in DM patients

From the table below, it is found that the percentage of getting enough rest with controlled blood sugar levels is 23.1% and getting enough rest with uncontrolled blood sugar levels is 76.9%. The percentage of lack of rest with controlled blood sugar levels was 14.3% and the percentage of lack of rest with uncontrolled blood sugar levels was 85.7%. From the results of the research above, it was found that p value=0.514, this means that there is no significant relationship between getting enough rest and blood sugar levels.

Table 7. Distribution of adequate rest to blood sugar levels in DM patients

Get Enough Rest	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
Get Enough Rest	6	23.1	20	76.9	26	100	0.514
Lack of Rest	6	14.3	36	85.7	42	100	0.514
Total	12	17.6	56	82.4	68	100	0.514

3.1.8 Relationship between family support and blood sugar levels in DM patients

From the research, it was found that the percentage of family support with controlled blood sugar levels was 21.4%, while the percentage of family support with uncontrolled blood sugar levels was 78.6%. The percentage of no family support for uncontrolled blood sugar levels is 100%. From the results of the analysis, it was found that the p value=0.077, where there was no significant relationship between family support and controlled blood sugar levels in type II DM patients. Family support is the main support system for providing direct care in every condition of health or illness. The family support referred to here is the support provided, both motivational and material, to family members who are sick with Diabetes Mellitus and provide encouragement for regular treatment.

Table 8. Family support with blood sugar levels of DM patients

Family Support	Blood Sugar Levels				Total		P - Value
	Under Control		Uncontrollable				
	N	%	N	%	N	%	
There is Support	12	21.4	44	78.6	56	100	0.077
There isn't Any	0	0	12	100	12	100	0.077
Total	12	17.6	56	82.4	68	100	0.077

3.1.9 Multivariate analysis

Based on the results of the Multivariate analysis, it was found that variables that simultaneously had a significant effect on blood sugar levels in type II DM patients at the Alak Community Health Center which had a p value (sig) < 0.05 in the multivariate analysis were routine exercise (p=0.001) and BMI (p =0.009). The interpretation of the probability that BMI and regular exercise simultaneously influence controlled blood sugar levels is 51.5%, meaning that if someone has a normal BMI and regularly exercises, the chance of controlled blood sugar levels in DM patients at the Alak Health Center is 51.5%.

Table 9. Analysis of the influence of BMI and routine exercise factors on blood sugar levels in type II DM patients at the alak health center

	B	Sig.	Exp.(B)	95 % C.I for Exp (B): Lower	95 % C.I for Exp (B): Upper
Body Mass Index (BMI)	2.64	0.009	14.01	1.95	100.67
Exercise Routine	3.04	0.001	20.98	3.51	125.51
Constant	-7.09	0.002	0.001	-	-

3.2 Discussion

3.2.1 Effect of BMI on blood sugar levels in type 2 DM patients

Body mass index is a description of a person's body weight (Kg) compared to a person's height (m2), which will give a person's BMI category. Based on the research results obtained at the Alak Community Health Center, it was found that the p value was 0.003, namely <0.05, indicating that there is a mutually influential relationship with controlled blood sugar levels in DM patients. The research reference for the relationship between BMI and blood sugar levels in Type II Diabetes Mellitus patients is in line with that carried out by Rana H. Harsari

et al (2018) in the research article The Relationship between Nutritional Status and Blood Glucose Levels in Type 2 Diabetes Mellitus patients which was carried out on 65 patients in Dr. Soetomo Hospital Surabaya carried out a Pearson test between nutritional status and GDP levels, obtaining a p value of 0.04, which shows that there is a relationship between BMI and blood sugar levels in type 2 DM patients.

