LITERATUR ARTICLE

Literature Review; The Effect of Buerger Allen Exercise on Ankle Brachial Index (ABI) Values in Diabetes Mellitus Type 2 Patients

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ABSTRACT

Introduction: *Patients with Diabetes Mellitus type 2 tend to have ABI values lower than the normal range due to lack of physical exercise and uncontrolled hyperglycemia. This needs to be prevented through joint movement exercises with Buerger Allen exercise which can increase blood perfusion in the lower extremities so that there is an increase in the value of the ankle-brachial index (ABI).* ***Objective:*** *This study aims to determine the effect of Buerger Allen exercise on the value of the ankle-brachial index (ABI) in patients with Diabetes Mellitus type 2 based on a review of research journals.* ***Methods:*** *This study uses a literature review method. Search literature using 5 databases, namely Portal Garuda, Sinta, ProQuest, Scopus, and Google Scholar with keywords according to MeSH, namely "Buerger Allen Exercise", "Ankle Brachial Index", "Diabetes Mellitus Type 2". The PICOS framework was used to adjust the inclusion criteria which were divided into 5 English journals and 5 Indonesian journals and then analyzed narratively based on similarity analysis.* ***Results:*** *The findings of the ten journals stated that the Buerger Allen exercise had a significant effect on the value of the ankle-brachial index (ABI). Discussion: Buerger Allen exercise is a physical exercise to improve foot peripheral perfusion that can increase the value of the ankle-brachial index in type 2 DM patients. Conclusion: Buerger Allen exercise has a significant effect on increasing the ankle-brachial index (ABI) score so that it can be used as a reference source for standard operating procedures and nursing interventions.*

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Introduction

Indonesia is a developing country with high non-communicable disease problems such as complications of diabetes mellitus (Ibrahim *et al.,* 2020). Diabetes mellitus (DM) is often not realized by the sufferer until complications arise (American Diabetes Association, 2016). Complications that often occur in DM are diabetic foot ulcers where wound healing takes a very long time. The trigger factor that often occurs in diabetic foot ulcers is poor vascularization of the leg veins. Poor vascularization can occur in both small and large blood vessels (Hawk, 2014). This vascularization will worsen the condition of blood circulation in the legs due to high glucose in the blood so that the blood is too thick resulting in constriction, blockage, and poor blood circulation, coupled with advanced age and comorbidities (cardiovascular) which will further worsen the condition of the blood vessels. Vascularization in the feet that is not well managed and not managed properly will lead to *Diabetic Foot Ulcers* (DFU) (Embuai, 2019).

Diabetes mellitus (DM) is categorized as a global disease that has increased fourfold from 1980 to 2016, so the *World Health Organization* (WHO) estimates that by 2025 the incidence of DM will increase to 300 million DM patients with peripheral vascular complications (WHO, 2016).

According to the *International Diabetes Federation* (IDF) in 2019, there were around 463 million people with diabetes in the world. This number will increase in 2030 by 578 million people and is expected to continue to increase by 51%, namely 700 million people in 2045 (International Diabetes Federation, 2019). Patients with diabetes mellitus in Indonesia have increased from year to year, in 2013 DM patients were 6.9% and increased to 8.5% in 2018 (Riskesdas, 2018). The prevalence of diabetes mellitus in East Java Province at all ages in 2018 was 2.02% and in the city of Surabaya at 3.5%. The city of Surabaya is ranked 3rd after Madiun and Mojokerto (Riskesdas Jatim, 2018). The prevalence of type 2 DM in the Surabaya area is 33.5% belonging to the category of lack of physical exercise while 66.5% is in the sufficient category (Riskesdas, 2018).

Diabetes mellitus (DM) is a group of metabolic diseases characterized by high blood glucose levels or hyperglycemia (*American Diabetes Association, 2015)*. Hyperglycemic conditions can increase the risk of acute and chronic complications such as *Peripheral Artery Disease* (PAD) and neuropathy due to narrowing, blockage, and decreased peripheral perfusion (Putri., 2020). Atherosclerosis and lack of physical exercise can cause a decrease in blood circulation, especially in the legs (Wahyuni, 2013). Decreased peripheral blood circulation to nerve fibers causes cells and tissues to lack oxygen and nutrients for metabolism (Black, J. M & Hawks, 2014). Continuous ischemic conditions will cause tissue to undergo necrosis and ulcers occur on the feet or diabetic foot ulcers due to neuropathic complications (Hassan & Mehani., 2012). Treatment of diabetic foot ulcers that are not optimal will result in amputation and make the quality of life of DM patients decrease and then end up with a high mortality rate (Salam & Laili., 2020).

