

Effect of Lower Extremity Range of Motion (ROM) Exercise on Improving Blood Circulation

Basri¹, Arlis², Phan Yongki³

Institut Kesehatan Sumatera Utara, Medan
Email: basri@gmail.com; arlisarlis67@gmail.com

ABSTRACT

Range of Motion Exercise (ROM) are used to increase peripheral perfusion with the aim of facilitating adequate oxygen diffusion and adequate supply of nutrients to the wound area and for the process of repairing wound tissue in the legs of diabetes mellitus patients. The aims to determine the effect of lower extremity range of motion (ROM) training on improving blood circulation in the legs of patients with type 2 diabetes mellitus at Aceh Singkil District Hospital. This Study design uses quasi experimental using a one group pre-test post-test design approach. The Study sample was 35 respondents. Data were analyzed using the Wilcoxon sign rank test. The results of the study showed that there was a significant effect on the blood circulation in the legs of type 2 diabetes mellitus patients before and after being given lower extremity Range of Motion (ROM) training with a value of $p = 0.000$, the average value before lower extremity ROM training was 1.28 with a minimum value of 1.00 and maximum 2.00. and after being given lower extremity ROM exercises the average value was 1.94 with a minimum value of 1.00 and a maximum value of 2.00. From the results of this Study, it is hoped that nurses at Aceh Singkil District Hospital can apply lower extremity exercises to reduce the risk of complications from peripheral vascular disease, especially in diabetes mellitus sufferers.

Keywords: range of motion (ROM), foot blood, circulation, diabetes mellitus, type 2

INTRODUCTION

Diabetes Mellitus (DM) is a disease characterized by hyperglycemia and disorders of carbohydrate, fat and protein metabolism which are associated with absolute or relative deficiencies in insulin secretion. In Diabetes Mellitus sufferers, the impact of long-term complications can cause microvascular disease, in cases of myocardial infarction, stroke and peripheral vascular disease (Ose et al., 2018).

The prevalence of Diabetes Mellitus sufferers in Indonesia is quite high and continues to increase every year. According to WHO (World Health Organization) in the Southeast Asia region in 2015 there were 415 million adults with Diabetes Mellitus (Katuuk & Gannika, 2019). Based on the International Diabetes Federation (IDF, 2019) the number of cases of DM patients in the world is increasing every year. In 2017 there was an increase of 425 million, and in 2019 it increased by 463 million with a diabetes rate of 9.0% in women and 9.6% in men. Meanwhile, it is estimated that by 2030 it will increase to 578 million, and by 2045 it is estimated that the incidence rate will continue to increase to 700 million people who will be diagnosed with DM

(IDF, 2019). Indonesia was ranked 7th in 2019 for DM sufferers after China, India, USA, Brazil, Mexico, namely 10.7 million. The incidence of DM is projected and expected to increase to 16.6 in 2045.

The incidence of DM in Aceh is 22nd out of 35 provinces with a prevalence of DM patients of 1.2% and experienced an increase of 2.2% in 2018 (Kementerian Kesehatan RI, 2018). The incidence of DM in Banda Aceh City according to the Banda Aceh City Health Service (2019) found 17,017 people suffering from Diabetes Mellitus. Meanwhile, in the Banda Aceh City Health Center Work Area, 1,557 cases of DM were found in 2019, and during the COVID-19 pandemic from March to June 2020, there was a significant increase, namely 1,223 cases of Diabetes Mellitus (Zamharira & Abdullah, 2023).

Diabetes is a disease that many people suffer from. This is caused by various factors, one of which is an unhealthy lifestyle, which makes normal blood sugar levels difficult to achieve. When diabetics have a viral infection, it is more difficult to treat because of fluctuations in blood glucose levels and the possibility of diabetes complications. This occurs because the immune system is compromised which makes it more difficult to fight the virus and possibly leads to a longer recovery period, furthermore because the virus can develop in an environment with high blood glucose (Kemenenterian Kesehatan RI, 2020).

