The Effects of Moderate Intensity Aerobic Exercise on Blood Glucose in Patients with Type 2 Diabetes Mellitus

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Abstract

Moderate-intensity aerobic exercise is exercise with regular movement so that the body can develop or pump oxygen and heart rate increases by 60-70 % VO_2 limit and 50-70 % MHR. Moderate-intensity aerobic exercise will activate the muscles that are not accompanied by increased levels of insulin. Many patients with type 2 diabetes mellitus do not know a lot about moderate intensity aerobic exercise to control blood glucose levels.
 The purpose of this study is to analyze the effect of moderate intensity aerobic exercise on blood glucose levels in type 2 diabetes mellitus. The Quasi- Experimental research design with non Equivalent Control Group. The population on this study were all patients with type 2 diabetes. The total sample of 40 respondents were divided into control group and intervention. Sampling technique used Purporsive sampling and data collection tool used Glucometer. The results show that there is influence of moderate-intensity aerobic exercise on blood glucose levels in type 2 diabetes mellitus. It is seen from the p value of 0.000 ($\alpha = 0.05$). Changes in difference of mean blood glucose levels after intervention in the intervention group decrease as many as 21,06 mg/dl and in control group increase as many as 4,43 mg/dl. Moderate-intensity aerobic exercise can be used as a non-pharmacological treatment in the management of type 2 diabetes to control blood glucose levels. Further research studies can control the counfounding factor, namely: activity and diet.

Keywords : Moderate-intensity aerobic exercise, blood glucose levels, type 2 diabetes patients.

Introduction

The prevalence of DM around the world varies greatly. The number of diabetics worldwide is currently estimated to be around 190 million. By 2025, it has risen to more than 330 million, with the majority of cases becoming type 2 diabetes (Sudoyo A., 2009). The prevalence of diabetes mellitus sufferers in Indonesia has also increased, WHO predicts that Indonesia will experience an increase in the number of people with DM by 12.9 million over the next 30 years (2000-2030). Especially for the sufferers of type 2 diabetes was increased of 7.1 million in the past 10 years (2000-2010) (Soegondo et al, 2013).

Complications that can be caused by the first Diabetes Mellitus are acute complications which include hypoglycemia, diabetes ketoacidosis, and hyperketmolar nonketotic hyperglycemic syndrome. Long-term complications that occur include macrovascular disease, microvascular disease, and neuropathy (Smeltzer & Bare, 2015).

Efforts to manage type 2 of diabetes are by planning food, physical exercise, hypoglycemic drugs, and counseling. All those actions can be taken in an effort to control blood glucose levels in type 2 DM patients. Food planning is with a 45-60% carbohydrate diet, 10-20% protein, and 20-25% fat. Regular physical exercise is recommended (3-4x a week) for approximately 30 minutes. As far as possible reach the target zone of 75-85% of the maximum pulse rate (220-age), adjusted for the ability and accompanying diseases (Sarwono, 2012).

Types of physical exercise for diabetics are vary, such as aerobics, yoga, and Thai chi, based on research from the three types of exercise that are suggested is aerobics has the highest average decrease in blood glucose. Aerobic physical exercise makes insulin work harder and faster and reduces body fat. Aerobic sports include cycling, dancing, jogging, jumping rope, walking through stairs, swimming, and walking (Sarwono, 2012).

One of the advantages of aerobic is its easy movements and there are several types of aerobics which are daily activities. Besides reducing blood glucose, aerobic can reduce stress levels, reduce the risk of heart failure, and reduce the risk of stroke. Lack of aerobics if it is not controlled will cause increasing

nonepinephrine by 800 times, increasing blood pressure, the effects resulting from physical exercise after 2 x 24 hours disappear, therefore to obtain these effects physical exercise needs to be done 3 times a week (Sidartawan, 2013).

The intensity of aerobic exercise is divided into 3; they are low intensity, moderate intensity (Moderate Intensity Aerobic Exercise), and high intensity (Vigorous Intensity Aerobic Exercise). Low intensity reaches VO2 max 40%, moderate intensity 50% -70% MHR and 60% - 70% VO2max, as high as 70% MHR and 80% VO2max (Harahap 2008). MHR is the Maximum Heart Rate that can be obtained by 220 - Age, VO2 is the maximum volume of O2 that is processed by the human body during intensive activities, VO2Max is: Distance traveled in meters - 504.9) / 44.73 (Sidatarwan, 2013).

Whereas in research conducted by Sakamaoto, moderate intensity exercise can reduce blood glucose levels. This decrease in blood glucose level is related to increasing glucose transporter due to simulation by the hormone insulin. In moderate intensity exercise can reduce blood glucose levels greater than in high intensity exercise. In his study only based on MHR (60%).

