THE EFFECT OF DIABETIC FOOT EXERCISES ON *ANKLE BRACHIAL INDEX* (ABI) VALUES IN PATIENTS WITH DIABETES MELLITUS TYPE II

Rahayu Setyowati [1*], Ayu Dhita Pratiwi [2], Merly Amalia [3], Wawan Hedianto [4]
[1] Doctoral Student in Medicine Faculty, Padjadjaran University, Indonesia
[2, 3] YPIB University Majalengka, Indonesia
[4] Cideres Hospital Majalengka, Indonesia
Corresponding Email: [1]rosdiananina1980@unigal.ac.id*

ABSTRACT

Diabetes Mellitus (DM) is a chronic metabolic disorder caused by the inability of the pancreas to produce enough insulin. The aim of this study was to determine the effect of diabetic foot exercise on the Ankle Brachial Index (ABI) in type II diabetes mellitus patients at the outpatient Installation at Cideres 2023 Hospital. The subjects of this study were 187 respondents who were taken from visiting data of diabetes mellitus patients who exercised control at Cideres Hospital in 2021 from January to September. This study used a pre-experimental research design in the form of one group pretest and post-test. Sampling in this study uses a purposive sampling technique. The analysis was univariate using the central tendency distribution and bivariate using the Wilcoxon test. It shows the ABI value in patients with type II diabetes mellitus before being given diabetic foot exercises, which had an average of 0,95 in the normal category, meaning that it is still acceptable in its interpretation. The average ABI value in patients with type II diabetes mellitus after being given diabetic foot exercises is 1,138 in the normal category, which means that the interpretation is normal. There is an effect of diabetic foot exercise on the value of the Ankle Brachial Index (ABI) in type II diabetes mellitus patients at the Cideres Hospital Outpatient Installation in 2023. It is proposed that patients use routine diabetic foot exercise activities independently to avoid injuries and help improve blood circulation in the legs in patients with type II diabetes mellitus. As well as increase patient knowledge about the implementation of diabetic foot exercises.

Keywords: *Ankle Brachial Index* (ABI), diabetes mellitus, neuropathy, diabetic foot exercise

INTRODUCTION

According to the International Diabetes Federation (2021), it is estimated that at least 463 million people aged 20 - 79 will suffer from Diabetes Mellitus (DM) in 2023, equivalent to a prevalence of 9.3% of the total population of the same age. (Aschner et al., 2022). The prevalence of DM is predicted to increase with the increase in population life expectancy to 65-79 years.(IDF, 2022)Indonesia is a developing country with significant lifestyle changes that have increased the prevalence of non-communicable diseases (NCDs). The World Health Organization (WHO) estimates that NCDs cause at least 40 million deaths each year worldwide, equivalent to 70% of deaths from all causes (Indonesian Ministry of Health, 2022). Based on the 2018 Riskesdas, the prevalence of DM in the population over 15 years old increased by 1.5%, and the prevalence of DM, according to blood sugar testing results, increased from 6.9% to 8.5% (Ministry ofHealth Re, 2018).

Of DM cases in the community, 80-90% are Type II DM, generally caused by abnormalities in the cell, namely the occurrence of insulin resistance, where cells do not respond to insulin, which functions to carry glucose into cells (Hinkle & Cheever, 2014). Under normal circumstances, glucose is regulated by insulin produced by pancreatic beta cells so that its levels in the blood are always within safe limits, both in the fasting state and after eating. Blood glucose levels permanently stabilize around 70-140 mg/dL (PERKENI, 2021). In the state of DM, the body will experience a decrease in insulin levels due to insulin resistance, which occurs so that glucose regulation in the blood does not happen (Johnson, 2010).(Johnson, 2010). This situation causes hyperglycemia (Of, 2005).

