

Low Impact Aerobics Against Blood Glucose Levels and Peripheral Circulation in Type II Diabetes Mellitus Patients in 2023

Dimas Dewa Darma¹, Sudirman², Budi Widiyanto³

¹Sapta Bakti STIKes; Cempaka City; Bengkulu

²³Poltekkes Kemenkes Semarang; Banyuwangi City; Semarang

* Correspondence e-mail; e-mail: dprasajamuda@gmail.com

Article history

Submitted:2023/03/06

Revised:2023/07/24

Accepted: 2023/07/31

Abstract

Physical activities carried out, such as Low Impact Aerobics in patients with type II diabetes mellitus, can increase insulin resistance sensitivity to optimize insulin function. The purpose of this study was to determine the impact of low aerobics on blood glucose levels and peripheral circulation in type II diabetes mellitus clients. This research design uses true experimental with pre-test and post-test control group design. The total sample of 36 people consisted of 12 intervention group 1, 12 people in intervention group 2, and 12 people in the control group. The activity was carried out at the UPT Puskesmas working area of Semarang City in 2022. The sampling technique uses simple random sampling. Data analysis using Wilcoxon and Wallis crucible was $\alpha < 5\%$. The results showed that the average value of blood sugar levels after being given low-impact. Aerobic intervention decreased by 57 mg/dl with p-value = 0.004. The mean peripheral circulation value of ABI after low impact aerobic intervention increased by 0.09 mmHg with p-value = 0.002. After the low impact aerobic intervention, the average CRT value of peripheral circulation decreased by 0.67 mmHg with p-value = 0.011. In conclusion, low impact aerobic has a low impact in lowering blood glucose levels and improving peripheral circulation.

Keywords

ABI Value Peripheral Circulation; Blood Glucose Level; CRT Value Peripheral Circulation; Low Impact Aerobic.



© 2023 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution 4.0 International (CC BY SA) license, <https://creativecommons.org/licenses/by-sa/4.0/>.

1. INTRODUCTION

Diseases that exist today are in line with the process of development over time which has experienced a shift from diseases caused by infection and malnutrition to degenerative diseases, one of which is diabetes mellitus (DM) which affects many people in society both in Indonesia and in the world. According to the American Diabetes Association (ADA), diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Based on global social and economic developments affecting people's living standards with many diseases and some chronic diseases, diabetes is becoming increasingly common. Among them, the number of diabetics has increased rapidly (Lu & Zhao, 2020).

The World Health Organization (WHO) states that in developing countries, it will increase by 69% in 2010-2030, and in developed countries, it will increase by 20%. The latest data report from the International Diabetes Federation (IDF) in 2018, around 451 million adults (over 18 years) worldwide suffer from diabetes. A developing country like China is one of the countries with the highest number of people with diabetes. It is predicted that the number of diabetes clients worldwide will reach 143 million in 2035. There are 5 million people with diabetes who die from complications. In addition, it is estimated that the number of people with diabetes can reach 693 million in 2045 (Lu & Zhao, 2020).

Based on the Central Statistics Agency (BPS) Of the Indonesian Republic who has DM reaches 13.7 million people, and in 2030 it is estimated that there will be an increase of 21.3 million people. Through this exposure, there is an increase of up to two times DM disease than before, estimated to increase by 1.5% per year. There are two types of DM, namely type I and I DM, but Type II DM is ten times more prevalent than type I DM. The prevalence of Type II DM is equivalent to 6.28% of the world's population affected by Type II DM.(Sempere-bigorra, 2021)Data from the 2019 Basic Health Research, the prevalence of type II DM in the city of Semarang is 1.3% of the total population of the city of Semarang and based on a preliminary study conducted at the Padang Sari Health Center with data recorded by officers there were 80 type II DM for control every month in 2021.