Based on the Consensus results in 2018, the proportion of efforts to control Diabetes Mellitus, namely food management 80.2%, exercise 48.1% and alternative herbal medicine. The risk of developing Diabetes Mellitus will continue to increase with increasing age, obesity and lack of physical activity (Kemenenterian Kesehatan RI, 2018).

As many as 15% of complications that occur in every DM sufferer are complications of peripheral vessels in the feet which are often called diabetic foot. Apart from that, severe arterial occlusive disease in the lower extremities in the form of peripheral artery disease (PAD) in DM is at risk of developing peripheral arterial occlusive disease. Patients with peripheral vascular disorders will experience reduced peripheral pulses and intermittent claudication (Fatmasari et al., 2019).

The increasing number of Diabetes Mellitus sufferers causes complications that often occur, namely wounds on the feet of Diabetes Mellitus sufferers. Diabetic foot ulcers are one of the most serious complications, 10% to 25% of Diabetes Mellitus clients develop diabetic foot ulcers. Diabetic foot ulcers must be given good wound care. Chronic wounds in sufferers are at risk of amputation, which is a non-traumatic event. The risk of amputation is 15-40 times more

common in Diabetes Mellitus sufferers. One of the factors that can speed up wound healing in Diabetes Mellitus sufferers is by doing footwork exercises or what is called Range of Motion (ROM) Exercise on the ankle (Titah et al., 2019).

One way to detect it early is to check circulation through measuring values Ankle Brachial Index (ABI) by comparing systolic blood pressure at the ankle with the arm. Ankle Brachial Index is a noninvasive test that functions to detect the presence of peripheral artery disease. One of the diseases that is at risk for peripheral artery disease is Diabetes Mellitus. ABI values $> 0.9-1.3$ are considered normal, a person is considered to have PAD when $ABI \leq 0.9$ (Wicaturatmashudi, 2019).

Range of Motion (ROM) Exercise on the ankle can help blood circulation and strengthen the small muscles of the feet and prevent foot deformities, overcome the limited amount of insulin in Diabetes Mellitus sufferers causing blood sugar levels to increase, this causes damage to blood vessels, nerves and structure. Leg exercises are also believed to manage patients who experience Diabetes Mellitus. Diabetes Mellitus patients after leg exercises feel comfortable, reduce pain, reduce nerve damage and control blood sugar and improve blood circulation in the legs (Titah et al., 2019).

Leg exercises can also help improve blood circulation in the legs, improve blood circulation, strengthen small muscles, prevent leg deformities, increase the strength of the calf and thigh muscles, and overcome limitations in joint movement (Utami, 2019). Several studies explain that the benefits of leg exercises can increase peripheral blood flow, including the results of Study conducted (Isnaini & Ratnasari, 2018) which states that there are differences in ABI values before and after lower extremity exercises, therefore one of the nursing actions to improve circulation is extremity exercises lower.

Data obtained from the Aceh Singkil District Health Service estimates that the population at risk of diabetes mellitus in Aceh Singkil District is 12,885 people and 1,229 of them have been detected in 2022. Of the 12 health centers, the highest number of diabetes mellitus sufferers in Aceh Singkil District is in Gunung District. Merry with 705 cases. Then Singkil District had 176 cases, Kuala Baru 71 cases, Simpang Kanan 50 cases, Singkohor 48 cases, Kuta Baharu 43 cases, Pulau Banyak 36 cases. Meanwhile, Danau Paris, Pulau Banyak Barat, Suro and North Singkil sub-districts have under 30 cases and the Kuta Tinggi health center has 6 cases. The results of a preliminary survey conducted at the Aceh Singkil Regional Hospital showed that the number of DM patient visits at the Aceh Singkil Regional Hospital was 1,106 people, based on RL data.

Previous Study has been conducted on the effect of ROM exercises on improving diabetic foot ulcers, while this Study will examine improving blood circulation in the feet of DM patients. This Study is important to do, because circulation problems in the legs can detect the occurrence of diabetic ulcers. This study aims to examine the effect of lower extremity Range of Motion (ROM) training on improving blood circulation in the legs of patients with type 2 diabetes mellitus.

