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Management of Diabetes Mellitus through Foot Exercise Activities: Literature Study

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ABSTRACT

According to the World Health Organization (WHO, 2020), the global prevalence of diabetes is estimated to affect around 422 million people. Foot exercise is a therapeutic practice performed by individuals diagnosed with diabetes mellitus with the aim of reducing the risk of injury and increasing blood circulation. The purpose of this study was to analyze journal findings regarding foot exercise activities in individuals diagnosed with diabetes mellitus. The method used in this study is a literature study approach. Sources of information in this article were searched through researchgate and google scholar using the keywords foot exercise and diabetes mellitus. Based on a comprehensive review of 15 scientific sources, it is known that leg exercise activities can improve blood circulation. This, in turn, results in the expansion of the capillary network, thereby increasing the availability and activity of insulin receptors. Consequently, these physiological changes contribute to reduced blood glucose levels in individuals diagnosed with diabetes.

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1. Introduction

Diabetes Mellitus (DM) is considered a very dangerous medical condition, sometimes referred to as a silent killer (Berek, 2020), along with other serious health problems such as cardiovascular disease. Diabetes Mellitus (DM), comes from the Greek word "diabainein" which means translucent or light, and the Latin term "Mellitus" which means sweet taste, usually called diabetes in Indonesia. Diabetes is classified as a metabolic condition that arises from many variables, causing symptoms such as chronic hyperglycemia and disorders of carbohydrate, lipid and protein metabolism (Selviani et al., 2020).

Long-term problems associated with this condition include several health problems, such as cardiovascular disease, chronic kidney failure, retinal damage leading to blindness, potential nerve damage resulting in impotence, and the risk of gangrene possibly requiring amputation (Kartikasari, 2019).

According to the World Health Organization (WHO), the global prevalence of diabetes is estimated to affect approximately 422 million people. This condition especially occurs in low and middle income countries (Hidayati, 2019). In addition, it is reported that around 1.6 million deaths per year are caused

directly by diabetes. The incidence and prevalence of diabetes shows an increasing trend over the last decade, as reported by the World Health Organization in 2020.

According to the International Diabetes Federation (IDF), one person dies from diabetes every 8 seconds globally (Hindriyastuti et al., 2023). The global population of diabetes sufferers reached 415 million people, and in 2017, this number increased to 425 million (Darmawan & others, 2019). However, most people are still unaware of their or their family members' diabetes status. There are five provinces in Indonesia, namely DKI Jakarta, DI Yogyakarta, East Kalimantan, North Sulawesi and East Java which have the largest prevalence of diabetes mellitus sufferers (Tsalissavrina et al., 2018). Among these provinces, DKI (Special Capital Region) has the highest prevalence of diabetes. It is very important for individuals living in these areas to pay attention to their consumption patterns and engage in regular physical activity to prevent the onset of diabetes (WATI, 2019).

According to data from the Ministry of Health of the Republic of Indonesia, the prevalence of diabetes mellitus (DM) in all age groups in Indonesia, as reported in the 2018 Riskesdas survey, was found to be 1.5%. The province with the largest prevalence of diabetes mellitus (DM) in all age groups based on data from medical personnel is still DKI Jakarta at 3.4%, while the lowest prevalence is in NTT at 0.8%. Compared with South Sumatra Province, the prevalence of individuals diagnosed with diabetes mellitus is 1.4%, as reported by the Ministry of Health in 2018.

Management of diabetes mellitus can be achieved by utilizing pharmacological and non-pharmacological therapeutic approaches. Pharmacological interventions involve the use of medications, while non-pharmacological interventions include various non-drug therapies. Administering pharmacological treatment, particularly insulin and hypoglycemic drugs, is an important aspect of managing medical conditions related to glucose regulation. This can be achieved through several means, including oral administration. Non-pharmacological interventions include weight management, physical activity, and dietary modification. Physical activity is considered one of the four cornerstones of managing diabetes mellitus. Engaging in physical exercise has been shown to have a beneficial impact on blood glucose levels. This is due to the fact that physical activity promotes glucose utilization by active muscles. (COVERAGE, n.d.).

Regular physical activity has been shown to increase glucose utilization by active muscles (Lisiswanti & Cordita, 2016). During exercise, muscles metabolize glucose stores to produce energy, which in turn causes a decrease in blood glucose levels. Additionally, doing physical exercise causes the burning of calories, which in turn increases the body's metabolism. As a result, apart from regulating blood sugar levels, it also facilitates weight loss.