Type II DM experiences insulin resistance, causing glycogen to increase, resulting in the process of breaking down new sugars (gluconeogenesis), which causes fat metabolism to increase. Insulin deficiency causes the use of glucose by cells to decrease so that the sugar level in the plasma is high (hyperglycemia) (Williams, 2019). Hyperglycemia, The chronic nature of diabetes mellitus, can result in long-term damage

and failure of many organs, such as the eyes, kidneys, heart, and blood vessels, increasing premature death (May et al., 2017).

Hyperglycemia can affect small blood vessels and small arteries so that the supply of food and oxygen to the periphery is reduced as a result affecting the peripheral nerves, the autonomic nervous system, and the central nervous system resulting in disorders of the nerves (Neuropathy) (Ema Farah Gems, 2019). Peripheral neuropathy is a microvascular disease that interferes with the circulation of the small arteries that supply blood to the periphery (Princess et al., 2020). The Peripheral arterial disease causes ineffective peripheral tissue perfusion, namely decreased blood circulation to the periphery, which can interfere with the health of Type II DM clients. Ineffective peripheral tissue perfusion can cause a feeling of tingling that often arises. This is related to decreased peripheral blood circulation to the nerve fibers (Lee et al., 2020). Blood circulation disorders at the ends or edges of the body in people with diabetes are caused by poor blood circulation because the blood is too thick and contains lots of sugar. Narrowing and blockage of peripheral blood vessels (the main ones), often occurring in the lower limbs (especially the feet) (Ema Farah Gems, 2019)

Decreased blood circulation is a complaint with minor symptoms such as paraesthesia, extremity pain, edema, slow wound healing, ankle branchial index <0.90, and femoral bruits (Ulfa, 2020). Peripheral circulation can cause severe complications that make sufferers unable to move or work as usual (Permatasari et al., 2020). Complications often occur include microangiopathy (microvascular damage, such as retinopathy, nephropathy, and neuropathy), macroangiopathy/macrovascular damage; such as ischemic heart and peripheral vascular disease (Ema Farah Gems, 2019).

There are more than 100 complications of diabetes, with an incidence of about 98% caused by peripheral circulation experienced by Type II DM Clients. Clinically, almost 80% of clients die from complications of peripheral circulation. Neuropathy is a chronic complication due to disruption of the peripheral circulation in Type II DM clients, who are the most common (Princess et al., 2020). Efforts that can be made using good management or management can be made with the four pillars of DM intervention: physical exercise, education, medical nutrition therapy, and pharmacological therapy. Pharmacological management with oral hypoglycemic drugs (OHO) and insulin injections (Umrah, 2019). To control the disease and prevent related complications, clients with type II diabetes must consume healthy foods, exercise, take medication, monitor blood glucose, and perform foot care (Duruturk & Özköslü, 2019).

Non-pharmacological research has been carried out to treat blood glucose levels and blood circulation, which can be done with nutritional therapy, physical activity

therapy such as walking, aerobics, yoga, diabetic foot exercises, and foot SPA. One of the recommended therapies for people with diabetes is Aerobic exercise which aims to improve body health and fitness, especially by increasing the function and efficiency of the body's metabolism and improving peripheral blood flow. Aerobic exercise is an effort to control blood glucose levels and peripheral blood flow (Hastuti & Tarigan, 2020). Proper and routine aerobic exercise plus a healthy and balanced diet will keep insulin production controlled and blood sugar levels stable (Mirnawati, Harliani, 2019). Aerobic exercise is done properly in DM sufferers using all the large respiratory and heart muscles (Siregar, 2019). Aerobic gymnastics is an exercise that uses all muscles, especially large muscles, with continuous, rhythmic, and continuous movements. Aerobics can improve insulin sensitivity, blood glucose, and lipid metabolism, reducing insulin doses and improving glycemic control. Aerobics can also increase the number of cellular glucose transporters, the function and quantity of insulin receptors in skeletal muscle cells and fat cells, peripheral tissue sensitivity to insulin, and regulate blood glucose metabolism. Still, in this research that has been done, there is no patent dose and movement in doing low-impact aerobics (Lu & Zhao, 2020).