METHOD

This type of Study uses quantitative methods with a quasi-experimental design using a one group pre-test post-test design approach. This Study was carried out by means of pre-test and post-test (Polit & Beck, 2004) This Study was conducted at the Aceh Singkil Regional Hospital. The population in this study were all patients with Diabetes Mellitus (DM) who were treated at the Aceh Singkil District Hospital. Saturated sampling technique is a sampling technique where all members of the population are used as samples. Inclusion criteria include: (1) willing to be a respondent, (2) history of DM for more than 3 years, (3) history of Diabetic Foot Ulcer, and patients who have never received the same intervention from Studyrs or other health workers. Exclusion criteria include: (1) the presence of injury or disability at the location of blood pressure measurement, (2) thromboflebitis or edema in the extremities, (3) the patient is uncooperative. The number of samples taken in this Study was 35 respondents. The instrument used in this Study was an observation sheet before and after the intervention to determine changes in knowledge values Ankle Brachial Index (ABI), Spigmomanometer, Vascular Doppler and standard operating procedures (SOP) for lower extremity exercises (ROM).

The method used to collect data in this Study is by providing intervention in the form of Lower Extremity Range of Motion (ROM) Exercises to determine changes in value Ankle Brachial Index (ABI) in DM patients. The ROM procedure is performed in a sitting position or in a supine position. Before the procedure, the ankle blood circulation is checked. The next exercise moves the hips, flexi, extension, hyperextension, abduction, adduction, rotation, knee exercises, leg movements and toes.

A pre-test and post-test were carried out to measure brachial systolic blood pressure and dorsalis pedis systolic blood pressure before and after the lower extremity exercise intervention was given. Then the results are compared between the values Ankle Brachial Index before and after giving the intervention to see if there is a change in values Ankle Brachial Index in DM patients who were given lower extremity exercises.

Data analysis in this study used univariate and bivariate analysis. Before testing the hypothesis, the data analysis requirements are first tested, namely the normality test to determine whether the data obtained is normally distributed or not. The normality test used is the Shapiro-Wilk test. The results of the normality test stated that the distribution of the data was not normal, so the Wilcoxon test was used.

RESULTS

Based on the Study that has been carried out, the following Study results were obtained:

Respondent characteristics

A description of the characteristics of respondents based on age, gender, education and occupation is presented in the following table:

Table 1. Frequency Distribution of Respondent Characteristics

Characteristics	Frequency (f)	Percentage (%)
Age		
41-50 years	9	25.7
51-60 years	20	57.1
61-70 years	6	17.1
Gender		
Man	12	34.3
Woman	23	65.7
Education		
Elementary School	12	34.3
Junior High School	8	22.9
Senior High School	15	42.9
Work		
Self-employed	6	17.1
Private sector employee	2	5.7
IRT	23	65.7
Farmer	4	11.4

Based on Table 1 above, it can be seen that the characteristics of the 35 respondents based on the age involved in this Study, the majority was 57.1% (20) of respondents were aged 51-60 years and minorities were 17.1% (6) aged 61-70 years. Characteristics of respondents based on gender, the majority of respondents were 65.7% (23) female and 34.3% (12) male. Furthermore, the characteristics of respondents were based on education. The majority of respondents were 42.9% (15) with high school education and the minority 22.9% (8) with junior high school education. Characteristics of respondents based on work, the majority of respondents, 65.7% (23), were housewives and the minority, 5.7% (2), worked as private employees.

Table 2. The Interpretation of Ankle Brachial Index (ABI) Values Before and After Being given Lower Extremity Range of Motion (ROM) Exercises on the Legs

Variable	Frequency (f)	Percentage (%)
ABI Pre Value		
ABI < 0.90	25	71.4
ABI > 0.91	10	28.6
ABI Post value		
ABI < 0.90	2	5.7
ABI > 0.91	33	94.3

Based on the test results listed in Table 2 above, it can be seen that the pre-test ABI value was <0.90 for 71.4% (25) of respondents and the ABI value was >0.90 for 28.6% (10) of respondents. The post-test results had an ABI value of <0.90 for 5.7% (2) of respondents and an ABI value of >0.90 for 94.3% (33) of respondents.

