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Application of Chair-Based Exercise in Improving Ankle Brachial Index Values in Type II Diabetes Mellitus Patients

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Abstract

Background: *In 2019, diabetes cases in various countries increased by 463 million people and 4.2 million deaths. In the long term, DM can result in complications, one of which is PAD. So it is necessary to detect it early by measuring the value of the ankle brachial index and making efforts to prevent complications with chair-based exercise and a combination of elastic bands so that blood circulation is smooth.* ***Research Objective:*** *To know the effect of chair-based exercise on improving the value of the ankle brachial index in people with type II DM.* ***Research Methods:*** *This type of research is Quasi Experiment with Pre-Posttest and control group design. The research was conducted from March 1-April 1, 2023. The sample consisted of 54 respondents, using the purposive sampling technique. The analysis test used is the paired T-test.* ***Results:*** *Analysis of the average ABI value showed that there was a significant difference in the increase in ABI value, namely the right extremity (p = 0.013) and left extremity (p = 0.000). Analysis of unpaired variable t-tests on ABI values showed that there was a difference between the groups given chair-based exercise with an improvement of p = 0.043 right extermity and p = 0.048 left extermity (p <0.05) compared to the group not given gymnastics, so it can be concluded that the hypothesis is accepted.* ***Conclusion:*** *Chair-based exercise has an effect on improving ABI values in patients with type II DM.*

Keywords: *Type II Diabetes Mellitus, Chair-Based Exercise, Ankle Brachial Index Value.*

INTRODUCTION

Diabetes mellitus (DM) is one of the non-communicable diseases (NCDs) that is commonly found in the community and is a major cause of death. Diabetes mellitus is a metabolic disease characterized by high glucose levels (hyperglycemia) due to the pancreas not being able to secrete insulin, the pancreas having impaired insulin action, or a combination of both[(1)]. It is estimated that the number of patients with DM in various countries has increased by 463 million people, and the number of cases of death is 4.2 million people[(2)].

Cases of diabetes mellitus in Indonesia based on the results of medical diagnoses by doctors in the population aged ≥ 15 years rose to 2%, where D.I. Yogyakarta Province was ranked 2nd with the highest prevalence of around 3.1%[(3)]. The number of DM cases in D.I. Yogyakarta in 2020 was 747,712 cases, and 49,110 patients with diabetes (63.2%) had received health services according to standards[(4)].

According to the data obtained from the Sleman Regency Health Office, in the period January–December 2021, type II DM ranked 4th out of 10 major disease patterns in the Sleman Regency area, with 27,090 cases, which continued to increase from the previous year's 13,173 cases. The Minggir Health Center ranks 1st out of 25 health centers in Sleman Regency with a cumulative number of people with type II DM per period in 2021 of 3,112 cases[(5)].

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According to the high prevalence of DM cases, it is important to manage DM well to prevent complications that can harm the body. The complications of chronic diabetes include macrovascular and microvascular complications. Peripheral artery diases (PAD) are one of the macrovascular complications, with a prevalence of 9.7%[(6).] PAD is a result of a decrease in limb and blood circulation characterized by constriction and obstruction of peripheral blood vessels, especially the lower extremities, due to distal tissue perfusion not functioning properly, so that it can develop into necrosis or gangrene[(7)].

Prevention of diabetic angiopathy and improvement of peripheral blood circulation are intended to overcome the occurrence of PAD and reduce the risk of amputation for people with DM, namely by changing lifestyles and routine physical exercise with low-impact exercises such as chair-based exercise according to the body's ability. Chair-based exercise is a type of physical exercise that has been modified to be done in a sitting position to maximize the benefits of exercise without risk to personal safety and reduce the risk of falls[(8)].

Exercise is effective in improving blood vessel circulation because the movement of the limbs during exercise causes the muscles to become tense and compress the blood vessels around the muscles, causing a push of blood pressure to the heart and a decrease in venous blood pressure, resulting in an increase in ABI values[(9)].

