



Understanding the Links Between Glycemic Control, Management Adherence and Hemoglobin Level Among Type 2 Diabetes Mellitus



Nian Afrian Nuari ^a, Handono Fatkhur Rahman ^b, Abdul Hamid Wahid ^c

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Corresponding Author ^a



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hemoglobin;

Abstract

Patients with diabetes must be monitored for hyperglycemia due to the risk of macrocellular and microcellular complications. High blood sugar levels force the kidneys to work harder to filter blood, which results in renal leakage. The objective of this study was to establish a relationship between glycemic control, management adherence, and hemoglobin level in patients with type 2 diabetes. This study employed a correlational design with a cross-sectional approach and a sample size of 72 respondents selected using purposive technique. Compliance with diabetes mellitus, which includes diet compliance, exercise compliance, medication compliance, and blood sugar monitoring compliance, is strongly correlated with glycemic control levels. Completely contrary, there was no link between hemoglobin levels and adherence to treatment. Microcellular processes of renal function are linked to the interaction between glycemic control and hemoglobin levels.

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^a Department of Nursing, STIKES Karya Husada Kediri, Kediri, Indonesia
^b Department of Nursing, Universitas Nurul Jadid, Paiton, Probolinggo, Indonesia
^c Department of Education, Universitas Nurul Jadid, Paiton, Probolinggo, Indonesia

1 Introduction

Diabetes Mellitus (DM), is a metabolic disorder characterized by hyperglycemia resulting from difficulties with insulin synthesis, insulin resistance, or both. Diabetes Mellitus can affect individuals of all ages, from children to senior citizens. Type 2 Diabetes Mellitus, also known as NIDDM, is caused by pancreatic beta cells retaining their insulin-producing characteristics. Diabetes Mellitus is sometimes referred to as the Silent Killer since it is asymptomatic and causes vascular damage prior to diagnosis (Nuari & Kartikasari, 2015). Long-term hyperglycemia in patients with diabetes mellitus may cause damage to impaired function, failure of numerous organs, especially the eyes, and organs, including renal organs and functions, resulting in kidney failure (Abate et al., 2013).

Based on a survey by the World Health Organization, 8.4 million Indonesians have diabetes mellitus, and this figure is projected to rise to 21.3 million by 2030 (International Diabetes Federation, 2021). According to basic health research conducted in Indonesia in 2013, there were 2.4% DM cases in 2013. According to the projections of the number of people with DM between the ages of 20 and 79, several countries have the highest number. Indonesia ranks seventh among the top 10 countries with the biggest number of sufferers, 10.7 million. Indonesia contributes to the diabetes prevalence in Southeast Asia (International Diabetes Federation, 2021). From 2013 to 2018, the prevalence of Diabetes Mellitus increased in all provinces. Based on the findings of the Riskesdas (2018), the prevalence of diabetes mellitus in Indonesia among those older than 15 years is 2 percent. In 2018, the prevalence of diabetes mellitus grew from 6.9% to 8.5%, according to blood sugar screening data. This indicates that 25% of diabetics are aware of their condition (Profil Kesehatan Indonesia, 2018).

In the management of diabetes mellitus, glucose levels are the primary focus. One of the glycemic status controls carried out by DM patients is adherence to diabetic therapy (Munekawa et al., 2020). Diet, exercise, medication usage, and blood sugar monitoring are components of the management of diabetes mellitus (Dehghan et al., 2017). Diet compliance of DM patients has a crucial role in stabilizing blood glucose, while compliance itself is crucial for developing habits that can aid patients in adhering to a diet program. Noncompliance with diet therapy by patients creates uncontrolled sugar levels. Especially for chronic diseases such as diabetes mellitus, adherence to therapy plays a crucial role in achieving the desired outcome of treatment. Low patient adherence to medication diabetes mellitus is one cause of sugar levels in the blood that are out of control (Putri et al., 2020). Compliance demands variables that facilitate compliance achievement (Eknithiset et al., 2018).

Kidney failure is one of the many risk factors for disease that Diabetes Mellitus can cause because high blood sugar levels lead the kidneys to work harder to filter blood, resulting in kidney leakage (Huang et al., 2020; Hussein et al., 2011). The patient initially experiences albumin protein leakage through the urine, which later progresses and causes the kidney's filtration ability to diminish (Sonmez et al., 2010). When kidney function decreases, it affects the generation of erythropoietin, a form of hemoglobin, and can lead to a drop in the body's hemoglobin levels (Bekele et al., 2019). As a result of the drop in Hb levels, which serve to carry oxygen throughout the body, type 2 DM patients develop anemia or a deficiency of red blood cells, which can be used as a proxy for a deteriorating nutritional status.