From the results of a preliminary study conducted by researchers on 9 to 11 October 2013 at Ungaran Community Health Center, the highest prevalence of type 2 DM was found in Langensari village with 65 patients in the last 6 months and increase from month to month during the last 6 months, from the results of glucose tests blood in 15 type 2 DM patients in Langensari village, an average of 14 out of 15 patients had experienced type 2 DM for about 6 years, and 1 patient said that he forgot how long to suffer from type 2 DM.

To control blood glucose with the DM diet, 6 out of 15 patients said they paid attention to their diet and the rest did not care about their diet, while those taking oral hypoglycemic drugs 3 out of 15 drank it, with 2 patients regularly and 1 patient taking it because of the rest of the drug from the results of the examination when the blood glucose is high.

Control of blood glucose with physical exercise was 4 out of 15 do it with an average frequency of 2 times a week with this type of aerobic exercise cycling and jogging. To find out blood glucose levels 3 out of 15 do regular control and the rest seek the help of health centers when there are complaints.

From the examination of blood glucose levels during the interview, 4 patients who did regular exercise 2 times a week had an average blood glucose level of 117.2 mg / dl and 11 patients who did not do physical exercise had an average glucose level of 178.4 mg / dl. Seeing the results of the interview above, more than a few patients who have type 2 diabetes did not pay attention to diet, do not diligently control, and did not do regular physical activity.

Based on the above phenomena, the researcher wants to know the effect of moderate intensity aerobic exercise on blood glucose in type 2 DM patients so that the resulting research can be used as a foundation in providing nursing care for type 2 DM patients. To find out the effect of moderate intensity aerobic exercise on decreasing blood glucose These researchers are interested in conducting research with the title "The Effect of Moderate Intensity Aerobic Exercise on Blood Glucose Levels in Type 2 Diabetes Mellitus Patients"

This research was to analyze the effect of mild intensity aerobictas toward blood glucose level of the patient's DM type 2.

Methods

The design of this study was Quasi Experiment, with the Non Equivalent Control Group Design approach. The populations in this study were all type 2 DM patients registered at the Ungaran Community Health Center. Samples were taken by purposive sampling and the amount was calculated using the two mean difference test, obtained 20 treatment groups and 20 control groups. The criteria used in this study were: Type 2 DM patients with blood glucose when 100 g / dl to 300 g / dl, not using insulin, not having foot injuries, not being able to do the maximum VO2 test.

The measuring instrument used a glucometer. The respondent both the treatment group and the control group performed a pretest by measuring blood glucose levels, the day after that in the treatment group, moderate intensity aerobic exercise for 2 weeks was conducted every 2 days, every exercise for 30 minutes. The control group for 2 weeks was not done with moderate intensity aerobics and controlled by factors that could influence blood glucose levels. Day 8 was carried out post-test by measuring blood glucose levels. When examining the factors that affect blood glucose levels. Data analysis used dependent t-test and independent t-test.

Results

Table 1. Frequency Distribution Based on Blood Glucose Levels Before Being Given Medium Intensity Aerobic Exercise in Intervention and Control Groups in Type 2 DM patients

Varable	Treatment	N	Mean	SD	t	P value
Blood glucoce level	Before	18	182,67	15,755	5,058	0,000
	After	18	161,61			
				18,977		

Based on table 5.4, it can be seen that in the intervention group, the average blood glucose level of respondents before being given moderate intensity aerobic exercise was 182.67 mg / dl, after given moderate intensity aerobic exercise was reduced to 161.61 mg / dl

Table 4. Differences in Blood Glucose Levels Before and After Treatment in the Control Group in Type 2 DM Patients

Variable	Treatment	N	Mean	SD	t	P value
Blood glucose level	Before	19	183,74	19,618	-2,820	0,011
	After	19	188,16			
				20,015		

Based on table 5.5, it can be seen that in the control group, the average blood glucose

level of the respondents before treatment was 183.74 mg / dl, after treatment it increased to 188.74 mg / dl.

Table 5 Differences in Blood Glucose Levels After Giving Medium Intensity Aerobic Exercises between Intervention and Control Groups in Type 2 DM Patients

Variable	Group	n	Mean	SD	t	P value
Blood glucose level	intervention	18	161,61	18,977	-4,135	0,000
		19				
	Control		188,16	20,015		

Based on table 5.6, the average blood glucose level of the respondents in the intervention group after giving aerobic exercise was moderate intensity at 161.61 mg / dl, whereas in the control group that was not given treatment at 188.16 mg / dl.