Controlling blood sugar levels in DM patients is not only focused on nutritional status but also diet patterns, physical activity and pharmacological therapy given. This research is in line with the results of research conducted by Adnan et al. (2018) entitled The Relationship between Body Mass Index (BMI) and Blood Sugar Levels in Type 2 DM Sufferers at Tugurejo Hospital, Semarang, where p value=0.000 (< 0.005). The results of this research are also in line with the results of Prema et al. (2016) research entitled The Relationship between BMI and Fasting Blood Sugar Levels in Type II DM Sufferers at the Idinas Health Center UPTD with p value=0.000 (< 0.005). This research is also in line with research conducted by AM.Harahap et al (2020) entitled The Relationship between BMI and Blood Sugar Levels in DM sufferers in Sisumut Village, Kota Pinang District, where p value=0.000. The results of this study are also in line with the results of research conducted by Ayu Hartati Bakri et al (2023) which was carried out at the Ibnu Sina Hospital in Makassar which measured the relationship between BMI and blood sugar levels in DM patients. It was found that the p value was 0.034 (< 0.05), indicating that there was significant relationship between BMI and blood sugar levels in Type II DM patients. In another research reference conducted by Qonita Putri Irawat et al at Abdoel Wahab Sjahranie Hospital (2022) entitled The relationship between Body Mass Index (BMI) and HbA1C levels in Type II diabetes mellitus sufferers, it was found that the p value was 0.063 (p> 0.05), there was no relationship between Body Mass Index and blood sugar levels in DM patients.

The results of this study are also in line with the results of research conducted by Ayu Hartati Bakri et al (2023) which was carried out at the Ibnu Sina Hospital in Makassar which measured the relationship between BMI and blood sugar levels in DM patients. It was found that the p value was 0.034 (<0.05), indicating that there was significant relationship between BMI and blood sugar levels in Type II DM patients. In another research reference conducted by Qonita Putri Irawat et al at Abdoel Wahab Sjahranie Hospital (2022) entitled The relationship between Body Mass Index (BMI) and HbA1C levels in Type II diabetes mellitus sufferers, it was found that the p value was 0.063 (p>0.05), there was no The relationship between Body Mass Index and blood sugar levels in DM patients. According to researchers' assumptions, the BMI factor in controlling blood sugar levels in Type II DM patients at the Alak Community Health Center is one of the supporting factors in controlling patient blood sugar levels in addition to several other factors which also influence patient blood sugar levels. Normal BMI in patients who were previously obese or overweight gluconeogenesis occurs, namely the breakdown of fat reserves in the DM patient's body so that the patient experiences weight loss and the BMI appears to be normal.

3.2.2 Influence of adherence to taking DM medication on blood sugar levels in DM patients

Patient compliance in taking medication regularly will keep the blood sugar levels of DM patients under control and reduce the risk of complications from DM. Compliance with taking anti-diabetic drugs (OAD) is very important in maintaining blood sugar control in DM patients. Compliance with taking OAD is based on the number of doses and the time of OAD administration. Proper and regular administration of OAD has an important influence in keeping blood sugar levels stable. well controlled. Non-compliance in taking medication results in lower control of blood sugar levels in patients as a result of which complications from DM will increase. Sometimes patients complain of side effects that make patients reluctant to take OADs regularly, or DM patients tend to take traditional medicines, this makes controlling blood sugar levels even more difficult due to the patient's non-compliance with taking medication. From the results of research at the Alak Community Health Center, it was found that the p value was 0.003, which means <0.05, so there was a significant

relationship between adherence to taking medication and controlled blood sugar levels in type II DM patients.

Based on other research conducted by Wulandari et al. (2020) entitled Medication Adherence Assessment Among Patients with Type 2 Diabetes in Indonesian Community Health Centers, a significant relationship was found between medication adherence and controlled blood sugar levels, p value=0.0047. Research was also conducted Rusminingsih & Purnomol (2022) entitled Realtionship of Patient Characteristics with Adherence in Type 2 DM found p value=0.001 where There is a correlation or relationship between adherence to taking diabetes medication and controlled blood sugar levels in DM patients. Compliance with taking diabetes medication by DM patients has an important factor in controlling blood sugar levels. Apart from the knowledge of health workers in administering diabetes medication at the right dose, patient compliance in taking the medication can have a significant impact on controlling blood sugar levels in DM patients. Research conducted at the Alak Community Health Center found that patients diagnosed with DM had complied with taking medication so their blood sugar levels could be controlled. According to the researchers' assumptions, the knowledge of health workers in prescribing DM medication and the accuracy of DM dosage influences the control of blood sugar levels in DM patients as well as compliance in taking DM medication.