Anemia in type 2 diabetes patients is caused by a shorter erythrocyte lifespan, iron metabolism problems, and bone marrow function disorders (Taderegew et al., 2020). In order to avoid and detect complications in patients with Diabetes Mellitus at an early stage, it is necessary to monitor the status of blood sugar by maintaining blood sugar and hemoglobin levels (Okada et al., 2015). Based on the context, This study aimed to establish the connection between glycemic control, adherence of management and hemoglobin level in type 2 diabetes (Naderi et al., 2012; Lavsa et al., 2011).

2 Materials and Methods

Study design, participants and data collection

This cross-sectional study was conducted among a diabetes mellitus type 2 patients in Kediri Region. The population in this study were all 240 patients with diabetes mellitus type 2. Recruitment this participant was carried out by secondary data from Public Health Services in Indonesia. The instrument in this study used questionnaire, glucometer and hemoglobinometer. The study protocol was approved by the STIKES Karya Husada Kediri Ethical Commite (071/EC/LPPM/STIKES/KH/II/2020) and offline informed consent was provided by all participants. Respondents were taken using purposive sampling method, with a sample size of 72 respondents.

Measurements

1. Dependent variable: Hemoglobin Level

A hemoglobinometer is a device for measuring the concentration of hemoglobin in the blood. Hemoglobinometers that are portable make measurement simple and convenient, especially advantageous in areas with no clinical laboratories. It is especially valuable in an emergency due to its simplicity of use, accuracy, and speed of results.

2. Independent variables: Glycemic control

- Glycemic Control

The glycemic control questionnaire uses a random blood sugar observation sheet. Normal score: ≤ 200 mg/dl.

- Adherence in Diabetes Management

Adherence in Diabetes medication used The MMAS-8 (Morisky Medication Adherence Scale) questionnaire comprises questions about medication adherence. In 2008, Morisky et al. published MMAS-8, an improved version with a greater reliability of 0.83, sensitivity, and specificity. Using a questionnaire to measure diet adherence, exercise adherence, and blood glucose monitoring adherence.

Data analysis

Using univariate and bivariate tests, the research outcomes were subjected to data analysis. The univariate test was used to determine the frequency distribution of the study's data, meanwhile the bivariate test applied the Spearman Rho and Pearson tests with a significance level of 0.05.

3 Results and Discussions

The frequency distribution of type 2 Diabetes Mellitus patients based on gender, age, length of diabetes mellitus, management adherence, and hemoglobin level was determined by the results.

Table 1
Sociodemographic

Variable	f	%
<i>Age</i>		
40-50 years old	9	12,5
51-60 years old	31	43,1
61-70 years old	32	44,4
<i>Gender</i>		

Male	14	19,4
Female	58	80,6
<i>Duration Suffering DM</i>		
0-3 years	32	44,4
4-6 years	31	43,1
7-9 years	9	12,5
<i>Adherence in Diabetes Diet</i>		
Low	24	33,3
Moderate	29	40,3
High	19	26,4
<i>Adherence in Exercise</i>		
Low	28	38,9
Moderate	27	37,5
High	17	23,6
<i>Adherence in Medication</i>		
Low	17	23,6
Moderate	35	48,6
High	20	27,8
<i>Adherence in Glycemic Monitoring</i>		
Low	20	27,8
Moderate	25	34,7
High	27	37,5
<i>Glycemic Control</i>		
Normal	40	55,6
Hyperglycemic	32	44,4
<i>Hemoglobin level</i>		
Normal	65	90,3
Anemia	7	9,7

Based on table 1, the majority of respondents in this study were aged 61-70 years and were female. Previous studies stated that the majority of respondents were also found to be female (Bekele et al., 2019). Other studies also showed that there are more female diabetic respondents than male (Nuari et al., 2018). At RISKESDAS 2018, the prevalence of DM in women was greater than in males with a ratio of 1.78 percent to 1.2 percent, but data from the previous five years in Indonesia indicated a little increase in the prevalence of DM in women. While the incidence in men decreased, it increased in women (Profil Kesehatan Indonesia, 2018).

Elderly people are found to suffer from diabetes mellitus, due to the degenerative process and lifestyle. Elderly with obesity and a lifestyle that has minimal activity will put the elderly at risk of developing diabetes mellitus (Eknithiset et al., 2018). The incidence of diabetes mellitus rises with the patient's age, reaching a peak between the ages of 55 and 64 (Hosomi et al., 2022). The pattern of growing RISKESDAS 2013 and 2018 demonstrates that the risk of acquiring diabetes increases with age. In Indonesia, the increase in prevalence from 2013 to 2018 occurred among those aged 45 to 75 (Profil Kesehatan Indonesia, 2018).