Bivariate Analysis

Bivariate analysis was carried out to determine the effect of the variable (lower extremity ROM exercise) on the dependent variable (blood circulation in the legs of type 2 diabetes mellitus patients) shown with a value of $p = 0.000$. Next, to find out whether the Study data is normally distributed or not, a test is used Shapiro-Wilk. After testing the normality of the data, all the data was not normally distributed. Test the differences pre and post using Wilcoxon Sign Rank Test.

Table 3. The Effect of Lower Extremity Range of Motion (ROM) Exercise on Improving Blood Circulation in the Legs

ABI value	Mean	Standard Deviation	Minimal	Maximum	P-Values
Pre Test	1.28	0.45	1.00	1.00	
Post-test	1.94	0.23	2.00	2.00	0,000

Note: *) Wilcoxon Sign Rank Test

Based on Table 3 above, the results of statistical tests with Wilcoxon Sign Rank Test of The pre-test and post-test obtained a p value = 0.000 means there is a significant change in blood circulation in the feet of patients with type 2 diabetes mellitus before and after it is given exercise Range Of Motion (ROM) lower extremity average value before exercise ROM lower extremities 1.28 with a minimum value of 1.00 and a maximum value of 2.00. And after being given lower extremity ROM exercises the average value was 1.94 with a minimum value of 1.00 and a maximum of 2.00.

DISCUSSION

Ankle Brachial Index (ABI) Value Before Being Given Lower Extremity Range of Motion (ROM) Exercises

Based on the Study results listed in table 4.2, it can be seen that the ABI value < 90 is 71.4% and the ABI value > 91 is 28.6%. Judging from these results, the majority of ABI values before being given ROM training were in the borderline perfusion/mild ischemia category. The Ankle Brachial Index (ABI) test is a diagnostic examination procedure for lower extremity circulation to detect the possibility of peripheral artery disease (PAD) by comparing the highest systolic blood pressure from both ankles and arms (Rachman, 2018). According to Pratomo and Apriyani (2018), ABI is in principle the same as blood pressure which is the result of multiplying cardiac output and peripheral resistance. So, in diabetes mellitus patients who experience ineffective peripheral tissue perfusion, if peripheral blood resistance and cardiac output increase, blood pressure will also increase. The Ankle Brachial Index is said to be normal if the leg blood pressure is comparable to the brachial blood pressure (Pratomo & Apriyani, 2018).

This Study is in line with Study by Lukita et al. (2018), with the title Ankle Brachial Index (ABI) in Type 2 DM Sufferers at the North Lampung Regency Health Center. The Study results showed that 76 respondents (77.5%) had a normal ABI. A normal ABI value means that blood is still circulating well, without significant obstruction in peripheral blood vessels, so that the nutritional and oxygen needs of the lower extremities can still be met properly. An ABI value in the range of 0.6 to 0.8 is borderline perfusion, as many as 22.5% of type 2 DM sufferers have an ABI interpretation of borderline perfusion. DM patients with borderline perfusion interpretation are two to three times more likely to experience peripheral blood vessel obstruction in the form of PAD compared to non-DM patients (Lukita et al., 2018).

Ankle Brachial Index (ABI) Value After Being Given Lower Extremity Range of Motion (ROM) Exercises

Based on the Study results listed, it can be seen that the ABI value < 90 is 5.7% and the ABI value > 91 is 94.3%. Judging from these results, the majority of ABI values after being given ROM training are in the normal category. Lower joint range of motion exercises or what is usually called active lower range of motion (ROM) are exercises carried out to maintain or improve the level of perfection in the ability to move the joints of the lower extremities normally and completely to increase muscle mass and muscle tone (Lestary et al., 2022). Exercise therapy in the form of lower extremity ROM can increase muscle strength and tendon reflexes, improve

protective sensation and ABI values, and minimize complaints of diabetic polyneuropathy so as to prevent complications of leg ulcers (Widyawati et al., 2017). Start of the ABI assessment obtained in the borderline category (border of perfusion) was 0.8. After implementing active lower ROM for 3 days, the ABI value decreased to normal on the third day (Murniasih, 2022).