Aerobics is divided into two, namely low-impact aerobics and high-impact aerobics. Low Impact is aerobics with moderate capacity with basic movements. In contrast, high Impact is aerobics, performed with a fast rhythm and has many difficult movements. Kurniasari et al. 2015 stated that low-impact aerobics can reduce blood glucose levels. Low Impact Aerobics, namely care that can be given, is primarily aimed at meeting the basic needs of clients who are disturbed and preventing or reducing complications of blood glucose levels and facilitating peripheral circulation to prevent further complications so that gradually the client can optimize his bio-psycho-social-spiritual function (Ulfa, 2020).

Low Impact Aerobicstherapy is suitable for patients with DM Type II with simple movements and slow rhythms. The movement produced by Low Impact Aerobic can stabilize blood glucose levels, prevent peripheral arterial disease, increase blood flow to the arteries, and affect glucose metabolism. Based on the data and background description above, the researcher is interested in researching "Low Impact Aerobics with Blood Glucose Levels and Peripheral Circulation in Diabetes Mellitus Clients at the UPT Puskesmas Semarang City in 2022".

2. METHODS

The method used in this research is quantitative. This type of research is true experimental with a pre-post-test control group design. The population in this study were type II DM patients, as many as 80 respondents, and the research was carried out from June 14 to July 19, 2022, in the UPT Puskesmas Semarang City working area. Respondents in this study had agreed to the consent form to become respondents before the researchers conducted the research. The technique used in taking the sample of this research is using a simple random sampling technique with a total sample of 12 people per group. Data analysis used univariate and bivariate. The measuring instrument used is the observation sheet of GDS, ABI, and CRT measurements.

3. FINDINGS AND DISCUSSION

3.1. Econometric Univariate Analysis

This study will discuss univariate results by the study's results that the frequency distribution can be seen.

Table 1. Frequency Distribution

No	Variable	Group			p-value
		Control	Intervent	Interventio	
1	Age				
	Means	51.08	53.65	52,25	
	Min	45	46	47	
	Max	55	55	55	0.882
	SD	3,147	2,989	3,019	
2.	Gender				
	Man	3 (25.0%)	4 (33.3%)	6 (50.0%)	0.096
	Woman	9 (75.0%)	8 (66.7%)	6 (50.0%)	
3.	Smoking History				
	Smoke	3 (25.0%)	3 (25.0%)	6 (50.0%)	0.046*
	Do not smoke	9 (75.0%)	9 (75.0%)	6 (50.0%)	
4.	Alcohol History				
	Once	2 (18.7%)	2 (18.7%)	5 (41.7%)	0.003*
	No	10 (83.3%)	10 (83.3%)	7 (58.3%)	

3.2. Bivariate Analysis

The bivariate analysis aims to see the relationship between variables, independent and dependent.

Table 2. Results of Measuring Blood Sugar Levels (GDS) during the Pre-Post Test

Current Blood Sugar Level Variables	N	Before		After		p-value*
		Median (min-max)	Means \pm SD	Median (min-max)	Means \pm SD	
Intervention1	12	232.50 (200-300)	243.00 \pm 42.876	190.00 \pm 41.609 (160-297)	201.75 \pm 41.609	0.003
Intervention 2	12	225.00 (198-300)	238.42 \pm 39.009	181.42 \pm 23.047 (150-230)	181.42 \pm 23.047	0.004
Control	12	235.00 (198-300)	242.42 \pm 44.081	218.50 \pm 37.403 (180-288)	224.08 \pm 37.403	0.002
p-value*		0.889		0.014		

Table 3. Results of Measurement of Peripheral Circulation Levels ABI Pre-Post Test Values