Doing regular physical exercise has been proven to be effective in reducing low-density lipoprotein (LDL) cholesterol levels, increasing high-density lipoprotein (HDL) cholesterol, and reducing triglyceride levels in the bloodstream. These beneficial effects contribute to a reduced likelihood of experiencing problems related to cardiovascular disease. Therefore, it can be said that engaging in physical activity not only has the potential to provide positive results in the management of diabetes mellitus, but also has the capacity to reduce the possibility of experiencing other related problems (Hardika, 2018).

One example of physical exercise is foot exercises. Foot exercise is a physical activity or series of exercises carried out by someone diagnosed with diabetes mellitus (Megawati et al., 2020). The main goal is to reduce the risk of injury and improve blood circulation in the lower extremities. The aim of these foot exercises is to increase blood circulation, facilitating the smooth delivery of nutrients to the tissues. Apart from that, this effort aims to strengthen small muscles, calf muscles and thigh muscles, as well as overcome the common problem of limited joint movement experienced by Diabetes Mellitus sufferers (MENDROFA, 2022).

In accordance with the findings of research conducted by (HASNI, 2013), it shows a statistically significant increase in foot sensitivity in the experimental group after giving therapy, as shown by the results of statistical tests with a p value of less than 0.05. It can be concluded that doing exercise has the potential to increase foot sensitivity in individuals diagnosed with type 2 diabetes mellitus.

Foot pain can be caused by a variety of factors, including diabetes mellitus, blood vessel problems, nerve problems, and infections. The presence of certain conditions such as prolonged hyperglycemia and

infection can significantly affect a person's capacity to regulate blood vessel contraction and relaxation. This causes reduced blood circulation throughout the body, especially in the lower extremities. As a result, individuals may experience symptoms of limb discomfort when performing activities that involve standing, walking, or physical exertion. Diabetic neuropathy patients who are hospitalized often receive limited education regarding the implementation of foot exercise interventions (Nopriani et al., 2021).

Based on the findings above, researchers conducted a literature study to determine the impact of diabetic foot exercises on foot sensitivity and blood glucose levels in individuals diagnosed with diabetes mellitus. The purpose of literature study is to obtain a theoretical basis for the chosen research subject. Consequently, researchers are required to engage extensively with many sources such as books, including theoretical texts, as well as research findings from other individuals, magazines, journals and similar publications (Syafruddin & Asri, 2022). In the process of conducting a case study, several approaches used in academic writing include: analyzing, comparing, and summarizing. This research focuses on the use of a summary approach in the context of exercise for individuals with diabetic feet in diabetes mellitus sufferers.

2. Methods

This research uses a literature review method. The process of collecting information used in this research comes from research that has been carried out and subsequently published in reputable academic journals, both national and international. This research utilized the Google Scholar search engine, using specific keywords such as "foot exercises" and "diabetes mellitus".

Data analysis methods refer to the systematic approach used to examine and interpret data in order to gain meaningful insights and draw valid conclusions. Research journals that meet the inclusion criteria are then collected and a summary of each journal is compiled. This summary includes the name of the researcher, year of publication, and a brief description of the conclusions or findings. The journal summary was then examined in relation to the content covered in the research objectives and the findings obtained from the research.

3. Results and Discussion

Based on the results of a review of various literature related to foot exercises and diabetes mellitus, 15 research results were found which became the main material in preparing this article.

Table 1.
Literature Related To Foot Exercises And Diabetes Mellitus

No.	Author	Year	Title	Conclusion
1.	HASNI, H.	2013	PENGARUH SENAM KAKI DIABETIK TERHADAP PENINGKATAN SIRKULASI DARAH KAKI PADA PASIEN DIABETES MELLITUS TIPE II NON ULKUS DI POLIKLINIK ENDOKRIN RSUP DR. WAHIDIN SUDIROHUSODO MAKASSAR. Universitas Hasanuddin.	Ada pengaruh senam kaki diabetik terhadap sirkulasi darah pada kaki pasien diabetes mellitus tipe II non ulkus di Poliklinik Endokrin RSUP Dr.Wahidin Sudirohusodo Makassar. Olehnya itu diharapkan kepada perawat untuk mengajarkan kepada pasien diabetes mellitus tipe II non ulkus tentang senam kaki diabetic untuk mencegah terjadinya ulkus diabetik.
2.	Oktaviah, D., Hasneli, Y., & others.	2015	Efektifitas senam kaki diabetik dengan bola plastik terhadap tingkat sensitivitas kaki pada pasien diabetes melitus tipe 2. Riau University.	Kesimpulannya senam kaki diabetik dengan bola plastik efektif terhadap peningkatan sensitivitas kaki pada pasien diabetes melitus tipe 2. Hasil penelitian ini diharapkan dapat menjadi salah satu intervensi