Diabetes mellitus induces hypercholesterolemia and significantly increases the likelihood of developing atherosclerosis (Of, 2005). Diabetes mellitus is also associated with the proliferation of smooth muscle cells in coronary arteries and the synthesis of cholesterol, triglycerides, and phospholipids: increased LDL and low HDL levels. In patients with type II diabetes mellitus, the prevalence of macrovascular complications is at least twice that of microvascular complications (Battula et al., 2017). Macrovascular complications such as stroke, peripheral arterial disease (PAD), and heart disease are 20 times more common in diabetic patients and at a younger age. Ischaemia in the diabetic foot is the only cause of amputation, whereas necrosis or gangrene indicates peripheral vascular complications only, e.g., necrosis caused by uncontrolled pressure or infection (Of, 2005)(Soelistijo, 2021).

Peripheral arterial disease (PAD) is atherosclerosis that occurs in the arteries of the lower extremities and is also associated with atherothrombosis in other vascular networks, including the cardiovascular and cerebrovascular systems (Battula et al., 2017) (Webber, 2013). The incidence of DM dramatically increases the risk and accelerates the occurrence of PAD (Webber, 2013). This makes diabetic patients more susceptible to ischaemic events and impaired functional status than patients without diabetes. The prevalence of concurrent *Peripheral Arterial Disease* (PAD) and DM is very high in *Critical Limb Ischemia* (CLI) patients, with more than 50% of patients with CLI also having DM. Many PAD patients have no symptoms, requiring ankle-brachial index (ABI) testing to diagnose PAD (Ruan & Ng, 2021). Decreased ABI values characterize patients with PAD (Of, 2005) Ankle-brachial index (ABI) is a noninvasive vascular examination test that detects a decrease in peripheral perfusion or circulation of the lower extremities by comparing the ankle's systolic value with the arm's systolic value (Mangiwa et al., 2017) (Prihatin & Dwi M, 2019).

Type II DM patients can perform metabolic and vascular control (Soelistijo, 2021). Metabolic control, which emphasizes the five pillars of DM management: diet, exercise, monitoring, therapy, and education, can prevent diabetic ulcers and improve peripheral circulation in patients with diabetes mellitus. Vascular control can be achieved by doing foot exercises and non-invasive vascular tests such as checking *Ankle*

Brachial Index (ABI) values, routine toe pressure, and ankle pressure, as well as modifying risk factors such as smoking cessation and using special footwear (Megawati et al., 2020) (Prihatin & Dwi, 2019). According to the Indonesian Health Profile 2021, NCD control is expected to be carried out through public health efforts, which consist of prevention and control efforts. (Indonesian Ministry of Health, 2022). Prevention efforts are carried out through health promotion efforts and early detection of risk factors, especially those that can be changed. Risk factors that can be changed include lack of physical activity and unhealthy diet.

Diabetic foot exercise therapy is a non-pharmacological approach to diabetes and is one of the efforts to prevent and control DM complications (Webber, 2013) (Prihatin & Dwi, 2019). Foot exercises that people can do with diabetes are commonly called diabetic foot exercises to prevent injury and help improve blood circulation in the feet (Utama & Nainggolan, 2021). These foot exercises are designed to improve circulation, allow nutrients to reach the tissues more smoothly, strengthen the small muscles, calves, and thighs, and overcome joint mobility limitations often experienced by people with diabetes. In addition, by doing foot exercises, there is a decrease in vascular resistance due to atherosclerosis and an increase in arterial endothelial vasodilation so that peripheral blood flow increases. With increased peripheral blood flow, foot deformities can be prevented (Utami, 2019).

Diabetic foot exercise is an appropriate way to improve circulation, especially in the foot area (Wirawan et al., 2016). Wirawan et al., (2016) Foot gymnastics is an aerobic exercise whose variations of movements in the foot area meet the criteria of continuous, rhythmical, interval, progressive, and endurance so that every stage of the movement must be performed. Diabetes foot exercises affect the ABI value (Utami, 2018). Physical activity is one of the principles of diabetes management, and regular physical activity is also included in the secondary prevention of risk factors for diabetes complications, especially the occurrence of diabetic foot and amputation.

Based on the description above, it is necessary to research how the effect of foot exercises on *Ankle Brachial Index* (ABI) values in type II Diabetes Mellitus patients.