Peripheral Circulation Variable ABI Value	N	Before		After		p-value*
		Median (min-max)	Means \pm SD	Median (min-max)	Means \pm SD	
Intervention1	12	0.885 (0.80-0.90)	0.869 \pm 0.036	0.950 (0.90-1.00)	0.943 \pm 0.035	0.005
Intervention 2	12	0.875 (0.80-0.90)	0.869 \pm 0.037	0.945 (0.90-1.00)	0.953 \pm 0.040	0.002
Control	12	0.880 (0.80-0.90)	0.872 \pm 0.030	0.940 (0.90-1.00)	0.916 \pm 0.031	0.008
p-value*		0.936		0.044		

Table 4. Results of Peripheral Circulation Measurement CRT Pre-Post Test Values

Peripheral Circulation Variable CRT Value	N	Before		After		p- value*
		Median (min- max)	Means ± SD	Median (min-max)	Means ± SD	
Intervention1	12	3.00 (2-4)	3.25 ± 0.622	2.00 (1-3)	2.00 ± 0.739	0.002
Intervention 2	12	3.00 (2-4)	3.25 ± 0.754	3.00 (2-3)	2.58 ± 0.515	0.011
Control	12	3.00 (2-4)	3.08 ± 0.447	3.00 (2-3)	2.67 ± 0.942	0.160
p-value*				0.038		

3.3. Low-Impact Aerobics Against Blood Glucose Levels in Type 2 Diabetes Mellitus Patients

The statistical test results showed differences in blood sugar before and after being given the Low Impact Aerobic treatment for 5x6 minutes 6x in 2 weeks with a value ($p = 0.004$). Treatment in the form of Low Impact Aerobics for 5x6 minutes 6x in 2 weeks proved effective in reducing blood sugar levels when respondents with an average value of measuring blood sugar levels showed a pre-test value of 238.42 mg/dl and a post-test of 181.42 mg/dl. It can be stated that there was a decrease after being given treatment.

Physical activity causes increased glucose absorption in contracting muscles so that insulin resistance decreases and insulin sensitivity increases. During physical activity, patients with type 2 DM will reduce insulin resistance and lower blood sugar levels. One of the benefits of exercise is preventing obesity by burning calories so that blood glucose can be used for energy (GDS3). Physical activity, such as gymnastics, is very influential for older adults in increasing the body's immunity, which regulates blood sugar levels (Kinasih et al., 2022).

Lack of physical activity can lead to reduced use of glucose by muscle tissue, increasing the need for insulin. People with diabetes need physical activity to increase glucose use. Physical activity that people can do with type 2 diabetes mellitus is gymnasticslow impact aerobics (Zucatti et al., 2017).

Research by Zheng Xin et al. 2020 states that aerobic exercise can lower blood glucose levels and improve glycemic control (Zheng et al., 2020). Sports or physical

activity for at least 24-48 hours can significantly lower blood glucose levels (Ducati). Aerobics with a duration of 30-45 minutes shows that there is an increase in heart rate of 40-60% and has the benefit of controlling blood glucose levels (Mirtha & Permatahati, 2018)

3.4. Low Impact Aerobics Against Peripheral Circulation ABI Values in Type 2 Diabetes Mellitus Patients

The statistical test results showed a significant difference in the Peripheral Circulation ABI value before and after being given the Low Impact Aerobic treatment for 5x6 minutes 6x in 2 weeks with a value ($p = 0.002$). The treatment in Low Impact Aerobic for 5x6 minutes 6x in 2 weeks proved effective in reducing Peripheral Circulation. The ABI value of the respondents showed that the mean value of peripheral circulation measurements showed that the ABI value showed a pre-test value of 0.869 and a post-test of 0.953, indicating an increase in peripheral circulation flow after being given treatment.

Complementary therapy, such as aerobics, applies caring behavior to nurses through activities that can provide training in the foot area, especially in patients with diabetes mellitus with peripheral circulatory complications (Artikaria & Machmudah, 2022). Physical exercise is a preventive measure to reduce or offset the effects of diabetes mellitus. Exercises performed by people with type II diabetes mellitus aim to improve insulin sensitivity, burn excess fat in the body, control weight, increase muscle strength, lower blood pressure, and help protect heart disease and blood vessels. Physical exercise prevents microvascular disorders such as nephropathy and peripheral neuropathy and macrovascular disorders such as coronary heart disease, stroke, and arterial vascular disease (Main & Nainggolan, 2021).