				keperawatan untuk meningkatkan sensitivitas kaki pada pasien diabetes melitus tipe 2.
3.	Hasnah, H., & Sau, A.	2017	Determining effects of leg exercises to increase blood circulation in the feet of diabetes mellitus patients. Indonesian Contemporary Nursing Journal, 53–61.	Senam kaki sangat efektif untuk meningkatkan sirkulasi darah kaki, memperkuat otot-otot kaki dan memudahkan pergerakan persendian. Diharapkan kepada masyarakat khususnya penderita diabetes melitus agar melakukan senam kaki secara mandiri dan teratur, menjalani pola hidup sehat guna mencegah terjadinya komplikasi penyakit diabetes melitus yaitu tukak diabetik.
4.	Katuuk, M. E., & Mulyadi, N.	2017	Pengaruh Senam Kaki Diabetes Terhadap Nilai Ankle Brachial Index Pada Pasien Diabetes Melitus Tipe II Di Rumah Sakit Pacaran Kasih Gmim Manado. Jurnal Keperawatan, 5(1)	Sebelum dilakukan atau diberikan senam kaki diabetes, sebagian besar pasien DM tipe II mempunyai nilai Ankle Brachial Index gangguan arterial ringan. Setelah dilakukan atau diberikan senam kaki diabetes, nilai Ankle Brachial Index mengalami perubahan yang cukup signifikan dengan meningkatnya nilai Ankle Brachial Index menjadi normal.
5.	Lariwu, C., & Rattu, D. A.	2017	Pengaruh Senam Kaki Diabetes Terhadap Penurunan Kadar Gula Darah Pada Pasien Diabetes Mellitus Tipe Ii Di Klinik Husada Manado. Journal Of Community \& Emergency, 5(2), 13–21.	Ada pengaruh senam kaki diabetes terhadap penurunan kadar gula darah pada pasien diabetes mellitus tipe II di klinik Husada Manado Disarankan kepada petugas kesehatan yang ada di klinik Husada Manado agar supaya penelitian ini dapat digunakan tenaga kesehatan yang ada di Klinik Husada untuk mensosialisasikan senam kaki diabetes sebagai pengobatan non farmakologis yang dapat mengontrol kadar gula darah pada pasien diabetes mellitus tipe II.
6.	Wibisana, E., & Sofiani, Y.	2017	Pengaruh Senam Kaki Terhadap Kadar Gula Darah Pasien Diabetes Melitus Di Rsu Serang Provinsi Banten. Jurnal Jkft, 2(2), 107–114	Terdapat pengaruh senam kaki pada kadar gula darah dan perbedaan pengaruh usia terhadap perubahan rata-rata kadar gula darah antara sebelum dan setelah senam kaki. Untuk kelompok muda pengaruh senam kaki terbukti lebih efektif.
7.	Hardika, B. D.	2018	Penurunan gula darah pada pasien diabetes melitus tipe II melalui senam kaki diabetes. MEDISAINS Jurnal Ilmu-Ilmu Kesehatan, 16(2), 60–66.	Senam kaki diabetes dapat menurunkan kadar gula darah secara signifikan pada pasien dengan diabetes mellitus tipe II.
8.	Nurlinawati, N., Kamariyah, K., & Yuliana, Y.	2018	Pengaruh Senam Kaki Diabetes Terhadap Perubahan Kadar Gula Darah Pada Penderita Diabetes Melitus di Wilayah Kerja Puskesmas Simpang Sungai Duren Kabupaten Muaro Jambi. Jurnal Ilmiah Ilmu Terapan	Hasil penelitian diketahui ada pengaruh terhadap penurunan kadar gula darah responden pada kelompok intervensi.