After determining the effect of foot exercises on the Ankle Brachial Index (ABI) value, the study results will be submitted to the hospital management and conveyed so that nurses can teach how to do foot exercises and explain their benefits to Type II Diabetes Mellitus patients.

METHODOLOGY

This research is a type of quantitative research using a pre-experiment research design, such as a *one-group pretest-posttest.* (Rosenbaum, 2021). This design has no comparison group, but the first observation *(pretest)* was made, which allowed testing changes to occur after the experiment (treatment). The treatment is foot exercise, done twice daily, morning and evening, and carried out within 14 days. The sampling technique used was probability sampling. The studywas conducted at the Majalengka Regional General Hospital with samples that met the inclusion criteria, namely patients diagnosed with type 2 Diabetes Mellitus, able to communicate well and not in the critical phase and willing to participate in the study by signing informed consent and exclusion criteria, namely subjects refusing to participate and not signing informed consent and subjects unable to participate in treatment activities for other reasons.

Research Location

This research was conducted at RSUD Cideres Majalengka, a hospital owned by the Majalengka Regency government, where RSUD Cideres Majalengka is a hospital with a total accreditation score.

Population and Sample

Population

The population is all patients diagnosed with Type 2 Diabetes Mellitus at RSUD Cideres Majalengka. The population in this study is all outpatient diabetes mellitus patients at Cideres Hospital.

Sample

The sample in this study was Type 2 Diabetes Mellitus patients willing to become respondents by the sample calculation. (M. S. Dahlan, 2010). The sample in this study is 25 respondents.

Data collection techniques

This study uses primary data. (Declercq et al., 2022). This study used primary data, namely by intervening with respondents. The intervention carried out is by teaching and doing foot exercises to Diabetes Mellitus patients for 14 days and done every day two times,

namely morning and evening. Before doing foot exercises on the first day of meeting the patient and the patient's willingness to become a respondent, the Ankle Brachial Index (ABI) assessment is carried out, and the results are recorded, which is the pretest data. On the afternoon of the 14th day, respondents returned to the ABI assessment, which was the posttest value after doing foot exercises.

Variables independent variablethe independent variable in this study is foot exercise dependent variable The dependent variable in this study is the Ankle Brachial Index (ABI) value. Data Analysis Univariate Analysis In this analysis, using central tendency Bivariate Analysis The statistical test used in this study was the Wilcoxon test because the data were not normally distributed in paired data. (S. Dahlan, 2017).

RESULTS AND DISCUSSION

Results

This study has been conducted to determine the effect of diabetic foot exercises on the value of the *Ankle Brachial Index* (ABI) in patients with type II diabetes mellitus in the outpatient installation of Cideres Hospital in 2023, with a total of 25 patients. The results of this study are described in tabular form and narrative as follows:

Univariat Analysis

1. Overview of *Ankle Brachial Index* (ABI) Values in Patients with Type II Diabetes Mellitus Before Being Given Diabetes Foot Gymnastics at the Cideres Hospital Outpatient Installation.

   Table 1 Central Tendency Test The average value of the Ankle-Brachial Indeks (ABI) before being given type II diabetes mellitus foot exercises at the Cideres Hospital outpatient installation.

Variables	Mean	Median	S.D	Minimal	Maximum
Pretest	0,95	1	0,242	0,6	1,38

   Based on the table above, the *pre-test* ABI value before being given diabetic foot exercises was found to have most ABI values> 0.9 (standard) with an average value (*mean) of* 0.95 in the normal category.

2. Overview of *Ankle Brachial Index* (ABI) Values in Type II Diabetes Mellitus Patients After Being Given Diabetic Foot Gymnastics at the Cideres Hospital Outpatient Installation.

   Table 2 Central Tendency Test The average value of the Ankle-Brachial Indeks (ABI) after being given type II diabetes mellitus foot exercises at the Cideres Hospital outpatient installation.