3.2.3 The effect of DM knowledge on blood sugar levels in DM patients of adherence to taking DM medication on blood sugar levels in DM patients

Patient knowledge regarding the course of DM disease is very important in motivating patients to be regular and disciplined in maintaining and controlling the patient's blood sugar levels. By being equipped with correct and appropriate knowledge regarding DM complications, it is hoped that patients will be able to take the right attitudes and actions in treating DM. Several things Knowledge related to the causes, symptoms, signs, tests, treatment and complications that patients have can contribute to changes in patient attitudes and actions in treating patients. From the results of research conducted at the Alak Community Health Center, it was found that the p value was 0.011, so there was a significant relationship between knowledge of DM patients and controlled blood sugar levels in Type II DM patients.

Based on other research conducted by Wulandari et al. (2020) entitled Medication Adherence Assessment Among Patients with Type 2 Diabetes in Indonesian Community Health Centers, a significant relationship was found between medication adherence and controlled blood sugar levels, p value=0.0047. Research was also conducted Rusminingsih & Purnomo (2022) entitled Realtionship of Patient Characteristics with Adherence in Type 2 DM found p value=0.001 where There is a correlation or relationship between adherence to taking diabetes medication and controlled blood sugar levels in DM patients. The results of this study are in line with research conducted by Sendekie et al (2021) entitled Medication adherence and its impact on glycemic control in type 2 diabetes mellitus patients in Northwest Ethiopia. It was found that p value=0.002 where patients with high adherence to taking diabetes medication then their blood sugar levels are more controlled than patients with low levels of medication adherence.

Based on other research conducted by Wulandari et al. (2020) entitled Medication Adherence Assessment Among Patients with Type 2 Diabetes in Indonesian Community Health Centers, a significant relationship was found between medication adherence and controlled blood sugar levels, p value=0.0047. Research was also conducted Rusminingsih & Purnomo (2022) entitled Relationship of Patient Characteristics with Adherence in Type 2 DM found p value=0.001 where there is a correlation or the relationship between adherence to taking diabetes medication and controlled blood sugar levels in DM patients. Compliance with taking diabetes medication by DM patients is an important factor in controlling blood sugar levels. The knowledge of health workers in administering diabetes medication at the right dose can be accompanied by patient compliance in taking the medication, which can have a significant impact on controlling blood sugar levels in DM

patients. Research conducted at the Alak Community Health Center found that patients diagnosed with DM had complied with taking medication so their blood sugar levels could be controlled. According to the author's assumption, educational background factors also influence the patient's level of knowledge about DM, shaping the attitudes and behavior of DM patients in controlling their blood sugar levels.

3.2.4 The effect of regular exercise on blood sugar levels in DM patients

Routine exercise carried out periodically is expected to be able to control excess blood levels in the body. Physical activity of at least 20 minutes a day regularly in Diabetes Mellitus patients is effective in reducing excess blood sugar levels in the body. With regular physical activity, excess blood sugar levels will be used for muscle formation or glycogenesis, being able to control sugar levels in the body. It is important for DM patients to regularly do at least 20 minutes a day, such as walking for twenty minutes a day, regularly to control glycemic control or control normal blood sugar levels. Physical activity is any body movement that burns calories. All activities and exercise are useful in controlling blood sugar levels. Regular exercise will provide benefits in controlling blood sugar levels. The results of research conducted at the Alak Community Health Center found a p value of 0.000 which shows a significant relationship with regular exercise on controlling blood sugar levels in DM patients. The results of research conducted by Henrianto Karolus Siregar et al (2023) entitled The Relationship between Physical Activity and Blood Glucose Levels in Diabetes Mellitus Patients at Koja Regional Hospital, Jakarta with p value=0.000, there is a significant relationship or correlation of physical activity which helps DM patients in controlling levels. blood sugar. Regular exercise or physical activity for at least twenty minutes every day can prevent patients from being overweight or obese which triggers metabolic disorders in the body which results in the risk of diabetes or uncontrolled blood sugar levels.