			Universitas Jambi| JIITUJ|, 2(1), 61–67.	
9.	Latifah, S., Fahdi, F. K., & Hafidzah, R.	2019	Pengaruh Senam Kaki Diabetes Terhadap Sensitivitas Kaki Pada Pasien DIABETES Melitus Tipe 2 Di UPTD RSUD Sultan Syarif Mohamad Alkadrie Kota Pontianak. ProNers, 3(1).	Hasil penelitian menyimpulkan senam kaki diabetes dapat membantu meningkatkan sensitivitas kaki pada pasien diabetes melitus tipe 2. Oleh karena itu diharapkan senam kaki diabetes dapat digalakkan untuk memperlancar sirkulasi perifer penderita demi mencegah komplikasi neuropati dan kaki diabetes.
10.	Megawati, S. W., Utami, R., & Jundiah, R. S.	2020	Senam Kaki Diabetes pada Penderita Diabetes Melitus Tipe 2 untuk Meningkatkan Nilai Ankle Brachial Indexs. Journal of Nursing Care, 3(2).	Terdapat pengaruh senam kaki diabetes terhadap nilai Ankle Brachial Index pada pasien Diabetes Mellitus Tipe 2. Senam kaki diabetes dapat terus dilaksanakan untuk meningkatkan sirkulasi ke daerah kaki pada pasien Diabetes Mellitus Tipe 2.
11.	Putra, M. M., Narayani, I. A. M.,Purwantara, I. K. G. T., & Astriani, N. M. D. Y. (2020).	2020	EFEKTIFITAS SENAM KAKI TERHADAP NILAI ANKLE BRACHIAL INDEX PADA PENDERITA DIABETES MELLITUS TIPE 2: Jurnal Ilmiah Keperawatan (Scientific Journal of Nursing), 6(1), 28–34.	Berdasarkan hasil dari penelitian dan pembahasan, sehingga dapat ditarik kesimpulan sebagian besar responden berjenis kelamin perempuan, usia tertinggi yaitu 74 tahun dengan kategori nilai ABI sedang, mayoritas responden merupakan lulusan SD. Menunjukkan ada pengaruh senam kaki terhadap nilai Ankle Brachial Index (ABI) pada penderita DM tipe 2.
12.	Astrie, J., & Sugiharto, S.	2021	Penerapan Pengaruh Senam Kaki Diabetes Terhadap Nilai Ankle Brachial Index (Abi) Pada Pasien Diabetes Mellitus Tipe 2. Prosiding Seminar Nasional Kesehatan, 1, 813–819.	Terbukti bahwa senam kaki diabetes dapat meningkatkan nilai ABI pada pasien diabetes mellitus. Saran bagi pelayanan kesehatan untuk mengkaji pengetahuan pasien terkait dengan senam kaki diabetes, dan mengajarkannya. Karena perawatan kaki merupakan salah satu pilar perawatan diabetes mandiri yang dapat mencegah komplikasi dan menurunkan kematian dini akibat diabetes.
13.	MENDROFA, R. L. W.	2022	HUBUNGANPENGETAHUAN PASIEN DIABETES MELITUS DENGAN PELAKSANAAN SENAM KAKI DIABETIK DI UPTD PUSKESMAS GUNUNGSITOLI UTARA.	Kesimpulan bahwa ada hubungan yang signifikan antara kedua variabel. Disarankan hasil penelitian ini dapat menjadi tambahan referensi dalam pengembangan penelitian selanjutnya terkait hubungan pengetahuan diabetes melitus dengan pelaksanaan senam kaki diabetik pada pasien diabetes melitus.
14.	Silva, É. Q., Ver\'\issimo, J. L., Ferreira, J. S. S. P., Cruvinel-Júnior, R. H., Monteiro, R. L., Suda, E. Y., & Sacco, I. C. N.	2023	Effects of a Home-Based Foot--Ankle Exercise Program with Educational Booklet for Foot Dysfunctions in People with Diabetic Neuropathy: Results of the FOCA-II Randomized Controlled Clinical Trial. Applied Sciences, 13(3), 1423.	Program latihan kaki-pergelangan kaki di rumah selama 8 minggu berdasarkan buku pendidikan ditambah perawatan kaki biasa tidak akan cukup untuk memperbaiki faktor risiko utama yang dapat dimodifikasi. berhubungan dengan ulkus kaki. Namun, hal ini tampaknya menjaga

				kinetika gaya berjalan dan pola distribusi tekanan peserta IG selama 16 minggu, sehingga mencegah memburuknya kondisi mereka.
15.	Wulandari, N. T., Nooratri, E. D., & Yuwono, J.	2023	Penerapan Senam Kaki Diabetes Melitus Terhadap Tingkat Kadar Gula Pada Lansia Penderita Diabetes Melitus Tipe II DI RSUD Kota Salatiga. Jurnal Ilmu Kesehatan Mandira Cendikia, 2(7), 140–148.	Terdapat penurunan kadar gula darah setelah dilakukan senam kaki diabetes melitus. Adanya perbedaan perkembangan penurunan kadar glukosa darah pada pasien diabetes melitus sebelum dan sesudah dilakukan penerapan senam kaki diabetes melitus