Prevention of complications of diabetes mellitus can be done through lower extremity joint movement exercises (Hijriana *et al.,* 2016*)*. Lower extremity joint movement exercises should be effective, efficient, easy to learn, and have a low risk, such as the Buerger Allen exercise (Chang *et al.*, 2015). Buerger Allen exercise is a muscle pump combined exercise with postural changes in gravity that can increase vascularization to the lower extremities to facilitate blood circulation in the legs (John & Rathiga, 2015; Chang *et al.,*2015). Buerger Allen exercise can increase the ankle-brachial index (ABI) in people with diabetes mellitus (Rahmaningsih *et al*., 2016). Supriyadi's research (2018) also states that Buerger Allen exercise can increase lower extremity perfusion, which can be seen from the ABI value of 0.84 or mild obstruction to 0.93 or normal (Supriyadi., 2018). This study aims to identify the frequency of Buerger Allen exercise in DM Type 2 patients, identify the value of the ankle-brachial index (ABI) in DM Type 2 patients, Determine the effect of Buerger Allen exercise on increasing ABI values in DM Type 2 patients.

Methods

This research is research using the literature study method or literature review. The topic search was conducted in May-June 2021 using the PICOS framework. The data sources used are secondary data in five databases with high – medium quality criteria, namely Portal Garuda, Sinta, Proquest, Scopus, and Google Scholar. Search literature using keywords in the form of "*Buerger Allen Exercise*", "*Ankle Brachial Index*", "*Type 2 Diabetes Mellitus*" and keywords in English namely "*Buerger Allen Exercise*", "*Ankle Brachial Index*", "*Type 2 Diabetes Mellitus*". The keywords have been adjusted to the Medical Subject Heading (MeSH) as follows:

Table 1. Keywords Based on Medical Subject Heading (MeSH)

Buerger Allen Exercise	*Ankle Brachial Index (ABI)*	*Type 2 Diabetes Mellitus*
OR	*OR*	*OR*
Lower Limb Exercise	*Ankle Arm Indeks (AAI)*	*Type 2 Hyperglycemia*
OR	*OR*	*OR*
Diabetes Joint Exercise	*Resting Pressure Index (RPI)*	*Type 2 Glycosuria*

The inclusion criteria in this literature review were Population: Patients type 2 diabetes mellitus with lower extremity perfusion. Patients with type 2 diabetes mellitus with an abnormal *Ankle Brachial Index* (ABI) value <0.9-1. Intervention: Physical exercise with the Buerger Allen Exercise and Observation of *Ankle Brachial Index* (ABI). Comparators: There is no comparison. Outcomes: There is an effect of the Buerger Allen Exercise on the value of the *Ankle Brachial Index* (ABI). Study design: Quasi-experimental study and True experimental study with pre-post test design. Publication years: Journals published after 2011-2021. Language: Indonesian and English. Exclusion criteria: scientific articles using cross-sectional studies. The results of the search and study selection based on PRISMA obtained 10 indexed journals. Then a critical appraisal is carried out and analyzed narratively based on a similarity analysis or summarized content.

Results

The results of a literature search through publications in 5 databases get 1,813 journals that match these keywords. The search results that have been obtained then examined the year of publication after 2011-2021, found 696 journals. Further duplication checks, remaining 206 journals. The researcher then conducted a screening based on the title (n = 64), abstract (n = 16), and full text (n = 10) which was adjusted to the theme of the literature review. Systematically the steps in the literature review can be described in the Flow Diagram below:

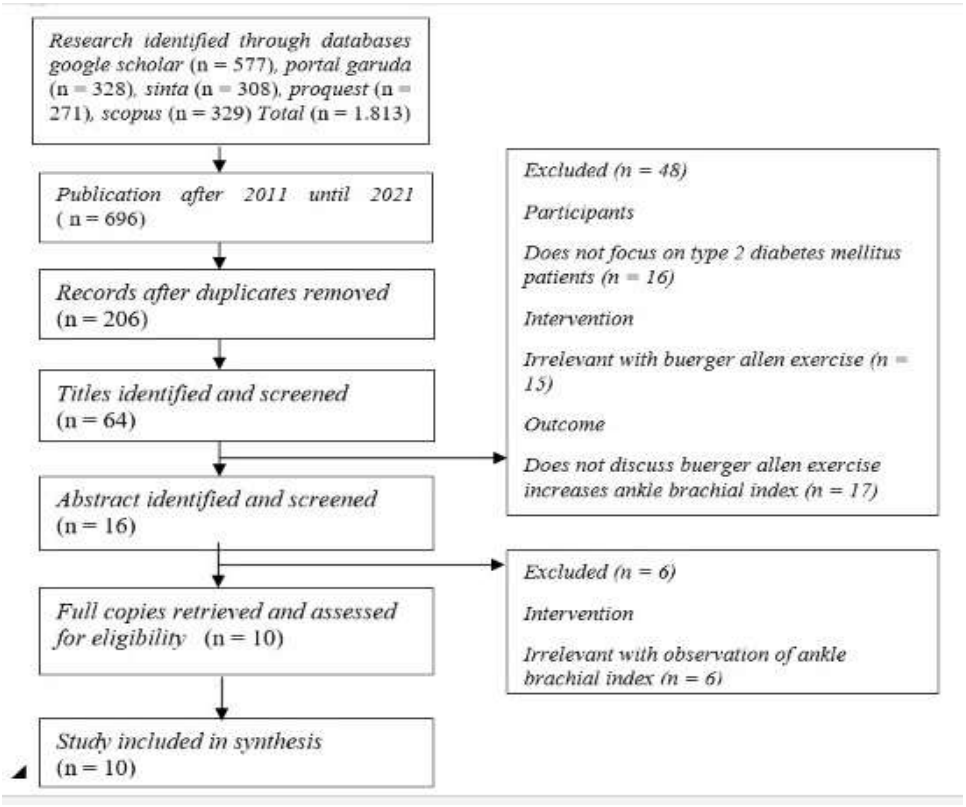

Figure 1. Flowchart of Literature Review based on PRISMA (2009) *cit* (Stovold *et al.*, 2014)

Table 2. Results of Literature Search The Effect of Buerger Allen Exercise on Ankle Brachial Index (ABI) Values in Type 2 Diabetes Mellitus Patients

No	*Title, Authors, and Years*	*Group*		*Results*	*Search System*
		Intervention	***Control***	**Summary of Results**	
1	Effects of Buerger Allen Exercise on Changes in Ankle Brachial Index (ABI) Values in Type II Diabetes Patients (Ainul Yaqin Salam, Nurul Laili, 2020)	10 people in the treatment group were given intervention 6 times for 6 days with a duration of 15 minutes for each meeting	10 people in the control group did not do physical exercise	The results of this study showed a change in the value of the ankle-brachial index (ABI) in the intervention group, namely the pre-test was 0.72 mmHg (mild obstruction) and the post-test was 0.90 mmHg (normal). While in the control group there was no increase in the ABI value, namely in the pre-test and post-test of 0.83 mmHg (mild obstruction)	Sinta 3 & Portal Garuda
2	The Effectiveness of Buerger Allen Exercise on Ankle Brachial Index (ABI) in Type 2 Diabetes Mellitus Patients (Donny Richard, Dewi Prabawati, Dwi Hapsari, 2020)	27 people in the Buerger Allen Exercise intervention group with intervention for 2 times a day (morning, afternoon) for 15-20 minutes duration in 5 consecutive days	*Without control groups*	The results showed that in the Buerger Allen exercise intervention group the average ABI value of the pre-test was 0.77 mmHg (mild obstruction), and the post-test was 0.96 mmHg (normal). The most changes in ABI values in the category of mild obstruction to normal in both treatments. Mild obstruction before treatment was 19 (70.4%) to normal after treatment was 18 (66.7%)	Sinta 4 & Portal Garuda
3	*Effectiveness of Buerger Allen Exercise on Lower Extremity Perfusion Patients with type 2 Diabetes Mellitus* (Jinna Radhika, Geetha Poomalai, Nalini, Ramanathan, 2020)	*50 participants in the intervention group, The intervention was repeated 5 times per day (morning 8 am to 1 pm two times and noon from 2 pm to 5 pm three times) for 4 days*	*Without control group*	*The result in the experimental group there was a significant difference between the pre-test mean value of 0,73 (mildly impaired perfusion) and the post-test mean value of 0.83 (mildly impaired perfusion) in Right-ABI. And then in Left-ABI pre-test mean value 0,79 to 0,84 (mildly impaired perfusion in post-test).*	Scopus SJR Q2
4	*Effect of Buerger Exercises on Improving Peripheral Circulation of the Lower Extremities*	*60 participants in the intervention group with Buerger Allen exercise and*	*Without control group*	*The result in the experimental group there was a significant difference between the pre-test mean value 0,88 or peripheral*	Scopus SJR Q4