The preliminary study conducted in September 2022 at the Minggir Health Center obtained data showing that 200 patients were registered as Prolanis DM members. The results of interviews with the doctor in charge of the prolanis program found that there were several routine activities that had been carried out, such as counseling, checking blood sugar levels, and prolanis exercises. Meanwhile, the interview results with patients with DM found that 7 out of 10 patients complained of experiencing a decrease in peripheral blood circulation, such as numbness in the legs; legs often feel pain like being stabbed; muscles in the legs feel cramps; and if there is a wound on the leg, it is often not felt. This is also evidenced by the direct examination of 5 people with DM, showing that 2 respondents had a normal ABI category, 2 respondents had a mild ABI category, and 1 respondent had a moderate ABI category.

MATERIAL AND METHOD

This method of research is quasi-experimental with a Pretest-Posttest and Control Group Design. This research was conducted on March 1–April 1, 2023. The population in this study was made up of people with type II diabetes mellitus. The number of samples used was 54 respondents divided into 27 intervention group respondents and 27 control group respondents using the purposive sampling technique. The instruments in this study were chair-based exercise SOP, vascular doppler, and an aneroid sphygmomanometer to measure the ankle brachial index (ABI) value.

This experiment was conducted by dividing two randomly selected groups and then measuring the ABI value as pre-test data. The intervention group was given a chair-based exercise intervention, and the control group was not given an intervention.

Then, the post-test examination was carried out on the two groups. Univariate data analysis used the frequency distribution of respondent characteristics, and bivariate data analysis used a paired T-test because the results of the data normality test showed that the data were normally distributed. This study has received ethically feasible information from the Health Research Ethics Committee of the Poltekkes Kemenkes Yogyakarta with letter number No.DP.04.03/e-KEPK.1/162/2023.

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RESULT AND DISCUSSION

This experiment was conducted from March 1 to April 1, 2023. A total of 54 samples in the study that have been identified according to the inclusion criteria were determined. The following are the characteristics of the respondents:

Table 1: Frequency Distribution of Respondent Characteristics

Characteristics of Respondents	Intervention		Control	
	N	Percentage (%)	N	Percentage (%)
Gender				
a. Male	8	29.6	9	33.3
b. Female	19	70.4	18	66.7
Old Age				
a. *Middle age* 45-59 years	11	40.7	10	37.0
b. *Elderly*, 60-74 years old	13	48.2	14	51.9
c. Old age 75-90 years	3	11.1	3	11.1
Recent Education				
a. Not in school	-	-	1	3.7
b. Elementary school	11	40.7	11	40.7
c. High school	15	55.6	12	44.5
d. College	1	3.7	3	11.1
Work				
a. Not Working / Housewife	9	33.3	13	48.1
b. Self-employed	4	14.8	-	-
c. Workers	6	22.2	3	11.1
d. Farmer	4	14.8	8	29.6
e. Retired	3	11.1	1	3.7
f. Others…	1	3.7	2	7.4
Duration DM				
a. 1-5 years	13	48.1	18	66.7
b. 6-10 years	10	37.0	7	25.9
c. >10 years	4	14.8	2	7.4
Diabetes Medication Consumption	2	7.4	3	11.1
a. Not taking medication	20	74.1	19	70.4
b. Medication consumption	4	18.5	5	18.5
c. Insulin				
History of *Ulcerative Diabetic Foot* (DFU)	3	11.1	3	11.1
a. Yes	24	88.9	24	88.9
b. No				
Exercise Habits				
a. Yes	22	81.5	15	55.6
b. No	5	18.5	12	44.4

Table 1. showed that based on the data distribution of respondents with female gender, 19 respondents (70.4%) in intervention group and 18 respondents (66.7%) in control group, with an average age of 60–74 years, 13 respondents (48.1%) in intervention group and 14 respondents (51.9%) in control group. Most of the latest education was at the secondary school level, with as many as 15 respondents (55.6%) in intervention group and 12 respondents (44.5%) in control group. Based on employment status, it was known that most respondents were housewives or not working, with a total of 9 respondents (33.3%) in the intervention group and 13 respondents (48.1%) in the control group. Most respondents had had DM for 1–5 years, with as many as 13 respondents (48.1%) in intervention group and 18 respondents (66.7%) in control group. Most of the respondents routinely

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consumed medicine as prescribed by the doctor, 20 respondents (74.1%) in intervention group and 19 respondents (70.4%) in control group.