The results of the study also showed that the duration of suffering from DM is between 0-3 years, this indicates that the patient is still experiencing an early stage in the course of the disease. Patients who have just suffered from diabetes mellitus are still adapting to their illness so they need information and support from health workers and people around them to apply the management of their disease management properly. This can be supported by support from family and high motivation from DM patients themselves (Deischinger et al., 2020).

The hemoglobin levels revealed that nearly all of them had normal hemoglobin levels and normal glycemic management (Foley et al., 2000; Fishbane & Berns, 2005). Only a few responders have hemoglobin levels below normal, indicating that they are anemic, according to the statistics. The majority of them had normal hemoglobin levels, and anemia was not clinically evident in any of them. Patients with diabetes mellitus will

exhibit symptoms of anemia if the respondent is anemic (Baisakhiya et al., 2017). Anemia is a frequent DM consequence that is linked to the severity of the disease and microvascular issues (Hosseini et al., 2014).

Table 2
Correlation between variables

	Adherence in Exercise	Adherence in Medication	Adherence in Glycemic Monitoring	Glycemic Control	Hemoglobin level
Age				0,036 *	0,299 *
Sex				0,552 *	0,233 *
Duration Suffering DM				0,083 *	0,545 *
Adherence in Diet				0,008 *	0,846 *
Glycemic Control	0,011 *	0,017*	0,012 *		0,033 *
Hemoglobin level	0,563 *	0,729*	0,027*		
Mean ± SD				202,2± 86,27	14,5 ±2,01
Min ± Max				78 ±396	9,1 ±18,2

*correlation significant at the 0.05 level

According to table 2, there is a connection between type 2 DM patients' adherence to their diet, adherence to their medications, adherence to exercise, and adherence to glycemic monitoring and glycemic control (Hirsch & Brownlee, 2005; Khattab et al., 2010). This has been demonstrated to be strongly connected to glycemic control. The average of the random sugar measurements made during the trial was normal (202.2±86.27). This demonstrates that the individual has good blood sugar regulation. Effective regulation can regulate and maintain normal blood sugar levels in the absence of substantial symptoms (Tornese et al., 2020).

The link between dietary compliance and glycemic status in diabetic individuals is considerable (p 0,008). Dietary compliance refers to the conformance of a person's behavior to dietary guidelines provided by health professionals. Dietary adherence of DM patients has a crucial part in stabilizing blood glucose levels, whilst developing routines (habits) that assist patients stick to a diet program is a crucial aspect of compliance (Guillausseau, 2003; Ashton et al., 2005). Noncompliance with nutrition therapy by patients causes uncontrolled glucose levels (Popoviciu et al., 2022).

The quantity, composition, and timing of daily meals are regulated for individuals with type 2 diabetes (Thomas & Mohite, 2014). The amount must be in accordance with the needs, the type must meet the needs, low in simple carbohydrates, high in fiber, and have a low glycemic index, and the eating schedule and frequency must be well-regulated, i.e. every 3 hours, both between main and interlude meals with a frequency of 6 times per day.

The majority of respondents this study have moderate adherence to DM medication. Prior research utilizing the MMAS-8 instrument shown that the majority of diabetic patients with mellitus have a modest level of compliance (Kuslan Avci, 2018). In accordance with the eight-item Morisky scale, four direct questions were asked about the reasons for low adherence's intentional action, and four questions were asked about the reasons for involuntary activity. Respondents with low adherence were induced by DM patients' perception that their sugar levels were normal or stable, despite the fact that this perception was impacted by the medicines they were taking (Alfian, 2015; Mokolomban et al., 2018). According to prior research, drug self-efficacy is a major predictor of medication adherence, and increasing drug self-efficacy is a prerequisite for enhancing patient self-care abilities in the management of chronic illness (Smith, 2018; Wabe et al., 2011).