Study conducted by Hijriana and Sahara (2020), regarding the effect of lower extremity joint movement training on ABI values in Type 2 Diabetes Mellitus patients, found a mean value before intervention of 0.89 with a standard deviation of 0.07, while the mean value after intervention was 0.98. with a standard deviation of 0.05 (Hijriana & Sahara, 2020).

The Effect of Lower Extremity Range of Motion (ROM) Exercises on Improving Blood Circulation in the Legs of Type 2 Diabetes Mellitus Patients

Based on the results of the analysis listed using a nonparametric statistical test, namely the Wilcoxon signed range test, the value of $p = 0.000$. This shows that there is an effect of lower extremity Range of Motion (ROM) training on improving blood circulation in the legs of type 2 Diabetes Mellitus patients at Aceh Singkil Regional Hospital.

Range of Motion (ROM) Exercise on the ankle can help blood circulation and strengthen the small muscles of the feet and prevent foot deformities, overcome the limited amount of insulin in Diabetes Mellitus sufferers causing blood sugar levels to increase, this causes damage to blood vessels, nerves and structure. Leg exercises are also believed to manage patients who experience Diabetes Mellitus. Diabetes Mellitus patients after leg exercises feel comfortable, reduce pain, reduce nerve damage and control blood sugar and improve blood circulation in the legs (Titah et al., 2019). Range of Motion Exercise (ROM) is an effort to increase peripheral perfusion with the aim of facilitating adequate oxygen diffusion and adequate supply of nutrients to the wound area and for the process of repairing wound tissue (Ratnasari, 2014). Efforts to help improve ABI values are very necessary in preventing the occurrence of diabetic foot. These complications can be prevented with physical activity.

Physical exercise can increase blood flow, improve endothelial vasodilator function, inflammatory response, tissue oxygenation and improve blood viscosity (Djamiludin et al., 2019). Physical exercise or physical exercise is one of the four pillars in managing DM (Soelistijo, 2021). Physical exercises that DM patients can do are Active Lower Range of Motion (ROM) exercises. This exercise is useful in improving blood circulation, especially in the area involved in the exercise (in this case the lower extremity area). Active Lower ROM exercises can increase muscle strength and tendon reflexes, improve protection sensation and

ABI values, and minimize complaints of diabetic polyneuropathy so as to prevent complications of foot ulcers (Widyawati et al., 2017).

The study by Zamaa (2016) shows that there is a significant difference between the difference between the pre-test and post-test results of the treatment group and the control group and there is an effect of giving active lower ROM on changes in the ABI values of type 2 DM patients. The study by Pebrianti et al. (2018) reveals that Range of Motion (ROM) ankle exercises can increase foot movement and reduce plantar foot pressure in diabetes mellitus sufferers with neuropathy (Pebrianti et al., 2018). The study by Widyawati et al. (2017) proves that ROM exercises carried out for 24 days at a frequency of twice a day can reduce symptoms of neuropathy. According to Lestary et al. (2022), active lower ROM twice per day, namely in the morning and evening with a duration of 10 minutes per session for three days, is effective in increasing the ABI value with an average increase of 0.5 mmHg. There is an influence of Active Lower ROM on the ABI value in Diabetes Mellitus patients during the pandemic in Andalas Health Center working area.

According to study Nani and Syafri (2018) states that the physiological mechanism of exercise to improve symptoms of claudication or arterial calcification causes effects such as increased endurance and muscle strength, improved endothelial function, reduced blood viscosity, improved cardiovascular factors (reduced blood pressure, insulin resistance, improvement in autonomic function and lipid profile). This can be concluded that physical exercise influences changes in values Ankle Brachial Index in Diabetes Mellitus patients.