	among Patients with Type 2 Diabetes Mellitus at Selected University Hospital–Egypt(Hanan Saber, Amal F, Nawal E, Naglaa M, 2019)	*intervention is 12 - 15 minutes for 15 days for each patient.*		*arterial disease (PAD) and the post-test mean value 1.09 or normal perfusion in Right ABI. And then in Left- ABI pre-test to post-test mean value 0,93 to 1,08 or normal perfusion.*	
5	*Effectiveness Of Buerger Allen Exercise On Level Of Lower Extremity Perfusion Among Patient With Type2 Diabetes Mellitus.Saveetha Medical College And Hospital*(Towar Shilshi Lamkang, Dr. Aruna, S. and Dr. Mangala Gowri, P, 2017)	*30 patients in the intervention group with Buerger Allen Exercise, the intervention was given for 12-13 minutes twice a day for a duration of 5 (five days)*	30 *patients in the control group were treated with routine hospital treatment.*	*The result in the experimental group there was a significant difference between the pre-test mean value 0.68 with SD 0.14 and post-test mean value 0.84 with SD 0.11 and the control group there was no significant difference between the pre-test mean value 0.68 with SD 0.12 and post-test mean value 0.68 with SD 0.13*	Scopus SJR Q4
6	*Effectiveness of Buerger Allen Exercise to Improve the Lower Extremity Perfusion among Patients with Type 2 Diabetes Mellitus* (Jemcy John, A.Rathiga, 2015)	*30 participants in the intervention group with Buerger Allen exercise 2 times a day for 5 days*	*30 participants in the control group with Routine Management*	*The result in the experimental group there was a significant difference between the pre-test mean value 0.922 with SD 0.0562 and post-test mean value 0.980 with SD 0407 and the control group there was no significant difference between the pre-test mean value 0.8427 with SD 0.0714 and post-test mean value 0.8400 with SD 0.0675*	Scopus SJR Q3
7	Ankle Brachial Index Value in Patients with Type 2 Diabetes Mellitus After Doing Buerger Allen Exercise at the Nganjuk District Health Center (Supriyadi, Nurul Makiyah, Novita Kurnia Sari, 2018)	30 people in the treatment group were given the intervention 12 times in 15 days, 3 times a week, and 2 times every day at 08.00 and 16.00 WIB. for ± 3 minutes	30 people in the control group did not do physical exercise	The results of this study indicate a change in the value of the ankle-brachial index (ABI) in the intervention group, namely the pre-test of 0.84 mmHg or mild obstruction, increasing to normal in the post-test of 0.93.mmHg. while in the control group there was no increase in the ABI value, namely in the pre-test of 0.86 mmHg and post-test of 0.84 mmHg or still mild obstruction.	Google Scholar
8	The Effect of Lower Extremity Joint Movement Exercises on Ankle Brachial Index (ABI) Values in Type 2 DM Patients(Isni Hijriana,	35 people in the treatment group with a joint movement exercise intervention once a day, with 10	*Without control groups*	The results showed that the mean pre-test ABI value in the left extremity was 0.90 (SD=0.06). While on the right extremity the average was 0.89 (SD = 0.07). The ABI value in the post-test	Google Scholar

	Dewi Elizadiani Suza, Yesi Ariani, 2016)	repetitions of movement, for 4 weeks		lower extremity joint movement exercise showed that in the left extremity the average ABI value was 0.99 (SD = 0.04) and in the right extremity the average ABI value was 0.98 (SD = 0.05).	
9	The Effect of Buerger Allen Exercise on Ankle Brachial Index (ABI) in Diabetic Foot Ulcer Patients at RSU dr. Garut(Sandra Pebrianti, Suriadi, Yani S, 2017)	27 people in the treatment group with the intervention of Buerger Allen exercise performed 2 times a day for 5 days with a duration of 15 minutes, namely at 09.00 and 15.00	27 people in the control group with the intervention of Buerger Allen exercise for 3 minutes.	The results showed that in the Buerger Allen exercise intervention group there was a change in the value of the ankle-brachial index (ABI), namely the pre-test of 0.80 mmHg or mild obstruction, increasing to normal at the post-test of 1.1 mmHg. While in the control group there was no increase in the ABI value, namely in the pre-test and post-test of 0.80 mmHg or still mild obstruction.	Sinta 2 & Portal Garuda
10	Study to Assess the Effectiveness of Buerger Allen Exercise to Prevent Risk of Diabetic Foot by Improving Lower Extremity Perfusion among Clients With Type-2 Diabetes Mellitus in Selected Hospitals at Villupuram District, Tamilnadu. (Sathya, Karthi, 2019)	30 participants in the intervention group with Buerger Allen exercise. twice a day for 5 days with the interval of six hours	30 participant in the control group to follow the regular activities in the hospital	The findings of the study showed that in the experimental group the pre-test means the score was 0,71 or Moderately occluded blood vessels and the post-test mean score was 0.921 or Normal perfusion. And in the control group, the pre-test mean value is 0,720 and the post-test mean value is 0.734, there is Moderately occluded blood vessels	Scopus SJR Q4