Variables	Mean	Median	S.D	Minimal	Maximum
Posttest	1,138	1,1	0,156	0,88	1,48

   Based on the table above, the *post-test* ABI value after being given diabetic foot exercises was found to have most ABI values> 0.9 (standard) with an average value (*mean) of* 1.138 in the normal category.

Bivariate Analysis

The effect of diabetic foot exercises on *Ankle Brachial Index* (ABI) values in type II diabetes mellitus patients at the Cideres Hospital Outpatient Installation.

1. Normal Test

Table 3 The results of data normality analysis of Diabetes Foot Gymnastics on Ankle Brachial Index (ABI) Values in Type II Diabetes Mellitus Patients at the Cideres Hospital Outpatient Installation.

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
ABI Pre-Test Results	.302	25	.000	.774	25	.000
ABI Post-Test	.301	25	.000	.804	25	.000

The table above shows that the data normality test uses Shapiro-Wilk because there are <50 respondents, namely 25. The results obtained are the *pre-test* ABI value of .000 and the results of the *post-test* ABI value of .000 with the condition that the *p-value* <0.05, which means thatthe data is not normally distributed. So, the researcher used the Wilcoxon Test.

2. Wilcoxon test

Table 4 Wilcoxon Statistical Test Results of Diabetes Foot Gymnastics on Ankle Brachial Index (ABI) Values in Type II Diabetes Mellitus Patients at the Cideres Hospital Outpatient Installation.

	posttest-pretest
Z	-2.642[b]
Asymp. Sig. (2-tailed)	.008

From the table above, based on the statistical test of the Wilcoxon Signed Ranks Test, Zhitung ≤ Ztabel (52.5 ≤ -2.624), the asymptotic sig. (2-tailed) value for the two-way test is 0.008 because the α value ≤ 0.05; this shows Ho is rejected and Ha is accepted. This means diabetic foot exercises affect *Ankle Brachial Index* (ABI) values before and after being given diabetic foot exercises.

DISCUSSION

1. Overview of Ankle Brachial Index (ABI) values in patients with type II diabetes mellitus before beinggiven Diabetes Foot Gymnastics.

The results showed that the ABI value before being given foot exercises averaged 0.95, including the Normal category, which could still be accepted in the interpretation. There were 25 respondents before being given foot exercises; 15 respondents (60%) had average ABI values, seven respondents (28%) experienced mild PAD, and three respondents (12%) experienced moderate PAD. This non-invasive examination is used to screen patients with arterial insufficiency to determine the status of lower limb circulation and risk of vascular injury and identify further actions. This examination is recommended in patients with type II DM, especially those with risk factors such as smoking, obesity, and high blood triglyceride

levels, based on laboratory results (Ruan & Ng, 2021). The prevalence of a low or pathological ABI increases in diabetic subjects and is associated with age, duration of diabetes, and gender (Kartikadewi et al., 2022).

This causes DM patients to have *lower ankle-brachial index (ABI) values* than the normal range (0.91-1.31). Many PAD patients have no symptoms, thus requiring an *ankle-brachial index (*ABI) test to diagnose PAD (Wahyuni, 2015).

Fatigue, a congenital symptom of DM disease, causes DM patients to have less activity and makes blood circulation less smooth. With this DM foot exercise, blood circulation in DM patients can become smoother, with reduced signs of edema and no diabetic ulcers found. Giving DM foot exercises to patients is carried out by showing videos and providing leaflets before doing foot exercises.

Efforts/Education to the community is carried out by providing DM foot exercises. DM Foot Gymnastics is included in the physical exercise pillar. In DM foot exercises, physical exercise is done in a sitting position and a relaxed state so that DM foot exercises can be done at any time according to the condition of the DM patient.

2. Overview of Ankle Brachial Index (ABI) values in patients with type II diabetes mellitus after receiving Diabetes Foot Gymnastics.

The results of this study showed that after being given diabetic foot exercises four times in two weeks, the ABI value after foot exercises was, on average, 1.138, including the Normal category, which means the interpretation is average. There were 25 respondents after being given foot exercises. Twenty-four respondents (96%) had normal ABI values, and one respondent (4%) experienced mild PAD. Routine foot exercises can improve blood circulation, especially in the lower extremities.

