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ORIGINAL ARTICLE

Walking as Simple Exercise to Reduce Blood Glucose Level in Type 2 Diabetes

Christina Yuliasuti, Setiadi, Nur Muji Astuti, Nisha Dharmayanti Rinarto

Sekolah Tinggi Ilmu Kesehatan Hang Tuah Surabaya, Jl. Gadung No.1 Surabaya 60244, Indonesia

ABSTRACT

Introduction: Patients with Type 2 Diabetes Mellitus (DM) who do not do physical exercise are more likely to be unable to control their blood glucose levels, which has the potential to cause various complications. Based on basic health research 2018, the prevalence of DM is mostly at the age of 55-64 years (15.6%). This current research aims to identify the effectiveness of walking to reduce blood glucose levels. **Methods:** This study, which applied the time-series design, involved 15 randomly selected patients with type 2 Diabetes Mellitus aged 45-65 years. The walking intervention was carried out three times in 2 weeks, namely twice in week 1 and once in week 2, each for 30 minutes. Data were collected using a glucometer and an observation sheet. Data were analyzed using paired t-test and repeated ANOVA with a significance level of $p < 0.05$. **Results:** We found differences in blood glucose levels before and after walking on days 1, 3, and 8 ($p < 0.001$). In addition, there were significant differences in all measurements of blood glucose levels of Diabetes Mellitus patients both at the start (before walking) and after walking on day 3 and day 8 ($p < 0.025$). This study found that walking was effective at lowering blood glucose levels. **Conclusion:** Walking as a simple exercise can increase the use of glucose by active muscles, reduce insulin resistance, and increase blood vessel flow. Health education on self-care management, especially physical exercise on walking, will support the control of blood glucose levels.

Keywords: Blood glucose, Diabetes mellitus, Exercise, Walking

Corresponding Author:

Christina Yuliasuti, M.Kep.

Email: christinayuliasuti@stikeshangtuah-sby.ac.id

Tel: +62 817328684

INTRODUCTION

Based on American Diabetes Association, 2005, Diabetes Mellitus (DM) is a group of metabolic diseases with the characteristic of hyperglycemia that occurs due to abnormalities of insulin secretion, insulin work, or both (1). Based on Perkeni's recommendation (Indonesian Endocrinology Association), to prevent chronic complications, effective DM control is needed. DM control applies the 4 pillars of diabetes mellitus control guidelines that involve education, dietary regulation, exercise, and medication adherence (2).

Based on the phenomenon that occurred at Puskesmas (Local Clinic) of Kebonsari in Surabaya, people with diabetes mellitus tend to be less familiar with the 4 pillars of DM control. They did not fully understand that walking is an easy and cheap way to control blood glucose levels. Several factors were inhibiting these activities, such as the patients were too busy, the patients' ignorance of the management of DM, economic reasons, and others. Based on the researchers'

knowledge, so far the effectiveness of walking to reduce blood glucose levels in diabetes mellitus sufferers in the respective research site cannot be explained.

"The number of people with diabetes rose from 108 million in 1980 to 422 million in 2014. Prevalence has been rising more rapidly in low- and middle-income countries than in high-income countries. Diabetes is a major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation. Between 2000 and 2016, there was a 5% increase in premature mortality from diabetes. In 2019, an estimated 1.5 million deaths were directly caused by diabetes. Another 2.2 million deaths were attributable to high blood glucose in 2012" (3 p. 1).

"The International Diabetes Federation (IDF) Atlas 2017 reported that the Diabetes epidemic in Indonesia showed an increasing trend. Indonesia was the sixth country in the world after China, India, the United States, Brazil, and Mexico whose around 10.3 million people aged 20-79 years suffered from Diabetes" (4 p. 1).

Based on the 2018 Basic Health Research, the prevalence of diabetes mellitus in East Java in the population of all ages was 2.0%. Meanwhile, the prevalence of Diabetes Mellitus in people aged >15 years was 2.6%.

The prevalence of diabetes mellitus based on the examination of blood glucose levels in people aged >15 years, according to the highest characteristics, is at the age of 55-64 years (15.6%) (5).