Discussion

The results showed that in the intervention group with the number of respondents 18 in Langensari Village, Semarang Regency, the average blood glucose level was obtained before being given moderate intensity aerobic exercise of 182.67 mg / dl with a standard deviation of 15.755 mg / dl, minimum blood glucose levels 152 mg / dl and a maximum of 211 mg / dl. Whereas in the control group with the number of respondents 19 in Langensari Village, Semarang Regency, it had an average of 183.74 mg / dl with a standard deviation of 19.618 mg / dl, a minimum blood glucose level of 146 mg / dl and a maximum of 210 mg / dl.

Patients with type 2 diabetes mellitus have high glucose levels due to abnormalities in insulin that are not sensitive to receptors so that glucose cannot enter the cells and remain in the blood. This is consistent with research into the understanding of diabetes mellitus.

Glucose levels in patients with type 2 diabetes mellitus in Langensari Village are high because based on interviews with 15 patients it was found that 9 of them did not pay attention to their diet, even though diet is one of the pillars in the management of diabetes mellitus, with a diet that does not comply with the rules will increase fat deposits that will aggravate insulin

insensitivity, this will trigger an increase in blood glucose levels

Based on the results of interviews with respondents, 11 of the 15 respondents said that they did not limit food, one of which was rice, even though rice would be broken down into glucose which would enter the digestive system which would be carried by the bloodstream. In people with diabetes mellitus glucose in the blood cannot enter the cell because of a lack of sensitivity receptors, this can increase glucose levels in the blood circulation or commonly called hyperglycemia, but people with type 2 diabetes mellitus are not only hyperglycemic but hypoglycemia can occur, when hypoglycemia occurs alpha cells will be responsible for increasing blood glucose levels

The level of blood sugar is regulated through negative feedback to maintain balance in the body. The level of glucose in the blood is monitored by the pancreas. When glucose concentration is decreased, because it is consumed to supply the body's energy needs, the pancreas releases glucagon, a hormone that targets cells in the liver. Then these cells convert glycogen to glucose (this process is called glycogenolysis). Glucose is released into the bloodstream, thereby increasing blood sugar levels.

Factors affecting blood glucose levels varied, in interviews with 10 respondents in the control and intervention group, 7 said that the respondent's parents or grandparents had diabetes (diabetes mellitus), then only 2 said they were diligent in exercising by cycling and jogging. The lack of exercise and hereditary factors are very influential in this regard, but the exercise factors can be changed.

In the intervention group, the respondent's average blood glucose level before being given aerobic exercise was 182.67 mg / dl and the control group had an average blood glucose level of 183.74 mg / dl, this could be categorized as poor control. . In patients with diabetes mellitus insulin resistance occurs which causes a lot of glucose to circulate in the blood and insulin cannot be effective in facilitating glucose entry into cells.

The results showed that after being given moderate intensity aerobic exercise in the intervention group with 18 respondents, the average blood glucose level of respondents was 161.61 mg / dl with a standard deviation of 18.977 mg / dl, a minimum blood glucose level of 134 mg / dld and maximum 198 mg / dl. While in the control group with 19 respondents after treatment had an average blood glucose level of 188.16 mg / dl with a standard deviation of 20.015 mg / dl, a minimum blood glucose level of 152 mg / dl and a maximum of 216 mg / dl.

DM management starts with a non-pharmacological approach, which is in the form of providing education, food planning / medical nutrition therapy, physical activities and weight loss when overweight or obese are obtained. If the non-pharmacological approach measures have not been able to achieve the DM control goals have not been achieved, then continued with the use of the need for the addition of medical therapy or pharmacological interventions in addition to continuing to do appropriate food and physical activity (Sudoyo A., 2009).

The training program given to the intervention group respondents in Langensari Village, Semarang Regency is known as CRIPE (Continuous, Rhythmical, Interval, Progressive, and Endurance), which is doing 37 minutes of exercise, 3 times per week, moderate intensity aerobic exercise can reduce blood glucose levels by how to open the capillary mesh so that the receptor will be more sensitive to insulin.

Moderate aerobic exercise in the intervention group was done by jogging with a predetermined distance in accordance with VO2 and MHR of the intervention group respondents, when respondents did jogging it would activate muscles so that oxygen and glucose requirements would increase after the initial few minutes. When the respondent is in a state of exercise, the need for glucose will increase accompanied by an increase in insulin sensitivity without an increase in insulin secretion by beta cells so at this stage glucose levels start to fall.

Based on the results of interviews saying that 15 patients 6 of them said paying attention to their diet and the rest did not care about their diet, diet is very influential and plays a big role for glucose levels of people with type 2 diabetes mellitus.