Contraction of the calf muscles (*gastrocnemius and soleus*) is required at the ankle. In patients who have decreased ankle mobilization, this exercise should be done to increase calf muscle strength (Sukartini et al., 2019). Diabetes mellitus foot exercises can be done quickly, which helps prevent wounds and improve blood circulation in the peripheral area. Diabetic foot exercises are also helpful in strengthening the small muscles of the feet, calf muscles, and thigh muscles and overcoming limitations in joint movement. They can also prevent deformities in the feet. The movements of diabetic foot exercises will make the body more relaxed and comfortable and can improve blood circulation. Smooth blood circulation will stimulate the blood to deliver oxygen and nutrients into the body's cells and help eliminate toxins (Qona'ah et al., 2022)

This study's results align with Perkeni's theory, which states that the muscles become more effective and sensitive during leg exercises. Gymnastic movements can flex the muscles, joints, and ligaments around the legs; the return blood vessels will be more active in pumping blood back to the heart so that blood circulation in the legs becomes smoother, which affects increasing blood pressure.

This is in line with the results of Wahyuni's research, which found an increase in the average ABI of type II diabetes mellitus patients after diabetic foot exercises of 0.31 from 0.62 to 0.93. In Mangiwa's research, an increase in ABI was found after being given diabetic foot exercises of 0.14 from 0.86 to 1. (Wahyuni, 2015) (Mangiwa et al., 2017). Routine and regular diabetic foot exercises can increase ABI values, as seen from the increase in ABI values.

3. Effect of Diabetes Foot Gymnastics on ABI in Type II Diabetes Mellitus Patients.

The Effect of Diabetes Foot Gymnastics on *Ankle Brachial Index* (ABI) Values in type II diabetes mellitus patients before being given foot exercises, the average value of 0.95 is included in the normal category, meaning that it can still be accepted in its interpretation and after being given foot exercises, the average value of 1.138 is included in the normal category, which means that the interpretation is standard. Shows an increase of 0.188 from 0.95 during the pre-test to 1.138 during the post-test. There is an effect of diabetic foot exercises on ABI values before and after being given diabetic foot exercises. Because the obtained p-value = 0.008 < α (0.05), then Ho is rejected, and Hα is accepted. Patients with type II diabetes mellitus who do diabetes mellitus foot exercises regularly three times a week with a duration of 30-45 minutes. Each exercise can prevent microvascular and macrovascular complications; for example, peripheral artery disease is not smooth so that it can affect the value of the *Ankle Brachial Index* (ABI) in someone suffering from type II diabetes mellitus.

Physical exercise is one of the principles in managing diabetes mellitus. Daily physical activity and regular physical exercise (3-5 times a week for 30 minutes) are pillars in managing diabetes mellitus, along with education, diet, and drugs (OHO and insulin). Physical exercises include walking, cycling, relaxing, jogging, gymnastics, and swimming. (Aschner et al., 2022).

Leg exercises cause the skeletal muscles to contract. When these muscles contract, the large veins in the extremities are compressed. This external venous pressure decreases venous capacity and increases venous pressure so that the fluid contained in the veins is squeezed toward the heart. This venous pumping effect is known as the skeletal muscle vein. The skeletal muscle pump is one of the ways venous bloods is transported to the heart during exercise. Increased muscle activity pushes more blood out of the veins and into the heart. (Journal & Clinical, 2023).

Interventions carried out by researchers in the community can maintain diabetes mellitus foot exercises independently, which are beneficial for improving peripheral blood circulation so that it can affect ABI values which originally had ABI values below the normal range will become normal after doing diabetes mellitus foot exercises regularly and will reduce the risk of Peripheral Arterial Disease or neuropathy.