Discussion

Based on the findings of a comprehensive literature analysis conducted by researchers in several scientific journals, it is known that individuals with type II diabetes mellitus usually show certain characteristics. These include being over 50 years old, predominantly female, and lacking physical activity. This is in line with the findings presented in the article (NOVIKA & others, 2022), which identified many groups at high risk of developing diabetes mellitus (DM). This group includes individuals aged 45 years and over, those who are overweight (with a body shape ratio [BBR] above 110% or a body mass index [BMI] above 25 kg/m2), and individuals with hypertension (defined as pressure blood). levels exceeding 140/90 mmHg). Mothers who have given birth to a baby weighing more than 4000 grams, have had gestational diabetes, have a family predisposition to diabetes mellitus, have low high-density lipoprotein (HDL) cholesterol levels (<35 mg/dl), or have a history of giving birth to a baby. with a body weight of more than 4000 grams. increased triglyceride levels (>250 mg/dl), as well as insufficient physical activity. (Marewa, 2015)

Based on the findings of a comprehensive literature analysis conducted by the researchers, it was found that non-medical approaches, such as therapy, physical exercise, and herbal medicine, can be used in the management of diabetes mellitus. This research mainly emphasizes non-medical intervention through the application of physical exercise therapy in the form of diabetes mellitus foot exercises. This is in line with the findings reported by (ARLENIA, 2019), which states that the main goal of controlling DM is to relieve symptoms and achieve optimal body weight. Therefore, the basic principles of management control or data management include food management which is considered the main and crucial aspect in managing diabetes mellitus (DM), which at first seems easy, but in fact it is difficult to regulate one's eating habits, the importance of physical exercise in managing health diabetic foot, and risk behavior change refers to the process of modifying behavior associated with potential negative outcomes or bad consequences. this process involves individuals making a conscious effort to change their actions, habits, or choices to reduce

Based on a literature review covering various journal sources, it was determined that the application of diabetic foot exercises had a real impact on reducing blood sugar levels in individuals diagnosed with type II diabetes mellitus. Research conducted by (Lariwu & Rattu, 2017) investigated the impact of diabetic foot exercises on reducing blood sugar levels in individuals diagnosed with Type II Diabetes Mellitus at the Husada Manado Clinic. This particular research methodology uses a one group pretest-posttest design. Participants in this study consisted of individuals diagnosed with diabetes mellitus, with 45.5% being in the age range of less than 50 years and 50.5% being in the age range of more than 50 years. The exercise regimen is carried out twice a week. The findings show that the pre-intervention average is 176.15, while the post-intervention average is 118.70. As a result, there is a significant difference of 57,450 in the average value before and after intervention. The P value obtained of 0.000 is smaller than the predetermined significance level, namely 0.05, causing the null hypothesis (Ho) to be rejected. Thus, it can be concluded that there is a real effect of diabetic foot exercises on reducing blood sugar levels in patients diagnosed with type II diabetes mellitus at the Husada Manado clinic.

According to research (ARITAMI, 2019), the inclusion of physical exercise or sports is a crucial element in diabetes management. This is due to its potential to effectively lower blood glucose levels by increasing glucose uptake in muscles and optimizing insulin utilization. Doing physical exercise causes an increase in blood circulation, thereby causing greater expansion of the capillary network and subsequently increasing blood flow. In diabetic patients, the presence of a large number of insulin receptors and an increase in their activity levels contribute to a decrease in blood glucose levels. Normally, under normal physiological conditions, postprandial blood glucose levels experience an increase, which then triggers a rapid spike in insulin secretion, which then causes a subsequent decrease after the nutrients consumed have been adequately stored. The hormone insulin, which is synthesized by the pancreas, plays an important role in facilitating the transport of glucose from the bloodstream into cells (ARITAMI, 2019).

Research conducted by (Wibisana & Sofiani, 2017) investigated the impact of leg exercises on blood glucose levels in individuals diagnosed with diabetes mellitus at RSU Serang located in Banten Province. This particular research methodology uses a one group pretest-posttest design. According to research conducted by (RAHMADHANTI, 2022), non-pharmacological therapy can be used to treat diabetes. Non-pharmacological interventions include exercise as a therapeutic modality. Physical activity plays an important role in the management of diabetes mellitus. A decrease in blood glucose levels can be associated with engagement in physical exercise, as this activity promotes increased glucose utilization by moving muscles.

One example of physical exercise is foot exercises. Engaging in leg exercises has been shown to increase blood flow and improve blood circulation (Astrie & Sugiharto, 2021). As a result, this physiological response causes expansion of the capillary network thereby increasing the availability and activation of insulin receptors. The findings of this study show the significant impact of leg exercises on blood glucose levels, as well as variations in the influence of age on changes in average blood glucose levels before and after doing leg exercises. In the case of the younger demographic, leg exercises show a greater degree of effectiveness. There are large differences in the magnitude of the effect of physical exercise specifically designed for diabetes management on changes in blood glucose levels. Individuals who did diabetes exercise for a longer duration showed a more significant reduction in blood glucose levels after doing leg exercises.