Discussion

The intervention was in the form of Buerger Allen exercise in 10 journals, 7 journals had the same frequency in their implementation in the treatment group, namely given the intervention 2x/day (Donny, 2020; Satya, 2019; Towar,2017; Sandra, 2017; Jemcy, 2015; Supriyadi, 2018; El-Fattah *et al*., 2019). The administration of the Buerger Allen exercise intervention in 7 journals has the same frequency in its implementation but there are variations in the intervention. In this variation, five journals said that Buerger Allen exercise was given intervention twice a day in the morning and evening for 15-20 minutes in 5 consecutive days. (Donny,2020; Satya,2019; Towar, 2017; Sandra, 2017; Jemcy, 2015). One journal said Buerger Allen exercise was given intervention 2x/day for ± 3 minutes in 15 days (Supriyadi, 2018). One journal says Buerger Allen exercise is given intervention 2x/day for ± 12-15 minutes in 15 days (El-Fattah *et al*., 2019).

The intervention was in the form of a Buerger Allen exercise in 10 journals, 2 journals had the same frequency in their implementation in the treatment group, namely 1x/day intervention (Hijriana et al., 2016; Radhika et al., 2020). The administration of the Buerger Allen exercise

intervention in 2 journals has the same frequency in its implementation but there are variations in the intervention. In this variation, one journal said that the Buerger Allen exercise was given an intervention 1x/day for ± 15 minutes in 6 days (Salam & Laili, 2020). One journal said that the Buerger Allen exercise was given an intervention 1x/day for ± 10 minutes in 4 days (Hijriana et al., 2016). Giving intervention in the form of Buerger Allen exercise in 10 journals, there is 1 different journal in giving the intervention which is given 5x/day for 3-5 minutes in 4 consecutive days (Radhika *et al.,* 2020).

Buerger Allen exercise is a joint exercise or stretching in all directions to increase perfusion of blood flow to the lower extremities, especially the leg area (Turan, Lipsky & Bayraktar.,2015). The Buerger Allen exercise combines a muscle pump (dorsiflexion, plantar flexion) and postural changes in gravity (45o leg elevation, leg descent, and supine sleeping) (Isral, 2014; Chang *et al*., 2015; Sherwood L.,2016). Muscle pump in the form of dorsiflexion and plantarflexion by moving the skeletal muscles actively causing the muscles to compress and stimulate blood vessels (Yollanda et al.,2016). Dorsiflexion is the movement of moving the soles of the feet towards the body at the top while plantarflexion is moving the soles of the feet towards the bottom to stimulate the endothelium of blood vessels to secrete or release Nitric Oxide which plays a role in vasodilation of blood vessels(Isral *et al*, 2014). Nitric Oxide is produced through the conversion of the amino acid L-arginine to L-citrulline by the enzyme *NO-synthase* (NOS). Nitric Oxide stimulates *soluble guanylate cyclase* (SGC) which causes an increase in the cyclic synthesis of GMP from *guanosine triphosphate* (GTP). This cyclic increase in GMP will cause the smooth muscle of the blood vessels to relax. When smooth muscle cells relax, blood vessels will vasodilate so that blood flow to the periphery of the legs becomes smooth (Purnawarman & Nurkhalis, 2014).

45^{o} leg elevation is useful for slowing blood flow to the legs. Lowering the legs in a hanging position is useful for accelerating blood flow to the legs so that these changes facilitate lower extremity perfusion. The supine sleeping position is useful in balancing blood circulation so that it does not gather at one point (John & Rathiga, 2015). Positioning the legs elevated will cause emptying of blood flow in the veins in the lower legs. In addition, if the amount of blood flowing to the heart increases it will cause the walls of the heart chambers to stretch so that the muscles contract even more strongly, therefore all additional blood returning to the heart will be pumped back into circulation automatically. During the process of descent, the legs and feet hang down lower than the heart, the blood carried by the arteries will flow quickly from high to low pressure, namely from the heart to the lower legs, and will fill the flow in the blood vessels so that blood flows to the ends. leg or lower leg will increase. Changing gravity will affect the distribution of fluids in the body by helping alternately to empty and fill the blood column, which can improve blood transport through the blood vessels. After that, the supine position is a position that aligns the body, plays an important role in the balance of blood circulation. (Sherwood, 2016). Buerger Allen exercise that is done regularly can increase the vascularization of the lower extremities (Hijriana *et al.,* 2016)

The researcher's opinion is that the Buerger Allen exercise can be an effective, efficient, easy to learn exercise, and has a low risk. This is because the simple movements only involve 3 movements, namely the muscle pump (dorsiflexion, plantar flexion) and postural changes in gravity (45o leg elevation, leg descent, and supine sleeping). Buerger Allen exercise equipment is also easy to find every day, namely a bed, 2 pillows, and a blanket. Buerger Allen exercise should

be done twice a day in the morning and evening for 15-20 minutes in 5 consecutive days and repeated so that the vascularization of the feet is optimal.