The results of this study reveal a correlation between DM patients' adherence to exercise and their random blood sugar levels. Physical activity plays a crucial role in avoiding insulin resistance and diabetes-related problems (Rusakova et al., 2022). Aerobic exercise and muscle strength training will improve the immediate action of insulin and help manage blood sugar, blood lipids, blood pressure, and the risk of cardiovascular disease. In order to provide long-term effects, exercise guidelines should be consistent and incorporate a variety of training methods (Marinho et al., 2018). Patients with type 2 diabetes can exercise safely. It is essential to monitor blood glucose levels before and after exercise, particularly when beginning or altering an

exercise regimen (Ruissen et al., 2021). Providing a physical activity-increasing exercise program is crucial for patients with type 2 diabetes to maintain optimal health. Other studies indicate that general adherence to prescribed self-care activities among part-time to elderly individuals with type 2 diabetes is poor, particularly due to poor diet and exercise adherence (Bourne et al., 2019; Marinho et al., 2018).

Important to the conventional management of diabetes mellitus is self-monitoring of glycemia. Self-monitoring has been recommended for diabetic patients and health service providers in reaching precise blood glucose levels and prevent hypoglycemia. Findings from other studies suggest that people with diabetes would consider learning the recommended frequency for self-monitoring and self-measuring sugar levels. Recommendations are also made to producers of blood glucose meters that they make the equipment more portable and user-friendly (Luo, 2019).

Hemoglobin is the iron-rich protein found in red blood cells that binds oxygen and distributes it to all bodily tissues for utilization during physical exercise. Normal amounts of hemoglobin in men and women are 14-17 grams/dl and 12.5-16 grams/dl, respectively. Hemoglobin levels can be used as a metric to represent the average sugar level of DM patients over the course of three months. Furthermore, Hemoglobin levels are not changed by food, medication, or exercise, thus they can be measured at any time without any specific preparation (Zhu et al., 2020).

The hemoglobin level, on the other hand, exhibits no significant correlation with adherence to either element of diet, activity, medicine, or frequent blood sugar monitoring. Diabetes mellitus problems are closely tied to low hemoglobin levels. Patients with diabetes mellitus who experience anemia in conjunction with kidney problems (Kim et al., 2021). Due to decreased erythropoietin production by the peritubular fibroblast of the kidney, urinary erythropoietin losses, a shorter RBC life span as a result of a uremic environment, and the potential contribution of circulating uremic-induced prevention of erythropoiesis, anemia results from renal impairment (Taderegew et al., 2020). The anemia suffered by patients with diabetes mellitus might be expected by periodically monitoring for anemia symptoms (Balouch et al., 2011).

Hyperglycemia, or a rise in blood sugar, can have detrimental consequences on the metabolism (Cho et al., 2008). A rise in blood sugar will result in an increase in the synthesis of reactive oxygen species (ROS) and non-glycation enzymes, which result in cellular structural alterations and the development of glycation end products (AGEs). Blood vessel structure and permeability are altered by AGEs (Biadgo et al., 2016). Oxidative stress will result from an increase in reactive oxygen species. Cell membranes will undergo lipid peroxidation due to oxidative stress. Membrane lipid peroxidation will enhance the hemolysis of erythrocytes. Hemolysis will cause the release of hemoglobin, resulting in decreasing hemoglobin levels (Esraa R et al., 2020; Wang et al., 2021).

4 Conclusion

Diabetes mellitus compliance, which comprises components of diet compliance, exercise compliance, medication compliance, and blood sugar level monitoring compliance, is highly associated to glycemic control levels. In contrast, there was no correlation between hemoglobin levels and adherence to diet, exercise, medicine, and blood sugar monitoring. Despite the fact that they are unrelated, it is vital to monitor routinely for signs of anemia. Anemia can be a sign of difficulties concerning the kidneys that manufacture erythropoietin. The relationship between glycemic management and hemoglobin levels is coupled with macrocellular mechanisms of renal function.

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Biography of Authors

	<p>Nian Afrian Nuari Lecturer in Department of Nursing STIKES Karya Husada Kediri, Indonesia. She earned Masters in Nursing in Master of Nursing Departement Airlangga University, Indonesia. She has article paper published in International Journal and Proceeding indexed scopus and National Journal indexed SINTA. She also published 7 books about nursing and health in Indonesia. ORCID: 0000-0002-9734-9617, SCOPUS ID: 57209459978 Email: nian.afrian@gmail.com</p>
	<p>Handono Fatkhur Rahman Lecturer in Department of Nursing, Universitas Nurul Jadid, Paiton, Probolinggo, Indonesia. He has article paper published in International Journal and Proceeding indexed scopus and and National Journal indexed SINTA. ORCID: 0000-0002-8687-0968 Email: handono.hfc@gmail.com</p>
	<p>Abdul Hamid Wahid Lecturer in Department of Education, Universitas Nurul Jadid, Paiton, Probolinggo, Indonesia Email: hamidw@gmail.com</p>