Research conducted by (Hardika, 2018) investigated the impact of diabetic foot exercises on reducing blood sugar levels in individuals diagnosed with type II diabetes mellitus. This study used a single group pretest-posttest design. Participants in this study consisted of individuals diagnosed with diabetes mellitus, aged between 40 and 70 years. There were 10 respondents (33.3%) aged between 40 and 49 years, 14 respondents (46.7%) aged between 50 and 59 years, and 6 respondents (20.0%) aged 60 to 70 years. Investigation findings showed statistically significant variations in blood glucose levels among individuals diagnosed with type II diabetes mellitus before and during the implementation of diabetic foot exercises ($p<0.01$).

According to research, managing blood sugar levels can be achieved by implementing non-pharmacological interventions, such as doing leg exercises (Asmita et al., 2023). The etiology of diabetes mellitus is caused by pancreatic dysfunction, namely impaired insulin production which plays an important role in regulating blood glucose levels. The observed decrease in blood glucose levels is an indicator of improvement in the condition of diabetes mellitus. Therefore, providing foot exercise activities can be considered an appropriate strategy for managing diabetes mellitus. Diabetes mellitus foot exercises refer to physical activity or exercise patterns undertaken by individuals diagnosed with diabetes mellitus, with the aim of reducing the risk of injury and improving blood circulation in the lower extremities.

Based on research conducted by (Nurlinawati et al., 2018), the study investigated the impact of diabetic foot exercises on changes in blood glucose levels in individuals diagnosed with diabetes mellitus. This research used a pretest-posttest group design with a control group. The participants in this research consisted of individuals diagnosed with diabetes mellitus in the Simpang Sungai Duren District. Muaro Jambi. The number of respondents was 22 people, with 11 respondents included in the intervention group who received foot exercises and the other 11 respondents in the control group without foot exercises.

After the leg exercises were completed, it was observed that 11 (100%) participants in the intervention group showed a decrease in blood glucose levels. The findings of this study showed a significant impact on reducing blood glucose levels among intervention group participants.

This study investigated the impact of diabetes exercise and walking on reducing blood sugar levels in Type II diabetes mellitus patients at the Krueng Barona Jaya Aceh Besar Health Center (Rehmaita et al., 2017). The research findings showed a statistically significant impact on reducing blood glucose levels (KGD) in individuals diagnosed with type II diabetes mellitus as a result of doing exercise specifically designed for diabetes management (p-value = 0.002) and doing physical activity. walking regularly (p-value = 0.001). Carrying out sports activities with adequate technique, consistency, regularity and quantity can contribute to stabilizing blood glucose levels (KGD), reducing dependence on insulin or medication, and maintaining a healthy body weight.

Physical exercise is known to cause increased blood circulation, which leads to the dilation of more capillaries. This expansion facilitates increased availability and increased activity of insulin receptors. Consequently, these physiological changes may contribute to a decrease in blood glucose levels in individuals diagnosed with diabetes (INDRIYANI, n.d.). Exercise is known to have a significant impact on the regulation of blood glucose levels in individuals with type 2 diabetes mellitus. This is largely due to the fact that during physical activity, glucose uptake by working muscles can increase significantly, reaching levels 15-20 times higher. compared to when resting (Adiwinanto, 2008). This increase in metabolic rate in active muscle leads to improved fat profiles and increased insulin sensitivity, ultimately resulting in a decrease in blood glucose levels. Apart from its efficacy in regulating blood glucose levels, exercise has been proven to have a positive impact on weight loss in individuals suffering from type 2 diabetes mellitus (Meidikayanti & Wahyuni, 2017).

This research, as documented in the journal Nasution (2017) in (Hasnah & Sau, 2017), investigated the impact of foot exercises on increasing leg blood circulation in patients diagnosed with diabetes mellitus. Specifically, this research examines changes in leg blood circulation before and after administering leg exercise treatment at the Haji Adam Malik General Hospital, Medan. Participants in this study consisted of individuals diagnosed with diabetes mellitus, with an age range of four people under 50 years of age to six people over 50 years of age. The exercise regimen is carried out three times every week. The findings of this study show that the use of foot exercises has been proven to have a positive impact on foot health, especially those related to the arch of the foot. Insufficient insulin levels in individuals with diabetes mellitus (DM) lead to increased blood glucose levels, which in turn contributes to detrimental effects on blood vessels, nerves, and other internal structures. As a result, the obstruction to blood flow to the lower extremities gets worse, resulting in circulation problems in the legs experienced by Diabetes Mellitus sufferers (Saputro & others, 2020).