Meanwhile, the history of diabetic foot ulcers and exercise habits showed that the majority of respondents had no history of DFU, with 24 respondents (88.9%) in each group of intervention and control groups. However, there were 3 respondents (11.1%) in the intervention group and control group who had a history of DFU. On average, patients who had injured their legs had improved and dried wounds. Also, 22 respondents (81.5%) in intervention group and 15 respondents (55.6%) in control group had routine physical activity habits such as gymnastics, walking, cycling, and badminton.

Table 2: Frequency Distribution of ABI Value Measurement in Patients with Type II DM before and after intervention

Group	Ankle Brachial Index value	Pre test	%	Post test	%
Intervention	Usual	16	59,2	27	100,0
	Lightweight PAD	11	40,8	-	-
Control	Usual	17	62,9	15	55,6
	Lightweight PAD	10	37,1	12	44,4

Table 2. shows the results of the pre-test measurement of ABI values in patients with type II DM who mostly have normal ABI values (0.9–1.3), with as many as 16 respondents (59.2%) in intervention group and 17 respondents (62.9%) in control group. However, not a few patients with DM had mild PAD (<0.9) as many as 11 respondents (40.8%) in intervention group and 10 respondents (37.1%) in control group. The results of the post-test after interventions found that all respondents (100%) in the control group had an increase or an improvement in ABI values, while respondents who were not given interventions found that there were still 12 respondents who experienced mild PAD or a decrease in ABI values.

Table 3: Test results differ in ABI values before and after intervention in the intervention group and control group

Group	Ectremity		Df	Mean Score	Mean paired	T	Sig.
Intervention	Right	*Pre test*	27	0.9370	0.03556	2.672	0.013
		Post test		0.9726			
	Left	*Pre test*		0.9167	0.04556	5.259	0.000
		Post test		0.9622			
Control	Right	*Pre test*	27	0.9667	-0.02000	-2.066	0.049
		Post test		0.9467			
	Left	*Pre test*		0.9600	-0.02185	-2.114	0.044
		Post test		0.9381			

In table 3. the results of the ABI value difference test above show that intervention groups given chair-based exercise with a combination of elastic bands had a significant difference in ABI values between the pre-test and post-test because the p value> 0.05. Meanwhile, the control group without the intervention also had a significant difference in ABI values between the pre-test and post-test because the p value> 0.05. However, in control group, the average result (paired mean) has a negative value, which means that there is a decrease in ABI value between the post-test and pre-test results.

Based on the results of the research, it is known that the ABI value of the intervention group before the chair-based exercise intervention was mostly in the normal category (59.2%), but as many as 11 respondents (40.8%) experienced mild PAD. Based on the results of the research after being given the intervention, all respondents experienced a change in ABI values in the normal range (100%). Although there was an increase in the average value of the difference in ABI values for the

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right extremity by 0.4 and the left extremity by 0.05. This data is in line with the results of previous research, which found that there was an increase in ABI values after the intervention[9]. Based on the difference test, there was a significant change, which is an improvement in ABI value with a p value = 0.013 ($p < 0.05$) for the right extermity and a p value = 0.000 ($p < 0.05$) for the left extermity.

Various factors influence ABI values, such as age and physical activity. Those aged 51–60 are at risk of PAD, which leads to a decrease in ABI values. Arterial blood vessel stiffness is one of the characteristics of the aging process, which can lead to the occurrence of the atherosclerosis process and have an impact on impaired peripheral blood flow[1][10]. Physical exercise should be done regularly to keep blood glucose levels in people with DM within the normal range, with a minimum of 2-3 times a week and an intensity of 30 minutes. Physical exercise can re-stimulate cell sensitivity to insulin as well as the breakdown of central fat and changes in muscle tissue, which indirectly influence the risk of foot ulcers[11].

The movements of chair-based exercise can stimulate contraction of the lower extremity muscles and compress the blood vessels around the muscles, causing a push of blood pressure to the heart and a decrease in venous blood pressure, resulting in an increase in ABI values[9]. Physical exercise can increase peripheral blood flow, open more capillary blood vessel access, which is useful in activating insulin receptors to open wider, and increase muscle and bone strength, especially in the hands and feet[8]. This is also in line with research conducted [12] that found blood glucose levels decreased after the implementation of chair exercise.