3.5. Low Impact Aerobics Against Peripheral Circulation CRT Values in Type 2 Diabetes Mellitus Patients

The statistical test results showed a significant difference in peripheral circulation CRT values before and after being given the Low Impact Aerobic treatment for 30 minutes 6x in 2 weeks with a value ($p = 0.011$). Treatment in the form of Low Impact Aerobic for 30 minutes 6x in 2 weeks proved effective in reducing respondents' peripheral circulation CRT value. This is indicated by the mean value of peripheral circulation measurements showing a pre-test value of 3.25 and a post-test of 2.58. It can be stated that there has been a change in the CRT peripheral circulation value after being given treatment.

The recommended physical exercise is in the form of aerobic physical exercise. The return of insulin sensitivity, so that insulin can work properly again, where insulin works to inhibit the process of lipolysis, namely the breakdown of triglycerides into fatty acids and glycerol, resulting in a decrease in the release of fatty acids excess of adipose tissue into the blood, reduces the risk of atherosclerosis and can increase blood flow to the lower extremities so that lower extremity CRT will improve.

4. CONCLUSION

Based on the data analysis and discussion of this study, it can be concluded that Low Impact Aerobics effectively reduces Blood Glucose Levels (GDS) and improves peripheral circulation (ABI and CRT Values). Low Impact Aerobics for 5x 6 minutes in 2 weeks can temporarily decrease 57 mg/dl of blood sugar in respondents with type II diabetes mellitus. Low Impact Aerobics for 5x 6 minutes in 2 weeks can increase the peripheral circulation ABI value of 0.084 mmHg in respondents with type II diabetes mellitus. Low Impact Aerobics for 5x 6 minutes 6x in 2 weeks can affect increasing the peripheral circulation CRT value of 0.67 in respondents with type II diabetes mellitus.

REFERENCES

- Artikaria, W., & Machmudah, M. (2022). Increased Ankle Brachial Index in Type 2 Diabetes Mellitus Patients Undergoing Diabetic Foot Exercise. *Young Nurse*, 3(2). <https://doi.org/10.26714/nm.v3i2.9401>
- Duruturk, N., & Özköslü, MA (2019). Effect of telerehabilitation on glucose control, exercise capacity, physical fitness, muscle strength, and psychosocial status in patients with type 2 diabetes: A double-blind, randomized controlled trial. *Primary Care Diabetes*, 13(6), 542–548. <https://doi.org/10.1016/j.pcd.2019.03.007>
- Hastuti, M., & Tarigan, R. (2020). The Effectiveness of Foot Therapy in Reducing Diabetic Neuropathy in Diabetes Mellitus Patients. *Journal of Maternity Midwifery*, 5(2), 11–20.
- Kinasih, A., Mangalik, G., & Oktafiani, E. (2022). The Effect of Low Impact Exercise on Blood Sugar Levels in the Elderly with a History of DM at the Elderly Posyandu Asoka Salatiga. *Sports Science: Scientific Journal of Sports Science*, 4(1), 13. <https://doi.org/10.24114/so.v4i1.16272>
- Lee, J., Lee, EH, & Chae, D. (2020). Self-efficacy instruments for type 2 diabetes self-care: A systematic review of measurement properties. *Journal of Advanced Nursing*, 0–1. <https://doi.org/10.1111/jan.14411>
- Lu, X., & Zhao, C. (2020). *Exercise and Type 1 Diabetes*. *Advances in Experimental Medicine and Biology*, 1228(107), 107–121. https://doi.org/10.1007/978-981-15-1792-1_7