The total population in the Kebonsari Surabaya is 48,962 people. Out of which 3,360 people in 2018 were affected by Diabetes mellitus (DM). Based on the registration data in 2019, the visits of DM sufferers at Puskesmas Kebonsari in the last 3 months (January to March 2019) were around 460 people. In a preliminary study conducted by researchers on April 1, 2019, out of 10 people with diabetes, most of them said that they came to Puskesmas only to get a free check-up regarding their blood glucose levels. In fact, Puskesmas already had got programs for people with Diabetes mellitus once a month in the second week, including education and exercise. However, in reality, not many people with Diabetes attended the programs. Mostly the sufferers reasoned that they had to take care of their grandchildren at home and they were still busy at works. The fact shows that lack of physical activity can be an obstacle in controlling blood glucose levels.

High blood glucose levels are the cause of diabetes mellitus, which is associated with metabolic problems. Insulin, a hormone secreted by the pancreas, regulates blood glucose levels by allowing cells to absorb sugar from the blood. Diabetes, on the other hand, is characterized by insulin insufficiency, which is produced by a lack of insulin secretion as well as insulin resistance to its receptors (6). In type 2 diabetes mellitus, the pancreas can still produce insulin, but the quality of insulin is poor and cannot put glucose into cells. As a result, glucose in the blood increases (7). Diabetes Mellitus requires continuous medical care and counseling for self-management to prevent acute and chronic complications (8).

Diabetes Control and Complication Trial (DCCT) shows that good diabetes mellitus control can reduce 20-30% of chronic complications of Diabetes Mellitus. When underestimated, the complication of Diabetes Mellitus can cause damage to organ functions, multi-organ failure, especially the eyes, kidneys, heart, nerves, and other blood vessels (8). Thus, the crucial thing needed is DM control through four pillars of diabetes mellitus control guidelines, which consist of education, dietary management, exercise, and medication adherence (2). DM sufferers who are overweight or not actively doing activities are most likely not able to control their blood glucose levels. Walking for 30 minutes can also improve glucose control, which can help muscles absorb blood glucose and prevent blockages in blood flow. These effects can last for hours or days, but they are not permanent. Thus, to control blood glucose, walking exercise should be done regularly (9). Diabetes Mellitus must be treated because the disease can cause various that can be fatal, such as heart disease, impaired

kidney functiocomplicationsn, blindness, leg rot which sometimes requires amputation, and impotence (10) (11).

As a counselor, i.e., a health nurse in the community, a nurse is often asked by individuals and families to solve the health problems at hand. The nurses' roles as educators and counselors play an important role in building self-confidence by optimizing or increasing the confidence of people with diabetes to be able to control the disease. Based on the description above, the authors were interested in examining the effectiveness of walking to reduce blood glucose levels in people with Diabetes mellitus at Puskesmas Kebonsari, Surabaya.

MATERIALS AND METHODS

This research used the time series design method and was conducted in May 2019. The research participants were 15 randomly selected patients with Type 2 Diabetes Mellitus at Puskesmas (public health center) Kebonsari Surabaya. The inclusion criteria were patients aged 45-65 years, blood glucose levels >100 mg/dl, taking OAD (Anti-Diabetes Medicine) drugs. Patients with diabetic foot ulcers were excluded from this study.

The research instrument was a structured questionnaire (sociodemographic data) consisting of 5 question items that involved gender, age, latest educational background, occupation, and duration of suffering from Diabetes mellitus. The instrument for walking interventions used a standard walking operational procedure: a stopwatch to measure the duration of the walk. The instrument for examining blood glucose level was a set of blood glucose checks (i.e., easytouch glucometer, blood glucose test strips, lancet, alcohol swab, and observation sheets).

Interventions for walking were carried out three times in 2 weeks; twice in week 1 (day 1 and day 3) and once in week 2 (day 8), each for 30 minutes. The walking location was the field around Puskesmas, researchers prepared and cleaned the location to minimize the occurrence of injuries. Patients are advised to use closed footwear that is soft and comfortable for walking. Walking therapy is done together in the morning at 7 am.

Data collection was carried out after the researchers obtained permission from the city's National and Political Unity Agency as well as the research location. The researcher gave a questionnaire to measure the sociodemographic status after the patient gave informed consent as a research respondent. The intervention of walking for 30 minutes was carried out on day 1, 3 and 8. Measurement of blood glucose levels was carried out before and after walking. Furthermore, the researchers analyzed the data on the results of the completed questionnaire and data on blood glucose levels. Blood glucose levels were tested by the Shapiro-Wilk normality test >0.05. All data were normally distributed. Data were

analyzed using paired t-test to determine differences in blood glucose levels before and after walking. The initial blood glucose levels (pre-test on day 1), blood glucose levels after walking (day 3 and day 8) were analyzed using repeated ANOVA tests to identify differences in the three measurements of blood glucose levels (CI 95%, $\alpha = 0.05$).