Based on the results of the experiment, it was known that the ABI values before the control group were mostly in the normal category (62.9%), but 10 respondents (37.1%) still experienced mild PAD. After 2 weeks, a re-examination of the respondents was carried out, and it was found that there were an additional 2 respondents who suffered from mild PAD, totaling 12 respondents. Although there was a decrease in the mean difference value for the right extermity by -0.03 and the left extermity by -0.02. Based on the paired t-test, there was a significant difference, which was a decrease in ABI values with a p value = 0.049 ($p < 0.05$) for the right extermity and a p value = 0.044 ($p < 0.05$) for the left extermity. This data is in line with previous research showing that there were changes in ABI values in the control group even without intervention[13]. Factors that can be changed include lifestyle, smoking, and physical activity. While factors that cannot be changed, such as age, gender, and duration of diabetes[14].

Table 4: The results of the ABI value difference test in the group given chair-based exercise and the group that was not given exercise

		Df	T	Mean	Sig. (2-tailed)
Post test Intervention – Post test Control	Right extremity	52	2.078	0.9726 0.9467	0.043
	Left extremity	52	2.022	0.9622 0.9381	0.048

In table 4. the difference in the increase in ABI values in the group given chair-based exercise and the group that was not given the exercise above obtained a significance value of 0.043 right extermity and 0.048 left extermity ($p < 0.05$), which means there is a significant difference between the group given chair-based exercise and the group that did not exercise, both on the right and left extermities. Based on these results, it can be concluded that Ho is rejected and Ha is accepted, which means that there is an effect of chair-based exercise on the improvement of ABI values in patients with Type II DM.

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The treatment given to the intervention group was in the form of chair-based exercise, which was done 3 times a week for a duration of 2 weeks with an intensity of 30 minutes. Chair exercise has an effect on the decrease in blood glucose levels and the improvement of physical performance in the elderly[12][8]. In addition, chair-based exercise also affects physical function in the upper body (e.g., shoulder flexibility and hand grip strength) and cardiorespiratory wellness (e.g., blood pressure and lung capacity)[18][19]. This physical activity is recommended for elderly people, with at least 150 minutes of moderate-intensity exercise per week for strength, balance, and flexibility training[19].

Physical exercise that focuses on foot movements, such as chair-based exercise, can inhibit the activity of the enzyme aldose reductase, causing sorbitol levels to decrease. With a decrease in oxidative stress, Na++/K=ATPase activity will improve sensitivity in the feet. With a decrease in oxidative stress, Na+/K=ATPase activity will improve sensitivity in the feet[17]. Physical activity of the foot can increase the contraction of the muscles of the lower limbs, such as the knee flexors, hip flexor muscles, and especially the ankle muscles for locomotion (plantarflexion, dorsiflexion, eversion, and inversion) and the inner toe muscles. This muscle contraction increases Ca2+, AMP, and ROS, while insulin signals the insulin receptor substrate and PI3-kinase (phosphoinositide inositol-3 kinase), which causes the insulin receptor substrate to phosphorylate AS160 (Akt substrate 160 kDa) and TBC1D1 (TBC1 domain family member 1) to activate GLUT4 (glucose transporter type 4) translocation to increase glucose absorption in muscles[15]. This increase in GLUT4 translocation affects the increase in the absorption capacity of glucose, which is converted into ATP (energy) in tissues. As GLUT4 expression increases, the amount of glucose in the blood decreases as it is diverted to tissues[16]. In line with previous studies [12] blood sugar level check results decreased after the implementation of chair exercise.

The results of the experiment showed that there was a positive effect obtained from chair-based exercise. The improvement in ABI values in the group given the gymnastics treatment was greater than the group that was not given the treatment, so it can be proved that chair-based exercise can facilitate the flow of peripheral blood circulation so as to improve sensitivity and blood circulation, especially in the legs, to prevent stiffness and numbness in the legs. This is because chair-based exercise focuses on limb movements and uses a combination of elastic bands to strengthen the muscles, especially the hands and feet. In the control group, some respondents also experienced improvement, but most did not experience improvement or a decrease in ABI values. This can occur because several factors affect changes in ABI values even when chair-based exercise is not given[20].

CONCLUSION

It can be concluded that chair-based exercise has a significant effect on increasing the value of the ankle brachial index in patients with type II diabetes mellitus.

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