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RESEARCH ARTICLE

FACTORS AFFECTING GLYCEMIC CONTROL IN DIABETES MELLITUS PATIENTS

Eros Hanif Dwi Wireno^{1*}, Andreas Arie Setiawan², Meita Hendrianingtyas³, Setyo Gundi Pramudo²

¹Faculty of Medicine, Diponegoro University, Semarang, Indonesia

²Department of Internal Medicine, Faculty of Medicine, Diponegoro University, Semarang, Indonesia

³Department of Clinical Pathology, Faculty of Medicine, Diponegoro University, Semarang, Indonesia

Corresponding author email : eroshanif10@gmail.com

ABSTRACT

Introduction: Indonesia ranked seventh in the prevalence of diabetes mellitus in the world. Improved glycemic control has been proven to prevent the diabetes and its complications. Adherence to treatment, weight regulation with benchmarks for Body Mass Index (BMI) indicators, activity or exercise habits, diet, and smoking history play an important role in glycemic control. **Objective:** The aim of this study was to identify factors affecting glycemic control in outpatient with diabetes mellitus.

Methods: A cross sectional study among 32 diabetes mellitus patients. This study was conducted from April 2019 to September 2019 at Rumah Sakit Nasional Diponegoro (RSND), Semarang. The glycemic control status were assessed by HbA1c. Factors such medication adherence, diet adherence, smoking status, and physical activity were assessed with a structured questionnaire. Anthropometric measurement done to get the BMI status. Data were analyzed with bivariat analysis with chi square test ($p < 0.05$).

Result: The factors that were significantly have relationship with glycemic control status are diet adherence ($p = 0.046$), and medication adherence ($p = 0.040$). Physical activity, smoking status and BMI doesn't have significant relationship with glycemic control status.

Conclusion: Factors affecting glycemic control of diabetes mellitus patients in this study were diet adherence and medication adherence. History of smoking, BMI, and physical activity were not factors that influenced the control status in diabetes mellitus patients in this study.

Keywords: medication adherence, diet adherence, BMI, smoking status, physical activity.

ABSTRAK

Latar belakang: Indonesia menempati urutan ketujuh untuk prevalensi diabetes mellitus di dunia. Peningkatan kontrol glikemik telah terbukti mencegah perkembangan dan kejadian komplikasi diabetes. Kepatuhan terhadap pengobatan, pengaturan berat badan dengan indikator Indeks Massa Tubuh (IMT), aktivitas atau kebiasaan olahraga, diet, dan riwayat merokok memainkan peran penting dalam kontrol glikemik. **Tujuan:** Mengidentifikasi faktor-faktor yang mempengaruhi kontrol glikemik pada pasien dengan diabetes mellitus.

Metode: Penelitian deskriptif kualitatif dengan pendekatan cross sectional pada minimal 32 pasien dengan diabetes mellitus. Penelitian ini dilakukan dari bulan April 2019 hingga September 2019 di Rumah Sakit Nasional Diponegoro (RSND) Semarang. Status kontrol glikemik dinilai dengan HbA1c. Faktor lain dinilai dengan pertanyaan terstruktur yang terdiri dari pertanyaan tentang kepatuhan pengobatan, kepatuhan diet, status merokok, dan aktivitas fisik, serta pengukuran antropometri untuk menilai status IMT. Data dianalisis dengan analisis bivariat dengan uji chi square ($p < 0,05$).

Hasil: Faktor-faktor yang secara signifikan terkait dengan status kontrol glikemik adalah kepatuhan diet ($p = 0,046$) dan kepatuhan pengobatan ($p = 0,040$). Aktivitas fisik, status merokok dan BMI tidak memiliki hubungan yang signifikan dengan status kontrol glikemik.

Kesimpulan: Faktor-faktor yang mempengaruhi kontrol glikemik pasien diabetes melitus pada penelitian ini adalah kepatuhan diet dan kepatuhan berobat. Riwayat merokok, IMT, dan aktivitas fisik bukan merupakan faktor yang mempengaruhi status kontrol glikemik pada pasien diabetes melitus pada penelitian ini.

Kata kunci: Kepatuhan berobat, kepatuhan diet, IMT, riwayat merokok, Aktivitas fisik.