- May, AK, Brandner, CR, & Warmington, SA (2017). Hemodynamic responses are reduced with aerobic compared with resistance blood flow restriction exercise. *Physiological Reports*, 5(3), 1–10. <https://doi.org/10.14814/phy2.13142>
- Mirnawati, Harliani, USA (2019). The Effectiveness of Aerobic Exercise on Blood Sugar Levels in Type II Diabetes Mellitus Patients at the Mamajang Health Center, Makassar City. *Nursing Media: Makassar Health Polytechnic*, 9(2), 101. <https://doi.org/10.32382/jmk.v9i2.486>
- Mirtha, LT, & Permatahati, V. (2018). The Effectiveness of Aerobic Exercise in Improving Peripheral Nerve Functions in Type 2 Diabetes Mellitus: An Evidence Based Case Report. *Acta Medica Indonesiana*, 50(1), 82–87.
- Permata Ema Farah, P. (2019). *Management of Ineffective Peripheral Tissue Perfusion in Mr. S with Diabetes Mellitus in the Bougenvile Room of Ungaran Hospital*. Manuscripts.
- Permatasari, KD, Ratnawati, D., & Anggraini, NV (2020). The Effectiveness of Combination Therapy of Foot Exercise and Warm Water Soak on Foot Sensitivity in Elderly with Diabetes Mellitus. *JKFT Journal*, 5(2), 16. <https://doi.org/10.31000/jkft.v5i2.3918>
- Putri, AM, Hasneli, Y., & Safri. (2020). Factors Affecting the Severity of Peripheral Neuropathy in Diabetes Mellitus Patients: Literature Review. *Journal of Nursing Science*, 8(1), 38–53.
- Sempere-bigorra, M. (2021). Differences and Similarities in Neuropathy in Type 1 and 2 Diabetes : A Systematic Review. *Journal of Personalized Medicine*, 11, 230.
- Siregar, LM (2019). Aerobic Exercise Physical Exercise Against Changes in Blood Glucose Levels in Type II DM. *HasanuddinJournalofMidwifery*, 1(2), 72–78.
- Ulfa, EH (2020). Scientific Literature Writing Review of Nursing Care for Clients with Diabetes Mellitus in Hospitals. In *SELL Journal* (Vol. 5, Issue 1).
- Umrah, H. (2019). *Application of diabetes mellitus exercise intervention in Mrs. h with DM problems in RW 01 RT 02 in Bungo Timur sub-district in 2019*. In Stikes Perintis Padang. <http://repo.stikesperintis.ac.id/1269/%0Ahttp://repo.stikesperintis.ac.id/id/eprint/947>
- Main, YES, & Nainggolan, SS (2021). Effect of Foot Exercise on Ankle Brachial Index Value in Type II Diabetes Mellitus Patients: A Systematic Review. *Scientific Journal of Batanghari University, Jambi*, 21(2), 657. <https://doi.org/10.33087/jiubj.v21i2.1439>
- Williams, R. (chair) et al. (2019). *IDF Diabetes Atlas 9th*. In *IDF Diabetes Atlas, 9th edition*. https://diabetesatlas.org/idfawp/resource-files/2019/07/IDF_diabetes_atlas_ninth_edition_en.pdf

- Zheng, X., Qi, Y., Bi, L., Shi, W., Zhang, Y., Zhao, D., Hu, S., Li, M., & Li, Q. (2020). *Effects of Exercise on Blood Glucose and Glycemic Variability in Type 2 Diabetic Patients with Dawn Phenomenon*. *BioMed Research International*, 2020. <https://doi.org/10.1155/2020/6408724>
- Zucatti, ATN, Paula, TP De, Viana, LV, Dallagnol, R., Cureau, FV, Azevedo, MJ, Gross, JL, Schaan, BD, & Leitao, CB (2017). Low Levels of Usual Physical Activity Are Associated with Higher 24 h Blood Pressure in Type 2 Diabetes Mellitus in a Cross-Sectional Study. *Journal of Diabetes Research*, 2017. <https://doi.org/10.1155/2017/6232674>