CONCLUSION

The description of the *Ankle Brachial Index* (ABI) value in type II diabetes mellitus patients before being given Diabetes Foot Gymnastics is 0.95 normal category, which means that it can still be accepted in its interpretation. *The Ankle Brachial Index* (ABI) value in type II diabetes mellitus patients after being given Diabetes Foot Gymnastics is 1.138, which is in the normal category, meaning the interpretation is normal. There is an effect of diabetic foot gymnastics on *pre* and *post-test ankle-brachial index* (ABI) values of type II DM patients because p = value = 0.*008* (*p* value> α (0.05), then Ho is rejected, and Hα is accepted.

ACKNOWLEDGMENTS

The research was sponsored by YPIB Majalengka University, West Java, Indonesia (No 104/YPIB-I/SK-01/V/2023).

DECLARATIONS

Ethical approval and consent to participate are obtained.

REFERENCES

Aschner, P., Basit, A., Fawwad, A., Guariguata, L., James, S., Karuranga, S., Malanda, B., Mbanya, J. C., O'neill, S., Ogle, G., Ogurtsova, K., Patterson, C., Ramachandran, A., Saeedi, P., Shaw, J., Simmons, D., Wild, S., Williams, R., Yáñez Jiménez, B., ... Wedekind, L. (2022). IDF Guide for Diabetes Epidemiology Studies IDF guide for diabetes epidemiology studies. *Webpage*, 1-69.

Battula, P., Afreen, S., Meena, E., Reddy, S. S. R., & Sujatha, G. (2017). Prevalence of sensory peripheral neuropathy in diabetic patients at diabetes care center: a cross-sectional study. *International Journal of Research in Medical Sciences*, *5*(9), 4066. https://doi.org/10.18203/2320-6012.ijrms20173984

Dahlan, M. S. (2010). *Sample size and sampling methods*.

Dahlan, S. (2017). Correlative Hypothesis. In *Statistics for Medicine and Health: Descriptive, Bivariate, and Multivariate Equipped with SPSS Applications* (pp. 221–232). https://doku.pub/download/statistik-untuk-kedokteran-dan-kesehatan-msopiyudin-dahlan- 30j8pxk4p5lw

Declercq, I., Van Den Eede, F., Roelant, E., & Verbraecken, J. (2022). SHIFTPLAN: a randomized controlled trial investigating the effects of a multimodal shift-work intervention on drivers' fatigue, sleep, health, and performance parameters. *Trials*, *23*(1), 662. https://doi.org/10.1186/s13063-022-06573-6

Hinkle, J. L., & Cheever, K. H. (2014). Brunner & Suddarth's Textbook of Medical-Surgical Nursing. In *The American Journal of Nursing* (Vol. 81, Issue 1).

IDF. (2022). Idf Atlas Reports. *Idf*.

Johnson, J. Y. (2010). Handbook for Brunner & Suddarth's textbook of medical-surgical nursing. In *Wolters Kluwer Health/Lippincott Williams & Wilkins* (Vol. 12, Issue 5).

Journal, T. H. E., & Clinical, O. F. (2023). American Diabetes Association (ADA). *The Grants Register 2024*, *46*(January), pp. 64–64. https://doi.org/10.1057/978-1-349-96073-6_16356 Kartikadewi, A., Setyoko, S., Wahab, Z., & Andikaputri, K. (2022). Ankle Brachial Index in Diabetics and Non-Diabetics, and its Relationship with Physical Activity and Smoking Behaviour. *Journal of Medicine and Health*, *18*(1), 57. https://doi.org/10.24853/jkk.18.1.57-68

Indonesian Ministry of Health. (2022). Indonesia Health Profile 2021. In *Pusdatin.Kemenkes.Go.Id*. Ministry of Health Re. (2018). National Basic Health Research. *Riskesdas*, 76.

Mangiwa, I., Katuuk, M., & Sumarauw, L. (2017). The Effect of Diabetes Foot Gymnastics on Ankle Brachial Index Values in Type II Diabetes Mellitus Patients at Pacaran Kasih Gmim Manado Hospital. *UNSRAT Nursing Journal*, *5*(1), 105018.