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic diseases characterized by chronic hyperglycemia caused by abnormal insulin secretion, insulin action, or both. In general, diabetes mellitus is classified into two categories namely type 1 and type 2 diabetes mellitus (PB. PERKENI., 2015). Type 1 diabetes mellitus is caused by autoimmune with the mechanism of destruction of insulin-producing pancreatic β -cells, whereas type 2 diabetes mellitus is caused by insulin resistance (Rasheed, Islam and Mahjabeen, 2015). The symptoms of DM include polyuria, polydipsia, and polyphagia with weight loss (Putri and Isfandiari, 2013).

World Health Organization (WHO) estimates that in 2014, 422 million people worldwide living with diabetes mellitus. Indonesia, in 2015, ranked seventh in countries with the highest the prevalence of diabetes mellitus in the world after China, India, the United States, Brazil, Russia and Mexico (World Health Organization, 2016). Central Java, in Indonesia, ranks 12th in the highest proportion of diabetes mellitus at the age of 15 years in 2018 according to the 2018 Basic Health Research Ministry of Health of the Republic of Indonesia (Kementerian Kesehatan, 2018). Diabetes with complications is the third leading cause of death in Indonesia. The percentage of deaths due to diabetes in Indonesia rank second highest after Sri Lanka (World Health Organization, 2016).

Diabetes mellitus has some serious long-term vascular complications which have traditionally been divided into two: macrovascular and microvascular complications. Good glycemic control in patients with diabetes mellitus has been associated with a reduced risk of macrovascular and microvascular complications and organ damage (Lee *et al.*, 2018). Macrovascular complications can include coronary artery disease, atherosclerosis, and cerebrovascular diseases such as stroke (Rasheed, Islam and Mahjabeen, 2015). Microvascular complications include diabetic retinopathy, neuropathy that can cause peripheral artery disease, and nephropathy which can lead to chronic kidney failure (Lee *et al.*, 2018). Diabetes mellitus is considered in a good glycemic control if HbA1c $< 7\%$, preprandial capillary plasma

glucose between 80-130 mg/dL, and postprandial peak capillary plasma glucose <180 mg/dL (American Diabetes Association, 2018).

The majority of patients fail to achieve good glycemic control due to multifactorial causes (Yigazu and Desse, 2017) (Fiseha *et al.*, 2018). Adherence to treatment, weight management with benchmarks BMI indicators, activity or exercise habits, diet, and smoking history play an important role and associated with glycemic control (American Diabetes Association, 2018).

Adherence to treatment, weight management with benchmarks BMI indicators, activity or exercise habits, diet, and smoking history play an important role and relationship with glycemic control (American Diabetes Association, 2018). Adherent to treatment plays an important role in maintaining control glycemic (Nanda, Wiryanto and Triyono, 2018). Diet in diabetes mellitus patients can affect levels of blood sugar and lipid profile in the blood, this causes the importance of maintaining diet in people with diabetes mellitus (Sami *et al.*, 2017). Body Mass Index is also associated with glycemic control in patients with diabetes mellitus. Epidemiological studies show that a high body mass index is associated with obesity, affecting the status of glycemic control in patients with diabetes mellitus so that patients with diabetes mellitus should have a normal body mass index (Boffetta *et al.*, 2011). Sports activities in patients with diabetes mellitus can affect insulin receptor sensitivity in tissue so that it can improve glucose influx into the tissue so this can affect the glycemic control status (Sampath Kumar *et al.*, 2019). Person with a history of active smoking have HbA1c levels as a benchmark higher glycemic control status than people who did not have ever smoked or have smoked but have stopped (Ohkuma *et al.*, 2015). All of this factors leads the authors to do the research about factor that affecting glycemic control in diabetes mellitus patient.

The aim of this study was to identify factors affecting glycemic control in outpatient diabetes mellitus patients especially in diet adherence, medication adherence, BMI, smoking history, and physical activity. The results of this study can be used as information to the public, especially people with diabetes mellitus in order to evaluate and correct if there are factors that can be corrected so that diabetes mellitus experienced can be controlled in order to minimize disease complications and improve the quality of life of people with diabetes mellitus. This research is also useful for health workers to evaluate the therapy and educational session that has been given to patients with diabetes mellitus. The results of this study can be used as study material for further research in diabetes mellitus.

METHODS

A cross sectional study in diabetes mellitus patients attending Rumah Sakit Nasional Diponegoro (RSND) Semarang. The inclusion criterias include diabetes mellitus, outpatient clinic of Rumah Sakit Nasional Diponegoro, who have been diagnosed at least 3 months, and willing to participate in research by agreeing to informed consent. The exclusion criteria include health related problems such as vision, hearing and age problems that are so old that it is difficult to fill out questionnaires. Ethical clearance was obtained from the Medical and Health Research Ethics Commission of the Faculty of Medicine, Diponegoro University No.213/EC/KEPK/FK-UNDIP/V/2019. The respondents were given a brief explanation of the purpose, benefits, research protocols, and possible side effects.