Research conducted by (Latifah et al., 2019) examined the effect of diabetes foot exercises on foot sensitivity in type 2 diabetes mellitus patients at the UPTD RSud Sultan Syarif Mohamad Alkadrie, Pontianak City. The results of the study concluded that diabetic foot exercises can help increase foot sensitivity in patients with type 2 diabetes mellitus. Therefore, it is hoped that diabetic foot exercises can be encouraged to improve peripheral circulation in sufferers in order to prevent complications of neuropathy and diabetic feet. This research used a quasi-experiment with a control group pre-post test design. The sample for this research consisted of 34 respondents. The assessment instrument uses a sensitivity scale with a monofilament tool. Foot exercises are done every day for a week. Statistical analysis uses the Wilcoxon test. The Wilcoxon test shows a p value <0.05, which means that there is an influence of diabetes foot exercises on increasing foot sensitivity in patients with type 2 diabetes mellitus at the UPTD of Sultan Syarif Mohamad Alkadrie Hospital, Pontianak City.

According to (RAHANMTU, 2019), the fitness pattern described for individuals with diabetes is characterized by its simplicity and flexibility, as it can be performed both indoors and outdoors. Foot exercises have the potential to improve intrinsic foot muscle function in individuals diagnosed with diabetes and neuropathy. Apart from the benefits mentioned above, this activity has the potential to strengthen the muscles in the calf and thigh area, reduce joint mobility problems, and as a preventive measure against physical deformities. Insufficient insulin levels in people with diabetes mellitus (DM)

cause increased blood glucose levels, which in turn contributes to damage to blood vessels, nerves, and other internal structures. As a result, the obstruction to blood flow to the lower extremities becomes increasingly severe, resulting in impaired circulation in the legs for DM sufferers.

Research conducted by (Flora, 2013) investigated the impact of diabetic foot exercises on changes in blood glucose levels in individuals diagnosed with diabetes mellitus at the Indralaya Community Health Center. This particular research methodology uses a one group pretest-posttest design. Participants in this study consisted of individuals diagnosed with diabetes mellitus, with approximately 30.5% being in the age range of less than 50 years, and 60.5% being in the age range of more than 50 years. The fitness regimen is done three times a week. Based on the findings of this activity, it can be concluded that all participants (100%) have a comprehensive understanding of the objectives, benefits, as well as indications and contraindications related to leg exercises. In addition, the participants showed high levels of enthusiasm, attention, and engagement during the leg exercise training sessions. Foot exercises are a physical activity specifically designed for individuals diagnosed with Diabetes Mellitus (DM) or those who do not suffer from this disease, with the aim of reducing the risk of injury and increasing blood circulation in the lower extremities. Use of a foot exercise routine has the potential to increase blood circulation in the lower extremities, strengthen the leg muscles, and facilitate increased mobility of the leg joints. In addition, the use of leg exercises has the potential to increase muscle strength in the thigh and calf areas, as well as overcome problems related to joint mobility.

The journal article entitled "Foot Exercises for Diabetes Mellitus Sufferers: Measures to Prevent Injury and Improve Blood Circulation of the Lower Limbs" (Flora, 2013) explains the importance of foot exercises as a preventive measure for individuals suffering from Diabetes Mellitus (DM). as well as those who are not affected by the condition. This exercise aims to reduce the risk of injury and improve blood circulation in the lower extremities. Use of this foot exercise routine has the potential to increase blood circulation in the lower extremities, strengthen the leg muscles, and facilitate increased mobility of the leg joints. There is hope that careful attention to foot care in people with diabetes can improve well-being and improve overall quality of life in this population. The main goals of doing leg exercises include improving blood circulation, strengthening the muscles of the lower extremities, reducing the risk of foot disorders, increasing the strength of the calf and thigh muscles, and overcoming existing mobility limitations.

Research conducted by (Oktaviah et al., 2015) investigated the impact of plastic ball training on foot sensitivity in individuals with type 2 diabetes mellitus (DM). This study compared an experimental group that performed the exercise with a control group. The research design uses quasi-experiments to explain causal relationships by combining a control group with an experimental group. The research sample consisted of 30 participants, with 15 people included in the experimental group and 15 people included in the control group. All participants were diagnosed with type 2 diabetes mellitus and are undergoing treatment at Arifin Achmad Hospital Pekanbaru. It can be concluded from these results that performing diabetic foot exercises using a plastic ball three times a week can increase foot sensitivity in individuals diagnosed with type 2 diabetes mellitus.