This current research had received ethical approval from the Health Research Ethics Committee of Sekolah Tinggi Ilmu Kesehatan Hang Tuah Surabaya, Indonesia, with a Certificate of Ethical Eligibility Number: PE/31.a/V/2019/KEPK/SHT, dated 8th May, 2019.

RESULTS

The research was conducted on 15 respondents with Diabetes mellitus in the working area of *Puskesmas Kebonsari Surabaya*. Most of the respondents were female (60%), aged 51-60 years (40%), with last educational background of senior high school (SMA) (73.3%), and on average, self-employed working (46.7%). Concerning the history of Diabetes Mellitus, the respondents, on average, had suffered from the disease for 3-5 years (46.7%). The characteristics of respondents can be seen in table I.

Table I : The characteristics of Respondents (n=15)

Characteristics of Respondents		Frequency (%)
Sex	Male	6 (40.0%)
	Female	9 (60.0%)
Age	45-50 years	4 (26.7%)
	51-60 years	6 (40.0%)
	61-65 years	5 (33.3%)
Last educational background	Elementary School	1 (6.7%)
	Junior High School	3 (20.0%)
	Senior High School	11 (73.3%)
Occupation	Homemakers	4 (26.7%)
	Self-employed	7 (46.7%)
	Not working	4 (26.7%)
Duration of suffering from DM	0-2 years	3 (20.0%)
	3-5 years	7 (46.7%)
	6-8 years	5 (33.3%)

Source : primary data

Table II shows differences in blood glucose levels before and after walking on the 1st, 3rd, and 8th days ($p < 0.001$). This study found significant differences in all blood glucose levels measurements of Diabetic Mellitus both at the beginning (before walking therapy), and after walking therapy on the 3rd and 8th day ($p < 0.025$). This means that walking is effective in lowering blood glucose levels of people with Diabetes mellitus (Table III).

Table II : Difference of Glucose levels of the respondents before and after walking therapy (n=15)

Glucose Level (GL)	N	Mean \pm SD	p
GL pre day-1 (before walking exercise)	15	241.60 \pm 36.56	<0.001
GL post day-1	15	215.20 \pm 30.89	
GL pre day-3	15	247.80 \pm 29.71	<0.001
GL post day-3	15	233.47 \pm 29.82	
GL pre day-8	15	242.27 \pm 21.05	<0.001
GL post day-8	15	223.0 \pm 20.06	

paired t-test. Glucose Level (GL)

Table III : Difference of glucose levels of the respondents before and after walking therapy (day-3 and day-8) (n=15)

Glucose levels	Mean \pm SD	p
Initial (before walking therapy)	241.60 \pm 36.56	0.016
Day-3	233.47 \pm 29.82	
Day-8	223.0 \pm 20.06	

Repeated ANOVA test. The test of *post-hoc paired-wise comparison* resulted in the comparison of all groups < 0.025 .

DISCUSSION

Diabetes Mellitus (DM) is a group of metabolic diseases with the characteristic of hyperglycemia that occurs due to abnormalities of insulin secretion, insulin work, or both (1). (2) recommended the need for good DM control to prevent chronic complications. Diabetes is well controlled when blood glucose levels reach the expected level (12). The average blood glucose level of the participants in this study was 241.60 mg/dl, with the lowest being 200 mg/dl and the highest being 302 mg/dl. This data indicate that diabetes control in respondents was very poor.

Factors that affect blood glucose levels include disease and stress, obesity, food intake, physical activity (exercise), treatment both with Oral Hypoglycemic Medications and with insulin, and duration of suffering from DM (7,13). (14) said that 150 patients in general had poor knowledge, attitude and practice towards type 2 diabetes care. The results showed that the majority of sufferers (73.3%) were more than 50 years old (56 \pm 6.85) and most (66.6%) had been suffering from Diabetes > 3 years. This means that as we get older, the body's intolerance to glucose increases, making sugar levels difficult to control.

Various distress conditions will trigger an increase in blood glucose levels, such as the threat of more severe disease (complications of diabetes). Perceptions of high blood glucose, disciplined and regular treatment that must be followed, or ignorance of treatment are various kinds of stressors for people with diabetes. If they are not managed properly, they can trigger an increase in blood glucose. Previous research on 34 DM sufferers showed that most respondents experienced diabetes distress (73.5%), and the dominant factor affecting it was the

threat of more severe disease (increased blood glucose levels with various complications) (16). So it can be assumed that stress and ignorance of diabetes treatment will cause a lack of control of blood glucose levels and can lead to distress conditions that have an impact on rising blood glucose levels.