Megawati, S. W., Utami, R., & Jundiah, R. S. (2020). Diabetes Foot Gymnastics for Patients with Type 2 Diabetes Mellitus to Improve Ankle Brachial Index Values. *Journal of Nursing Care*, *3*(2). https://doi.org/10.24198/jnc.v3i2.24445

Of, T. H. E. E. (2005). The encyclopedia of endocrine diseases and disorders. In *Choice*

Reviews Online (Vol. 43, Issue 01). https://doi.org/10.5860/choice.43-0044

PERKENI. (2021). Guidelines for self-monitoring of blood sugar. *Endocrinology Indonesia*, pp. 1–36.Prihatin, T. W., & Dwi M, R. (2019). The Effect of Diabetes Foot Gymnastics on Ankle Brachial Indeks Values in Type II Diabetes Mellitus Patients at Puskesmas Bergas Semarang Regency. *Indonesian Nursing Science Scientific Journal*, *9*(02), 571-576. https://doi.org/10.33221/jiiki.v9i02.227

Prihatin, T. W., & Dwi, R. (2019). Diabetes Foot Gymnastics Affects Ankle Brachial Index Values in Type 2 Diabetes Mellitus Patients. *Indonesian Nursing Science Scientific Journal*, *9*(2), 571-576.

Qona'ah, A., Tyas, A. P. M., Wahyudi, A. S., & Mardhika, A. (2022). Diabetic foot exercise training for diabetes mellitus patients to control blood glucose during the COVID-19 pandemic. *Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang*, *7*(4), 708-718. https://doi.org/10.26905/abdimas.v7i4.7672

Rosenbaum, P. R. (2021). Causal Inference in Observational Studies. In *Replication and EvidenceFactors in Observational Studies.* https://doi.org/10.1201/9781003039648-ch2

Ruan, J. S., & Ng, K. E. (2021). Ankle-Brachial Index Test. *A Medication Guide to Internal Medicine Tests and Procedures*, *4*, 40–43. https://doi.org/10.1016/B978-0-323-79007-9.00009-X

Soelistijo, S. (2021). Guidelines for managing and preventing Adult Type 2 Diabetes Mellitus inIndonesia 2021. *Global Initiative for Asthma*, 46. www.ginasthma.org.

Sukartini, T., Asmoro, C. P., & Alifah, P. N. (2019). The Influence of Diabetic Foot Exercise in Sensory Peripheral Neuropathy with Monofilament Test on Diabetes Mellitus Clients. In *Jurnal Ners* (Vol. 14, Issue 3 Special Issue, pp. 340-344). https://doi.org/10.20473/jn.v14i3(si).17263

Utama, Y. A., & Nainggolan, S. S. (2021). The Effect of Foot Gymnastics on Ankle Brachial Index Values in Type II Diabetes Mellitus Patients: A Systematic Review. *Jambi Batanghari University Scientific Journal*, *21*(2), 657. https://doi.org/10.33087/jiubj.v21i2.1439

Utami, I. T. (2018). *The Effectiveness of Diabetes Foot Exercise Intervention on Ankle Brachial Index(Abi) and Ipswich Touch Test (Iptt) Values in Diabetes Mellitus Patients Type 2. 3*(2).

Utami, I. T. (2019). The Effect of Diabetic Foot Gymnastics on Ankle Brachial Index (Abi) and Ipswich Touch Test (Iptt) Values in DM Type 2 Patients. *Journal of Health Discourse*, *3*(2), 1–6. https://doi.org/10.52822/jwk.v3i2.77

Wahyuni, T. D. (2015). Ankle Brachial Index (Abi) After Diabetes Foot Gymnastics in Patients withType Diabetes Mellitus. *Journal of Nursing*, *85*(6), 232–232.

Webber, S. (2013). International Diabetes Federation. In *Diabetes Research and Clinical Practice* (Vol. 102, Issue 2). https://doi.org/10.1016/j.diabres.2013.10.013

Wirawan, N., Sukawana, N. I. W., Kep, S., Pd, M., Gusti, N. I., Pramitaresthi, A., Programme, S. K., Science, S., & Sample, P. (2016). *Effect of diabetic foot exercise on value. 1*.