In research conducted by (Wulandari et al., 2023), the focus was to determine the effect of health education using audiovisual media on knowledge of doing foot exercises in Type 2 Diabetes Mellitus patients. This research used a quasi-experimental research approach, specifically utilizing pretest and posttest experiments. Based on the findings of the research conducted, it can be concluded that the application of health education using audio-visual media in the experimental group resulted in a significant increase in the understanding and application of foot exercises in individuals diagnosed with type 2 diabetes mellitus. Carrying out sports activities effectively shows the need for physical exercise, especially in the context of diabetes mellitus foot exercises.

In research conducted by (Putra et al., 2020), the focus was to investigate the effectiveness of diabetic foot exercises in improving the brachial ankle index in individuals with type 2 diabetes mellitus. The research findings showed that incorporating diabetic foot exercises into the treatment program of individuals with diabetes type 2 mellitus can cause an increase in the ankle-brachial index (ABI). It was also explained that doing diabetic foot exercises is an effective way to improve circulation, especially in the

foot area. The lower extremity region meets the requirements of continuity, rhythm, interval, progression, and endurance, thus requiring completion of each phase of movement. Aerobic exercise is highly recommended for people with diabetes mellitus (DM) because it is oxygen dependent. This type of exercise improves blood circulation, increases the strength of the small muscles of the feet, reduces the risk of foot deformities that can cause diabetic foot wounds, and stimulates insulin production. Insulin plays an important role in facilitating glucose transport to cells, thereby helping to reduce blood glucose levels. The foot movements performed during diabetic foot exercises are similar to the movements performed during a foot massage. These movements involve applying pressure and movement to the legs, which impacts various hormones. Specifically, this stimulation causes an increase in the secretion of endorphins, thereby reducing pain. In addition, manipulation of the legs causes vasodilation of blood vessels, leading to a decrease in blood pressure, especially in the brachial systolic area, which is directly related to blood pressure levels. The acronym ABI stands for Acquired Brain Injury.

Based on the findings obtained from the literature review in the journals mentioned above, it can be concluded that foot exercise therapy shows considerable efficacy in reducing blood glucose levels in individuals diagnosed with diabetes mellitus. This is in line with the idea put forward by (Nuryanto & others, 2017) who states that the objectives of exercise for treating diabetes mellitus feet include improving blood circulation, strengthening small muscles, preventing foot deformities, increasing the strength of the calf and thigh muscles, and overcoming limited joint mobility.

In a scientific publication written by (Silva et al., 2023), this discourse discusses the topic of rehabilitation technology in the context of self-care, specifically focusing on the use of foot and ankle training software tailored for individuals diagnosed with diabetes. The research design used was Quasi Experiment. The study involved a total of 29 participants diagnosed with diabetes mellitus. This study found that most of the participants, namely 45.5% of the sample, were in the 40-50 year age range. In addition, the exercise regimen was implemented three times a week during the study period. The findings of this study are as follows: In the expert community, the coefficient of variation (CVI) reached a value of 0.812 after the initial round, and ultimately reached a unanimous consensus of 100% after the second round. In the initial round, the coefficient of variation (CVI) was determined to be 0.902 among participants. Furthermore, the final agreement rate was observed to be 97%.

In a scientific publication written by Jane (Katuuk & Mulyadi, 2017), relaxation and increased blood circulation due to effective foot exercises are explained. Improved blood circulation is facilitated by doing leg exercises, as these exercises allow the transport of greater amounts of oxygen and essential nutrients to the body's cells, while facilitating the elimination of greater quantities of pollutants. Exercises that target the soles of the feet, especially around the affected organs, can stimulate the nerve points associated with the pancreas, thereby increasing insulin production through the nerve points located on the soles of the feet.

4. Conclusion

Based on a comprehensive analysis of the literature regarding diabetic foot exercises in individuals with diabetes, it can be concluded that doing foot exercises causes increased blood flow, resulting in more open capillary networks. As a result, there is an increase in the availability and activation of insulin receptors, thereby contributing to a decrease in blood glucose levels in individuals diagnosed with diabetes. Physical activity has the potential to reduce blood glucose levels due to its ability to increase glucose utilization by active muscles. One example of physical exercise is foot exercises. There is an expectation that the proposed changes will enhance the research process for students, such as by expanding the available references and literature. This, in turn, will facilitate scientific development and contribute to the accumulation of information, knowledge, and comprehension. These contributions, in the form of educational resources, can further advance the field of science, particularly in the realm of health sciences. The anticipated outcome of this study is that its findings will serve as a point of reference for both the current researchers and future researchers. This will enable them to pursue further

investigations using alternative methodologies in the realm of diabetes mellitus treatment, hence fostering greater diversity in research endeavours.

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