Subject of Research

Subject was selected using purposive sampling by selecting subjects based on subjective and practical considerations in accordance with research criteria to be the subject of research. The research subject can provide adequate information to answer research questions. Based on the sample size formula, a minimum sample obtained was 32 samples with history of diabetes mellitus.

$$n = \frac{Z_{\alpha}^2 P (1-P)}{d^2}$$

- n : Sample size
P : Proportion of disease or condition studied In this study the prevalence of diabetes in Central Java Province based on RISKESDAS 2018 is 2.1% (0.021)
 α : The desired significance level of 95% is obtained
 Z_{α} : 1,96
d : The desired margin of error is 5% or 0.05

Primary data collection included measurement of HbA1c using HPLC (High-performance liquid chromatography) method using blood sampling conducted at the laboratory of RSND Semarang. Anthropometric measurement consists of body weight and body height. A structured questionnaire of MMAS-8 used for medication adherence. Structured questionnaire by Amalia Harumi for diet adherence, smoking history, and physical activity was used. Cut-off status of glycemic control was adjusted to PERKENI's recommendation: controlled if the patient has a HbA1c level below 7%, and uncontrolled if HbA1C above 7%.

Adherence to treatment was measured using Morisky's Medication Adherent Scale (MMAS-8). Low adherence defined as a score <7, while high adherence as score greater than or equal to 7. BMI is body weight in kilograms divided by square of height in meters. BMI categorization: underweight (<18.5), normal weight (18.5-24.9), Overweight (25.0-29.9) and obese (>30). Diet adherence was evaluated using Amalia Harumi's questionnaire. Classified obey if the score is less than 55, disobey defined as score greater than or equal to 55. Smoking history included active current/former smokers, and never smoke. Active current smoker was those who regularly smoke or in the last one week still smoke minimum 5 cigarettes. Former smoker is when person ever smoke within 10 last years as an active smoker. Never smoke if person never smoke at all, or already stop smoke at all more than 10 years. Activity is conducted in order take care of health and body fitness according to 2015 PERKENI recommendation. Daily activities and physical exercises carried out independently regularly 3-5 times per week for about 30-45 minutes, for a total of 150 minutes weekly with breaks between physical exercises. The answer was yes or no.

HbA1c Measurement

After obtaining informed consent from the subject, a 3 ml venous blood sample was obtained from subjects's arms. Venous blood samples then placed in EDTA (Ethylenediaminetetraacetic acid) tubes. HbA1c examination was carried out by the HPLC (High-Performance Liquid Chromatography) method.

Statistical Analysis

Bivariate analysis was used to describe the relationship between independent and dependent variables. Hypothesis testing was performed with bivariate analysis of Chi square test. Chi square test was used to determine the significance of each independent variable on the dependent variable. A $p < 0.05$ indicated that the independent variable has a significant relationship with the dependent variable.

RESULTS

The population subjects of this study were diabetes mellitus patients attending Rumah Sakit Nasional Diponegoro (RSND), Semarang. This study was conducted from April 2019 to September 2019. There were 87 subjects who agreed to participate and answer the questionnaire. Subjects with controlled glycemic status was 26 people, while 61 subjects had uncontrolled glycemic status (Table 1).

Table 1. Subjects characteristic with glycemic control status

Characteristics	Glycemic control status n (%)	
	Controlled	Uncontrolled
Gender		
Male	19(43.2)	25(56.8)
Female	7(16.3)	36 (83.7)
Type of Therapy		
Oral	17(27.4)	45(72.6)
Insulin	0(0)	6(100)
Combination	9(47,4)	10(52.6)
Age		
Mean		57.3
Max		84
Min		34
HbA1c (%)		
Mean		8.06
Max		14.1
Min		5

The result of the analysis of relationship between factors are describe in table 2. Variable BMI, smoking history, and physical activity doesnt have significant relationship with glycemic control status. Variable of diet aand medication adherence had asignificant relationship with glycemic control status.