The results of this study are in line with the results of research by Mainous et al. (2017) entitled Physical activity and Abnormal Blood Glucose among Adults where p value=0.003, which means there is a significant relationship between physical activity and blood sugar levels. The results of the research were also carried out by Teh et al (2015) entitled Association of Physical Activity with Blood Glucose among Malaysian Adults found p value=0.04. The results of research were also conducted by Nurayati & Adriani (2017) entitled The Relationship between Physical Activity and Fasting Blood Sugar Levels in Type 2 DM Sufferers at Mulyorejo Community Health Center, Surabaya found p value=0.000. The factor of regular exercise plays a role in controlling blood sugar levels in DM patients. When exercising, it triggers glycogenesis, namely the burning of fat cells in the body and the burning of blood sugar so that it becomes a form of energy. Blood sugar levels can be reduced and controlled during physical activity. Regular exercise will stimulate the work of the insulin hormone in the pancreas which helps control blood sugar levels in the body.

3.2.5 The effect of adjusting diet on blood sugar levels in DM patients

A good and appropriate diet can reduce high blood sugar levels in the body. DM patients must have the will to regulate the patient's diet so that blood sugar levels remain under control. High blood sugar levels when eating food can influence the increase in blood sugar levels in DM patients. DM patients must know the amount and type of food we need every day based on existing local food sources. This dietary regulation aims to control blood sugar levels in DM patients. The number of calories needed is adjusted to the patient's age, gender, weight and height and occupation. The results of research conducted at the Alak Community Health Center found a p value of 0.024, so there was a significant relationship between regulating diet and controlling blood sugar levels in DM patients.

The results of this study are in accordance with the results of research conducted by Musee et al (2016) entitled Dietary Adherence patterns in the context of type 2 diabetes management within Clinical Settings in Kenya where p value=0.001 was found with an

emphasis on a diet low in fat and sugar. and reducing salt and increasing foods containing fiber. This research is also in line with research conducted by Susilawati & Hasanah (2023) in researching the Influence of Diet and Blood Glucose Levels in Type 2 Diabetes Mellitus Patients at Mataram City Hospital in NTB Province where p value=0.003 means there is a significant relationship or correlation with the settings. Diet on the impact of controlling blood sugar levels in DM patients. Other research also shows the relationship between diet compliance and controlling blood sugar levels in Type 2 DM patients which was conducted by Nursihhah & Wijaya (2021) on DM patients at Karya Medika Hospital in Bantargebang, Bekasi which found a p value=0.000 where there was a significant correlation with regulation. diet/eating patterns in DM patients by controlling blood sugar levels.

Foods that are nutritionally balanced between carbohydrates, protein and fat play an important role in controlling patient blood sugar levels. With a regular eating pattern, blood sugar levels are not excessive so there is no damage to the insulin hormone. Blood sugar levels that are too high from food eaten that cannot be controlled by the insulin hormone will be stored as protein or fat in the body. The possible reason why this factor does not contribute is the perception that the diet is not in accordance with the standard nutritional needs of diabetes patients. The principles of diet for people with DM are almost the same as food recommendations for the general public, namely food that is balanced and in accordance with the calorie and nutritional needs of each individual. DM patients need to be given emphasis on the importance of regular food schedules, the type and number of calories in the food consumed. According to researchers' assumptions, the need for education by health workers regarding eating patterns that are adapted to the body condition or needs of DM patients plays an important role in regulating the diet carried out by DM patients.