In patients with diabetes mellitus the control group got an average pretest glucose level of 183.74 mg / dl and posttest of 188.16 mg / dl, thus there was a slight increase in the control group, this was caused by variables that could not be controlled by researchers was diet

The result showed that intervention group with 18 respondents, blood glucose before being treatment 182,67 mg/dl, after being treatment it decreased into 161,61 mg/dl, and its difference was 21.06 mg/dl

Glucose levels before exercise are high due to hyperglycemia due to impaired insulin resistance (peripheral insulin action) and disorders of insulin secretion, high glucose levels before exercise are also caused by respondents' unwillingness and inability to control blood glucose levels, in addition to that few of them know that physical exercise can reduce blood glucose levels.

Decrease in blood glucose levels in this study has an average of 21.06 mg / dl, this is similar to M. Zuhal Purnomo's research (2014) that there is an effect of exercise on reducing blood sugar in NIDDM in the Internal Medicine Polyclinic, a decrease of 17.30 mg / dl after exercise with a duration of 45 minutes. When the intervention group does moderate aerobic exercise, there will be an increase in oxygen uptake, then there will also be an increase in blood flow which will result in increased opening of the capillary nets so that many receptors are active.

In the intervention group when given exercise, the VO2 and MHR were very concerned because they saw an increase in oxygen demand and an increase in cardiac output. In the exercise conducted on 7-15 February 2014, respondents were in the interval 60-70% of the maximum VO2 and 50-70% of the maximum MHR, this is demonstrated to avoid undesired effects.

Aerobic exercise with the intensity being done on 20 respondents by researchers for 3 times a week with a duration of 37 minutes each exercise in patients with type 2 diabetes mellitus, exercise is done in the morning because the respondent has not done much activity by checking his blood glucose level first to ascertain levels glucose above 100 mg / dl and below 250 mg / dl. The final result was only 18 respondents because 2 others were dropouts.

The intervention group numbered 20 respondents, one respondent when blood glucose levels were checked before exercise was 275 mg / dl, and another respondent was not at home when the intervention was given so it was dropped out, and the intervention group numbered the final 18 respondents. When the intervention group did moderate aerobic exercise, it would activate the muscles of the intervention group respondents, even though the muscle need for glucose increased, not accompanied by an increase in insulin levels. This is due to the increased sensitivity of insulin receptors in the muscles and the increasing number of insulin receptors that are active during exercise.

The results showed that in the control group of 19 respondents, the average blood glucose level of respondents before treatment was 183.74 mg / dl, after treatment it increased to 188.74 mg / dl. Blood glucose levels of people suffering from type 2 diabetes mellitus will still circulate in the blood vessels because they cannot enter the cells and are stored by the liver, fat, and muscles, which can interfere with metabolism in the body.

In the management of diabetes there are 4 pillars, one of them is medical nutrition therapy in type 2 diabetes should be in the control of glucose, lipids, and hypertension. Low calorie diets are generally not effective in achieving long-term weight loss, in this case it should be emphasized that the goal diet is on glucose and lipid control. However, in some individuals weight loss can also be achieved and maintained. Food planning should be of sufficient nutritional content and accompanied

by a reduction in total fat, especially saturated fat (Indonesian Endocrinology Association).

Based on the results of the study found the average blood glucose level of the respondents in the intervention group after giving aerobic exercise was moderate intensity of 161.61 mg / dl, whereas in the control group who were not given treatment of 188.16 mg / dl, with an average difference of a decrease of 21.04 mg / dl

Increasing insulin sensitivity during exercise was when exercise increases blood flow, this causes more open capillary nets so that more insulin receptors are available and active. Controlled exercise according to maximum MHR and VO2 will cause an increase in catecholamine secretion, whereas if it is not in accordance with the maximum MHR and VO2 interval there will be an increase in nonepinephrine by 800 times, due to this increase will cause an increase in blood pressure and heart rate, then microangiopathy can occur, otherwise there will be an increase in cortisol levels more quickly (Suyono S., 2013).

Data from research results in Langensari village, Semarang Regency shows that moderate intensity aerobic exercise has an influence on blood glucose levels in type 2 diabetes mellitus patients. The results of this study are in line with the theory that increases insulin sensitivity while exercising, when exercising blood flow will increased, this causes more open capillary nets so that more insulin receptors are available and active.

Conclusion

There is an effect of moderate intensity aerobic exercise on blood glucose levels with an average glucose level in the intervention group

of 161.61 mg / dl and in the control group of 188.16 mg / dl with a difference of 26.55 mg / dl with a p value of 0,000 (α = 0.05).

The results showed a decrease in blood glucose levels in patients with type 2 diabetes mellitus after moderate intensity aerobic exercise, then moderate intensity aerobic exercise can be used as a nonpharmacological treatment in the pillars of physical exercise to keep blood glucose levels within normal threshold.

The limitations of the research that has been done, it is hoped that further research can carry out more intensive supervision of the factors that determine blood glucose levels and help control research confounding factors.

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