The first step in managing Diabetes Mellitus that must be done is non-pharmacological management, in the form of meal planning and physical activities (1). This current study found that there were differences in blood glucose levels before and after walking on days 1, 3, and 8 ($p < 0.001$). In this study, the intervention was carried out 3 times, namely twice in week 1 and once in week 2. Before the intervention of walking, the respondent's blood glucose level was measured and an evaluation was carried out after walking.

Periodic evaluation is needed to see the progress of training and to find out the benefits of physical training that has been done. Good and satisfying results will increase the motivation of people with diabetes to continue doing physical exercise (17). The results of this current research showed that, on the 3rd day, the mean blood glucose level after the intervention on foot was 233.47 mg/dl, which means that there was a decrease. Likewise, the mean blood glucose level on day 8 (or week 2) was 223.0 mg/dl, which also indicates a decrease. Measurement of blood glucose levels before and after walking therapy is needed to monitor and prevent the potential risk of hypoglycemia in diabetes pandemic and to evaluate the achievement of walking therapy.

The results also showed a significant difference in all measurements of blood glucose levels in Diabetes Mellitus patients both at baseline (before walking therapy) and after walking therapy on day 3 and day 8 ($p < 0.025$). These data show that walking is effective at lowering blood glucose levels. The efforts of DM sufferers to carry out self-care (Diabetes self-management), both preventing and tackling, will be related to DM control (18).

Taking medication, physical activity, exercise, and eating habits are related to blood glucose levels (19). During exercise, insulin resistance is reduced; conversely, insulin sensitivity increases, thereby reducing insulin requirements in people with type 2 diabetes. This response only occurs every time a person exercises; it is not a permanent or long-lasting effect. Therefore, exercise must be carried out continuously and regularly (17). This study assumes that, in addition to anti-diabetes drugs, blood glucose levels are influenced by the patient's ability to perform self-care, patient compliance in physical activity and sports, and dietary compliance.

Overweight is the most significant risk factor (20). Walking can reduce the blood glucose level. To lower

blood glucose levels, a person can walk for 30-50 minutes per day. Doing the physical activity in everyday life is one way to control the blood glucose levels of DM patients (9). In line with the research of (21), 30 minutes of leisurely walking exercise can reduce blood glucose levels. Physical activity needs to be done not only for people with diabetes but also for individuals with a high risk of type 2 diabetes. They need to start a healthier life by maintaining their physical activity, especially in sports (22). This study argues that walking not only moves the lower extremity muscles but also moves the upper limb muscles. The more active body muscles, the greater the benefits of exercise that a person will get.

This study adds to the evidence that a walking program can lower blood glucose levels. As explained in the previous studies, a walking exercise program can reduce fasting blood glucose levels (23–25), random blood glucose levels (21,26), can increase daily physical activity, physical strength, and energy consumption (behavioral aspects), and reduce HbA1c and triglycerides (biochemical aspects) in people with type 2 diabetes (25). Furthermore, the pedometer-based walking program can lose weight and improve metabolic health such as fasting glucose, cholesterol, and blood pressure (27).

In this study, the walking intervention was carried out 3 times, namely twice a week with a duration of 30 minutes for each activity. It was done so considering that walking is an activity and physical exercise that is cheap, without any additional tools, and easy to do. In addition, most of the respondents in this study were aged 50 years and over. People with diabetes are recommended to adopt a healthy lifestyle so that blood glucose levels can always be under control, for example by adjusting their diet and increasing physical activity (e.g., exercising or another physical exercise). Physical exercise can increase blood flow. More capillaries open, resulting in the number of insulin receptors so that the receptors will be more active and have an impact on reducing blood glucose levels in people with diabetes (1).

The limitation of this study is that several confounding variables cannot be controlled by the researchers which may also affect the results of the study, including daily physical activity, diet, and stress in people with diabetes mellitus.

CONCLUSION

Walking is one of the physical exercises that DM people can do to control their blood glucose levels. Walking that is carried out 2 to 3 times a week with a duration of 30 minutes is effective in reducing blood glucose levels in type 2 Diabetes Mellitus. Health education on self-care management, especially physical exercise on walking, will support the control of blood glucose

levels. However, further research is needed regarding pedometer-based walking physical exercise on the blood glucose levels of DM patients by controlling confounding variables.

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