3.2.6 Effect of smoking on blood sugar levels in DM patients

Smoking can worsen complications from Diabetes. Smoking can cause glucose intolerance in the body and can damage blood circulation to the heart, brain and lower limbs. The nicotine content in the body can cause damage to the blood vessels of the heart and cause faster damage in Diabetes Mellitus patients. There are many dangerous substances in the contents of a cigarette and This is exacerbated by the number of cigarettes smoked each day or the number of cigarettes smoked each day. In DM patients, smoking should be avoided because it can cause disturbances in blood sugar levels in the body. The results of research conducted at the Alak Community Health Center found a p value of 0.947, meaning that there was no significant relationship in controlling blood sugar levels in DM patients. From the results of research conducted by Nakanishi et al. (2000), a significant relationship was found between the influence of smoking habits and blood sugar levels. blood disorders in male Type II DM patients in Japan where p value=0.001.

Research conducted by Sari et al. (2017) at FK USU Medan regarding Cigarette Smoking and Hyperglycaemia in Diabetic Patients showed that there was a significant relationship between smoking and increased blood sugar levels in DM patients where the p value=0.016. Research conducted by Wang et al (2022) entitled Smoking Causes The Disorder of Glucose Metabolism in China found p value=0.003, where p <0.05 which means there is a significant relationship between smoking and increased blood sugar levels in DM patients. According to the researchers' assumptions, the results of this study are different from other research references because it is possible that the sample taken was inadequate, where the results of this study found that the number of DM patients was mostly women, and in the socio-cultural society smoking is rarely found in women.

3.2.7 The effect of adequate rest on blood sugar levels in DM patients

Adequate rest time, in this case sleep time, plays an important role in controlling blood sugar levels in the body. Sufficient rest or sleep time is if the sleep time is above 8 hours, while insufficient sleep time is under 8 hours. A study shows that seven to eight hours of

sleep is recommended for adults for the body to function properly. In controlling blood sugar levels, we must also be able to control stress patterns in our body. High blood sugar levels are influenced by an increase in the hormone cortisol in our body which increases blood sugar levels. When stress occurs, our body releases the hormone cortisol which can increase blood sugar levels. From the research results found at the Alak Community Health Center, the p value was 0.524, so there was no relationship or link between lack of rest and uncontrolled increases in blood sugar levels in DM patients. According to research by Knutson et al (2006) on the Role of Sleep Duration and Severity of Type 2 Diabetes Mellitus, it was found that p value=0.01, so it can be said that there is a relationship between lack of sleep and an increase in blood sugar levels.

Likewise, research conducted by Tasali et al. (2009) on reduced sleep duration and relationship with type 2 diabetes found p value=0.02, which means there is a significant relationship between sleep duration or rest time and increased blood sugar levels in patients. DM. According to research from Ginting & Mufidah (2021) entitled Lack of Quality Sleep can Increase the Incidence of Diabetes Mellitus with an OR of 1.37. Lack of sleep or lack of rest causes the body to release the hormone cortisol, aka the stress hormone, which then increases blood sugar levels. Poor sleep habits affect blood sugar levels and insulin sensitivity, thereby increasing the risk of developing type 2 diabetes. This also causes appetite and weight to increase. A causal relationship between sleep quality and diabetes cannot be confirmed, but poor sleep quality will trigger metabolic changes. According to the researcher's assumption, the variable adequate rest does not have a significant relationship with uncontrolled blood sugar levels in DM patients, perhaps due to insufficient research samples or the need to carry out in-depth observations or interviews regarding the variable adequate rest.