The results of the ABI measurement in 10 journals, 8 research journals have similarities in changes in the *ankle-brachial index* (ABI) score, namely the category of mild obstruction before giving the intervention and after giving the intervention to the category of normal perfusion. (Salam & Laili, 2020*;* Donny Richard, Dewi Prabawati, 2020*;* El-Fattah et al., 2019*;* John & Rathiga, 2015*;* Supriyadi, 2018)*;* Hijriana *et al.,* 2016*;* Sandra, Suriadi, 2017*;* Sathya & Karthi, 2019). 2 other research journals show changes in the *ankle-brachial index* (ABI) score from the category of moderate obstruction before giving the intervention and after giving the intervention to the category of mild obstruction (Towar, Aruna, and Mangala, 2017*;* Radhika *et al.,* 2020)*.* However, all journals (10 journals) in the treatment group had something in common, namely that there was an increase in the ABI score or an improvement in the ABI score

The ankle-brachial index is a non-invasive examination to determine the decrease in perfusion of blood flow to the lower extremity area by measuring the ratio of brachial or arm systolic pressure to ankle or leg systolic pressure. (Janice L & Kerry, 2018). *Ankle-brachial index* (ABI) measurement can be done by dividing the systolic blood pressure at the ankle (ankle) with the highest systolic pressure in the arm (brachial). ABI measurement results can be interpreted in terms of normal perfusion ie 0.91-1.3 mmHg, mild obstruction ie 0.71-0.90 mmHg, moderate obstruction ie 0.41-0.70 mmHg and 0.40 mmHg severe obstruction occurs (Parkin, 2011). Increased ABI scores due to increased circulation of muscle microvascular blood flow, due to continuous and repeated exercise (Rosales-Velderrain, A., Padilla, M., Choe, C.H. & Hargens, 2013). This is associated with widening of the arteries (vasodilation), increased capillary permeability which allows glucose uptake by muscle cells (John, J., & Rathiga, 2015).

Researchers believe that most changes in ABI values occur in mild obstruction to normal perfusion due to physical exercise with Buerger Allen exercise which is carried out routinely and repeatedly so that it is effective in increasing lower extremity perfusion, especially in the feet of diabetic patients. DM patients who have an ABI value of 0.90 (mild ischemia) will be at risk of PAD (peripheral arterial disease) so the researcher believes that non-pharmacological interventions are needed, such as physical exercise, especially Buerger Allen exercise. ABI value 0.70 (moderate ischemia) causes atherosclerosis in blood vessels and is at risk of developing diabetic foot ulcers, so the researcher believes that the need for physical and pharmacological exercise intervention is important to reduce atherosclerosis in blood vessels. ABI value 0.40 (severe ischemic) then experience gangrene, necrotic, ulcers, and risk of amputation, so the researchers believe that the importance of multi-disciplinary foot care, pharmacological and non-pharmacological interventions.

The results of the ten journals revealed that Buerger Allen exercise has a significant effect on the value of the *ankle-brachial index* (ABI) in patients with type 2 diabetes mellitus(Donny, 2020; Satya, 2019; Towar,2017; Sandra, 2017; Jemcy, 2015; Supriyadi, 2018; El-Fattah *et al*., 2019; Hijriana et al., 2016; Radhika et al., 2020; Hijriana et al., 2016). Buerger Allen exercise is effective in improving lower limb perfusion and reducing pain in patients with type 2 diabetes. veins and fill the column of arteries alternately in the legs, ultimately increasing blood transport through leg exercises (Buerger Allen exercise)(Bottomley, 2007 *cit* Jannaim *et al*., 2018).

The research of Turan et al (2015) also supports that physical exercise (Buerger Allen exercise) that uses joint motion or stretching in all directions can increase blood supply to the

extremities so that it has the potential for the formation of new vascular structures, increasing foot sensitivity, especially in diabetic foot ulcers and diabetic foot ulcers. accelerate wound healing (Turan,Lipsky & Bayraktar, 2015). The results of Jannaim's study also stated that the administration of the Buerger Allen exercise intervention could improve the circulation of the lower extremities with an impaired circulation of venous ulcers and arteriovenous ulcers in diabetic foot ulcer patients. (Jannaim *et al*., 2018).