CONCLUSION

Physical exercise boosts blood flow, improves endothelial vasodilator function, inflammatory response, tissue oxygenation, and blood viscosity, particularly in the lower extremity area. Active Lower ROM exercises enhance muscle strength, tendon reflexes, protection sensation, and ABI values, reducing diabetic polyneuropathy complaints and preventing foot ulcer complications. Based on the results of study on the effect of lower extremity Range of Motion (ROM) exercise on improving blood circulation in the legs of type 2 diabetes mellitus patients at the Aceh Singkil District Hospital, the following conclusions can be drawn: Pre-test results with $ABI < 0.90$ were 71.4% (25) respondents and ABI values > 0.91 were 28.6% (10) of respondents. Post-test results had an ABI value of < 0.90 for 5.7% (2) of respondents and an ABI value of > 0.91 for 94.3% (33) of respondents. There are significant changes on repair foot blood

circulation in type 2 diabetes mellitus patients after being given Exercise Range of Motion (ROM) Lower Extremities with p value = 0.000.

LIMITATION

This research was carried out using ROM on the extremities of the feet, and was only carried out on patients with diabetes mellitus. It is recommended that further research be able to perform ROM in the upper and lower extremities, and find circulation problems.

REFERENCE

- Djamaludin, D., Setiawati, S., & Yulendasari, R. (2019). Pengaruh latihan range of motion (ROM) ankle terhadap pencegahan terjadinya neuropati dan angiopati pada klien diabetes melitus. *Holistik Jurnal Kesehatan*, 13(3), 263–269. <https://doi.org/10.33024/hjk.v13i3.1941>
- Fatmasari, D., Ningsih, R., & Yuswanto, T. J. A. (2019). Terapi kombinasi diabetic selfmanagement education (DSME) dengan senam kaki diabetik terhadap ankle brachial index (ABI) pada penderita diabetes tipe II. *Medica Hospitalia : Journal of Clinical Medicine*, 6(2). <https://doi.org/10.36408/mhjc.v6i2.389>
- Hijriana, I., & Sahara, T. (2020). Gambaran nilai ankle brachial index (ABI) pada pasien dm tipe 2. *Idea Nursing Journal*, 11(3).
- IDF. (2019). IDF Diabetes Atlas 9th edition 2019. In *IDF Diabetes Atlas, 9th edition*.
- Isnaini, N., & Ratnasari, R. (2018). Faktor risiko mempengaruhi kejadian Diabetes mellitus tipe dua. *Jurnal Kebidanan dan Keperawatan Aisyiyah*, 14(1). <https://doi.org/10.31101/jkk.550>
- Katuuk, M., & Gannika, L. (2019). Hubungan health locus of control dengan kepatuhan terapi insulin pada pasien dm tipe II di RSUD Gmim Pancaran Kasih Manado. *JURNAL KEPERAWATAN*, 7(1). <https://doi.org/10.35790/jkp.v7i1.25225>
- Kementerian Kesehatan RI. (2018). Hasil utama riskesmas tentang prevalensi diabetes mellitus di indonesia 2018. *Hasil Utama Riskesdas Tentang Prevalensi Diabetes Melitus Di Indonesia 2018*.
- Kementerian Kesehatan RI. (2020). Infodatin tetap produktif, cegah, dan atasi kesehatan diabetes melitus. In *Pusat Data Dan Informasi Kementerian 1–10*, 4.
- Lestary, P. I., Hasanah, U., & Dewi, R. N. (2022). Penerapan active lower rom terhadap nilai ankle brachial index pasien dm tipe 2. *Jurnal Cendikia Muda*, 2(4).
- Lukita, I. Y., Widyati, N., & Wantiyah, W. (2018). Pengaruh range of motion (rom) aktif kaki terhadap risiko terjadinya ulkus kaki diabetik pada pasien diabetes melitus tipe 2 di Desa Kaliwining Kecamatan Rambipuji Kabupaten Jember. *Universitas Jember*, 6(2). <https://doi.org/10.19184/pk.v6i2.7776>
- Murniasih, E. (2022). Pengaruh range of motion (rom) ankle terhadap pencegahan neuropati dan angiopati pada penderita diabetes mellitus di Ruang Sun Flower RSAB Pekanbaru. *Initium Variety Journal*, 4(1). <https://journal.medinerz.org/index.php/IVJ>
- Nani, N., & Syafri, M. (2018). Diagnosis dan tatalaksana klaudikasio intermiten. *Jurnal Kesehatan Andalas*, 7. <https://doi.org/10.25077/jka.v7i0.840>
- Ose, M. I., Utami, P. A., & Damayanti, A. (2018). Efektivitas perawatan luka teknik balutan wet-dry dan moist wound healing pada penyembuhan ulkus diabetik. *Journal of Borneo Holistic Health*, 1(1). <https://doi.org/10.35334/borticalth.v1i1.401>
- Pebrianti, S., Pramudya, T. A., & Pratiwi, Y. (2018). Latihan ekstremitas bawah pada pasien