3.2.8 The effect of family support on blood sugar levels in DM patientsof adherence to taking DM medication on blood sugar levels in DM patients

The form of support for a DM patients from the family can be seen in empathetic support, namely a sense of understanding of what the patient is feeling. Support can be in the form of material or financial assistance. Family support is assistance that can be given to other family members in the form of goods, services, information and advice that can make the support recipient feel loved, appreciated and at peace. This support is the attitude, actions and acceptance of the family towards the sick sufferer. Family members perceive that a supportive person will always be ready to provide the necessary help and assistance. Based on the results of research conducted by the Alak Community Health Center, a p value of 0.077 was found, where a p value > 0.05 indicated that there was no significant relationship between family support and controlled blood sugar levels in DM patients.

From the research, it was found that the p value=0.077, where there was no significant relationship between family support and controlled blood sugar levels in type II DM patients. Family support is the main support system for providing direct care in every condition of health or illness. The family support referred to here is the support provided, both motivational and material, to family members who are sick with Diabetes Mellitus and provide encouragement for regular treatment. This research is not in line with research conducted by Mayberry & Osborn (2012) in a study entitled Family Support and Glycemic Control Among Adults With Type 2 Diabetes where p=0.03 where there is a significant relationship between family support and lower blood sugar levels. controlled in type II DM patients. This research is also not in line with research conducted by Onyango et al. (2023) in research conducted in Uganda regarding forms of family support in relation to controlled blood sugar levels in adult patients with Type II DM in Uganda where p value=0.008 which means there is a correlation significant relationship between family relationships and blood sugar levels.

This research is also not in line with research conducted by Susanti et al. (2020) in their research entitled The Relationship between Family Support and Blood Sugar Levels in People with Type 2 Diabetes Mellitus at the Beringin Raya Community Health Center,

Bengkulu City where p value=0.002 means there is a significant relationship Between family support and controlled blood sugar levels in Type II DM patients. In the researcher's opinion, the coverage of the DM program at the Alak Community Health Center is not good enough, although family support is available, but this factor is not the main supporting factor in controlling blood sugar levels. The government has borne the cost of treatment by participating in the National Health Insurance (JKN), both from drug costs and laboratory costs. so that financial support by the patient's family does not have much influence on the financing of DM patients.

4. Conclusion

There is an influence of body mass index (BMI), it was found that DM patients at the Alak Community Health Center had a BMI category of fat or a obese. There is a relationship between BMI and blood sugar levels in DM patients where p value=0.003. There is a significant influence or relationship between patient compliance with taking Diabetes medication regularly and controlled blood sugar levels in Diabetes Mellitus patients where p value=0.003. There was an influence of knowledge on DM, a significant relationship was found to control blood sugar levels in Diabetes Mellitus patients where p value=0.011. There was an influence of physical activity, it was found that there was a significant influence or relationship on controlling blood sugar levels in type II DM patients where p value=0.000. There is an influence on managing diet, with a p value of 0.024, where p value <0.05 means there is a significant influence on food management by controlling blood sugar levels. There is no effect of smoking habits on controlling blood sugar levels in DM patients with a p value of 0.947. There is no effect of adequate rest on controlling blood sugar levels in Diabetes Mellitus patients with a p value of 0.514. There is no effect of family support on controlling blood sugar levels in DM patients with a p value of 0.077. The final results of the mutivariate analysis showed the influence of BMI and exercise routine on controlling blood sugar levels in DM patients.

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Biographies of Authors

Panondang N. Panjaitan, Public Health Science Study Program, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, 85228, Indonesia.
- Email: panondangpanjaitan00@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Pius Weraman, Public Health Science Study Program, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, 85228, Indonesia.
- Email: piusweraman@staf.undana.ac.id
- ORCID: 0000-0002-7749-3347
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: https://sinta.kemdikbud.go.id/authors/profile/6652867

Apris A. Adu, Public Health Science Study Program, Universitas Nusa Cendana, Kupang, East Nusa Tenggara, 85228, Indonesia.
- Email: apris.adu@staf.undana.ac.id
- ORCID: 0000-0002-0311-6215
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57200583768
- Homepage: N/A