Buerger Allen exercise is one of the variations of active movement in the lower extremity and plantar areas by applying the force of gravity so that each stage of the movement must be done regularly. This exercise helps the need for oxygen and nutrients into the arteries and veins, strengthens, and maximizes the work of small muscles, prevents foot deformities, and improves circulation in the legs. Buerger Allen exercise helps the healing process of diabetic foot ulcers and increases insulin production which is used to transport glucose to cells. This helps lower blood glucose in diabetic patients(Chang et al., 2015).

Buerger Allen exercise can increase perfusion of blood flow to the lower extremity area, especially in the legs by stimulating the endothelium to release nitric oxide to cause vasodilation of blood vessels and alternately stimulating the filling and emptying of the blood column thereby increasing blood transport in the legs (Israel.,2014; Sherwood L.,2016).

Researchers believe that Buerger Allen exercise can be done by DM patients to increase the adequacy of lower extremity perfusion (blood flow) or increase peripheral vascularization of the legs. This is evidenced by all journals stating an increase in the ABI value. The movements are simple and easy to do by combining simple muscle pump movements (dorsiflexion, plantar flexion) and postural changes in gravity (45o leg elevation, leg descent, and supine sleeping) to increase peripheral perfusion (blood flow) optimally in diabetic feet.

Conclusion

Based on the results of the study using a literature review research design, conclusions can be drawn; Buerger Allen exercise should be carried out in diabetes mellitus type 2patients as much as 2x/day for 15 minutes on 5 consecutive days. The value of the *Ankle Brachial Index* (ABI) in patients with diabetes mellitus type 2 all experienced an increase in scores. Buerger Allen exercise has a significant effect on increasing the *ankle-brachial index* (ABI) score in diabetes mellitus type 2 patients

Ethics approval and consent to participate

This study is a literature review study so no ethical approval was carried out.

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References

American Diabetes Association. (2015). Diagnosis and classification of diabetes mellitus. *Diabetes Care*, *33*(SUPPL. 1), S62–S69. https://doi.org/https://dx.doi.org/10.2337%2Fdc10-S062

American Diabetes Association. (2016). Standards of Medical Care in Diabetes. *The Journal of Clinical & Applied Research & Education Diabetes Care*, *39*(1).

Black, J. M., & Hawks, J. H. (2014). *Keperawatan Medikal Bedah: Manajemen Klinis untuk Hasil yang Diharapkan. Alih Bahasa* (Edisi 8.). Salemba Medika.

Bottomley, J. M. (2007). *The Insensitive Foot in U.K. Geriatric Rehabilitation Manual* (2nd Ed. Ch). Churchill Living-stone Elsevier.

Chang, C.-F., Chang, C.-C., & Chen, M.-Y. (2015). Effect of Buerger's Exercises on Improving Peripheral Circulation: A Systematic Review. *Open Journal of Nursing*, *05*(02), 120–128. https://doi.org/10.4236/ojn.2015.52014

Donny Richard Mataputun, Dewi Prabawati, D. H. T. (2020). Efektivitas Buerger Allen exercise dibandingkan dengan Rendam Kaki Air Hangat terhadap Nilai Ankle Brachial Index dan Gula Darah pada Pasien Diabetes Mellitus. *Media Publikasi Promosi Kesehatan Indonesia; The Indonesian Journal of Health Promotion*, *2*(2), 165. https://doi.org/10.1088/1758-5090/abb063

Janice L Hinkle (2018). *Brunner & Suddarth's Textbook of Medical-Surgical Nursing*.

El-Fattah, H. S. A., Garas, A. F., Hanna, N. E., & Elsayed, N. M. (2019). Effect of Buerger exercises on improving peripheral circulation of the lower extremities among patients with type 2 diabetes mellitus at selected university hospital Egypt. *Indian Journal of Public Health Research and Development*, *10*(6), 692–697. https://doi.org/10.5958/0976-5506.2019.01358.5

Embuai, S. (2019). Efektifitas Diabetes Self Care Activity Terhadap Status Vaskuler Pasien Diabetes Melitus. *Moluccas Health Journal*, *1*(April), 1–9. https://ojs.ukim.ac.id/index.php/mhj/article/view/36/93

Hassan, S & Mehani, M. (2012). Comparison Between Two Vascular Rehabilitation Training Program for Patient with Intermittent Claudication as a Result of Diabetic Atherosclerosis. *International Journal Faculty of Physical Therapy*, *1*(17), 7–16.