- dengan ulkus kaki diabetik. *Jurnal Kesehatan Holistik (The Journal of Holistic Healthcare)*, 12(1).
- Polit, F. D., & Beck, T. C. (2004). *Nursing Study: Principles and methods*. Lippincott Williams & Wilkins. In *Study in Nursing and Health* (Vol. 29, Issue 5).
- Pratomo, B. I., & Apriyani, H. (2018). Ankle brachial index (ABI) pada penderita dm tipe 2 di Puskesmas Kabupaten Lampung Utara. *Jurnal Ilmiah Keperawatan Sai Betik*, 14(1). <https://doi.org/10.26630/jkep.v14i1.1004>
- Rachman, T. (2018). *Angewandte Chemie International Edition*, 6(11), 951–952. *Angewandte Chemie International Edition*, 6(11), 951–952.
- Ratnasari, D. (2014). Pengaruh latihan range of motion (rom) ekstremitas bawah terhadap perbaikan ulkus kaki diabetik pada pasien diabetes melitus tipe 2 di ruang rawat inap bedah dewasa RSUD Kabupaten Ciamis. *Jurnal Medika Cendikia*, 1(2). <https://doi.org/https://doi.org/10.33482/medika.v1i2.17>
- Soelistijo, S. (2021). Pedoman pengelolaan dan pencegahan diabetes melitus tipe 2 dewasa di Indonesia 2021. In *Global Initiative for Asthma*.
- Titah, A. N., MNS, M., Choירוel SKM, A. M., Ari, S., & Irma HY, S. (2019). Effectiveness combination of foot care with active range of motion (ROM) and plantar exercise for reducing diabetic foot ulcer risk in diabetes mellitus type II. *Journal of Endocrinology and Diabetes*, 6(2). <https://doi.org/10.15226/2374-6890/6/2/001131>
- Utami, T. I. (2019). Pengaruh senam kaki diabetes terhadap nilai ankle brachial index (ABI) dan nilai ipswich touch test (IPTT) pada pasien diabetes melitus Tipe II. *Jurnal Ilmiah Keperawatan Sai Betik*, 15(1). <https://doi.org/10.26630/jkep.v15i1.1543>
- Wicaturatmashudi, S. (2019). Faktor determinan ankle brachial pressure index (ABPI) pada pasien diabetes mellitus di Poliklinik Rumah Sakit Islam Siti Khadijah Palembang. *Jurnal Keperawatan Sriwijaya*, 6(2355), 16–26.
- Widyawati, Y. I., Irawaty, D., & Sabri, L. (2017). Latihan active lower range of motion menurunkan tanda dan gejala neuropati diabetikum (active lower range of motion reduce the sign and symptom of diabetic neuropathy). *Jurnal Ners Vol. 5 No. 2*, 53(9).
- Zamaa, S. M. (2016). Pengaruh kombinasi latihan range of motion ankle dorsolfeksi dan foot massage terhadap nilai ankle brachial index pada pasien diabetes melitus tipe 2. *Jurnal Mitrasehat*, 6(1). <https://doi.org/10.51171/jms.v6i1.166>
- Zamharira, C., & Abdullah, A. M. (2023). Analysis of public trust in the government on the importance of injecting the covid-19 vaccine in Aceh. *Jurnal Administrasi Publik Public Administration Journal*, 13(1). <https://doi.org/10.31289/jap.v13i1.8900>