Table 2. Data Distribution and Correlation Test

Variable	Glycemic Control Status		PR	P
	Controlled	Uncontrolled		
BMI				
Underweight	1 (25%)	30 (61.2%)		0.254
Normal	8 (30.8%)	18 (69.2%)		
Overweight	16 (35.6%)	29 (64.4%)		
Obesity	1 (8.3%)	11 (92.7%)		
Medication Adherence				
High	19 (38.8%)	30 (61.2%)	2.11	0.040*
Low	7 (18.4%)	31 (81.6%)		
Diet Adherence				
Obey	14 (46.7%)	19 (53.3%)	2.1	0.046*
Not Obey	12 (21.1%)	42 (78.9%)		
Smoking History				
Never	24 (34.3%)	46 (65.7%)	3.09	0.069
Current or Former	2 (11.8%)	15 (88.2%)		
Physical Activity				
Yes	10 (38.5%)	16 (61.5%)	1.65	0.254
No	16 (26.2%)	45 (73.8%)		

*Significant at $p < 0.05$. Chi Square

DISCUSSION

This cross sectional study investigated the factors affecting glycemic control in patients with diabetes mellitus. Normal weight is one of the pillar for controlling diabetes mellitus according PERKENI (PB. PERKENI, 2015). We found that BMI was not associated with glycemic control status. This finding was compatible with previous study investigating factors affecting glycemic control showed that there was no correlation between BMI and glycemic control status (M *et al.*, 2015; (Su *et al.*, 2014). Other study suggested that body fat percentage is thought to be more reliable associated with glycemic control status, than BMI. A high BMI does not necessarily reflect the percentage of body fat (Bower *et al.*, 2017). Fatty deposits in the body can reflect the resistance and sensitivity of insulin, an indicator of glycemic control. Body composition in patients with diabetes mellitus such as waist circumference, percentage of visceral fat, and percentage of total body fat affect HbA1c levels as indicators for glycemic control (Patel and Abate, 2019) (Sephora *et al.*, 2019).

Diet and medication adherence have a significant relationship with glycemic control status. This research shows that people with diabetes mellitus who adhere to their diet will have a 2.1 times glycemic control better than those without adherence. This study also shows that people who have high adherence to diabetes mellitus multiple drugs treatment will have 2.11 times glycemic control better than those with low one. Diet and pharmacological treatment are pillars in controlling diabetes mellitus according PERKENI (PB. PERKENI., 2015). Almadhoun and Alagha do the research about medication

adherence and poor glyceimic control, and there is significant relationship between medication adherence and poor glyceimic control (Almadhoun and Alagha, 2018).

No significant relationship between smoking history and glyceimic control status was found consistent with the previous study (Fiagbe *et al.*, 2017). In contrast, the previous study revealed that smoking history was associated with glyceimic control status (Ohkuma *et al.*, 2015). Many factors related to smoking affect the status of glyceimic control such as smoker status (active or passive) and smoking dose in a person. Smoking can cause acceleration and worsening of complications from diabetes mellitus such as nephropathy, retinopathy, peripheral arterial disease, and cardiovascular problems (Id *et al.*, 2019). The possible reason for the discrepancy is that the majority of the respondents of this study were not smoker.

Measured exercise activity for diabetics can increase sensitivity and reduce insulin resistance in the tissues. Measured sports activities such as exercise intensity and length of time can also affect glucose uptake in tissues (Little *et al.*, 2017). The result between physical activity and glyceimic control status shows there is no significant relationship. Previous research showed a significant relationship between sports activity and glyceimic control status (Ji-Hye-Park, 2015). Other study has shown that sports activity is not associated with glyceimic control (Fiagbe *et al.*, 2017). This might be due to the fact that most of the respondents were older adults incapable of performing exercise according to PERKENI recommendation.

CONCLUSION

In this study, diet adherence and medication adherence are factors affecting glyceimic control status of diabetes mellitus outpatients attending the Diponegoro National Hospital Semarang. BMI, smoking history, and physical activity are not factors affect the glyceimic control status.

A further investigation is required to evaluate other screening tools other than HbA1c as an indicator of glyceimic control status. HbA1c is susceptible to patients with hematological disorders, especially those that interfere with hemoglobin levels such as anemia, impaired liver function, impaired kidney function and others.

ACKNOWLEDGMENT

We thank the clinical pathology resident Diponegoro University, Akhmad Raumulfaro, and Hafid Bagus Aji Prasetyo as research partners who have also helped this research. We thank to Dimas Muhammad Ilham and Muhammad Iqbal Fauzi in preparing this article. We also thank Medical Faculty Diponegoro University in funding this research using 2019 RPP (Riset Pengembangan dan Penerapan) grants.

CONFLICT OF INTEREST

There is no conflict of interest within this manuscript.

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