Hawk, B. (2014). *Keperawatan Medikal Bedah, Manajemen klinik untuk Hasil yang Diharapkan* (8th ed.). EGC.

Hijriana, I., Suza, D. E., & Ariani, Y. (2016). Pengaruh Latihan Pergerakan Sendi Ekstremitas Bawah Terhadap Nilai Ankle Brachial Index (Abi) Pada Pasien Dm Tipe 2. *Idea Nursing Journal*, *7*(2), 32–39.

Ibrahim, I., Sofiani, Y., & Irawati, D. (2020). Perbandingan Buerger Allen Exercise Dengan Foot Spa Diabetic Terhadap Nilai Ankle Brachial Index Pada Pasien Diabetes Melitus Tipe Ii. *Journal of Islamic Nursing*, *5*(2), 86. https://doi.org/10.24252/join.v5i1.13673

International Diabetes Federation. (2019). *IDF Diabetes Atlas 9th edition 2019*.

Isral, Ghozi Natul, Afriwardi, Afriwardi, Sulastri, D. (2014). Hubungan Aktivitas Fisik dengan Kadar Nitric Oxide (NO) Plasma pada Masyarakat di Kota Padang. *Jurnal Kesehatan Andalas*, *3*(2), 173–177. http://jurnal.fk.unand.ac.id/index.php/jka/article/view/77/72

Jannaim, J., Dharmajaya, R., & Asrizal, A. (2018). Pengaruh Buerger Allen Exercise Terhadap Sirkulasi Ektremitas Bawah Pada Pasien Luka Kaki Diabetik. *Jurnal Keperawatan Indonesia*, *21*(2), 101–108. https://doi.org/10.7454/jki.v21i2.652

John, J., & Rathiga, A. (2015). Effectiveness of Buerger Allen exercises to improve the lower extremity perfusion among patients with type 2 diabetes mellitus. *International Journal of Current Research and Academic Review*, *3*(4), 252–263. https://doi.org/10.3102/0034654310362998.

Ms. Towar Shilshi Lamkang, Dr. Aruna, S. and Dr. Mangala Gowri, P. (2017). Effectiveness of Buergerallen Exercise on Level of Lower Extremity Perfusion Among Patient With Type2 Diabetes Mellitus. *International Journal Of Development Research Saveetha Medical*, *7*(October), 14723–14726.

Parkin, T. (2011). *Activ Ankle Brachial Index (ABI) pada DM Tipe II*. Poltekkes Kemenkes Semarang.

Purnawarman, A., & Nurkhalis, N. (2014). Pengaruh Latihan Fisik terhadap Fungsi Endotel. *Jurnal Kedokteran Universitas Syiah Kuala*, *14*(2).

Radhika, J., Poomalai, G., Nalini, S. J., & Revathi, R. (2020). Effectiveness of Buerger-Allen exercise on lower extremity perfusion and peripheral neuropathy symptoms among patients with diabetes mellitus. *Iranian Journal of Nursing and Midwifery Research*, *25*(4), 291–295. https://doi.org/10.4103/ijnmr.IJNMR_63_19

Rahmaningsih, B. Y., Hidayat, N., & Mahmuda, I. N. N. (2016). *Hubungan Antara Nilai Ankle Brachial Index Dengan Kejadian Diabetic Foot Ulcer Pada Penderita Diabetes Melitus Tipe 2 Di Rsud Dr. Moewardi Surakarta*. 19.

Rikesdas Jatim. (2018). *Hasil utama riskesdas 2018 provinsi jawa timur*. 1–82.

Riskesdas. (2018). *HASIL UTAMA RISKESDAS 2018*.

Rosales-Velderrain, A., Padilla, M., Choe, C.H., &, & Hargens, A. R. (2013). Increased microvascular flow and foot sensation with mild continuous external compression. *Physiological Reports*, *1*(7), e0057001.

Salam, A. Y., & Laili, N. (2020). Efek Buerger Allen Exercise terhadap Perubahan Nilai ABI (Ankle Brachial Index) Pasien Diabetes Tipe II. *JI-KES (Jurnal Ilmu Kesehatan)*, *3*(2), 64–70. https://doi.org/10.33006/ji-kes.v3i2.149

Sandra Pebrianti, Suriadi, Y. S. (2017). Pengaruh Buerger Allen Exercise Terhadap Ankle Brachial Index (ABI) Pada Pasien Ulkus Kaki Diabetik Di RSU dr. Slamet Garut. *Keperawatan Universitas Muhammadiyah Jakarta*.

Sathya, K., & Karthi, R. (2019). A Study to Assess the Effectiveness of Buerger Allen Exercise to Prevent Risk of Diabetic Foot by Improving Lower Extremity Perfusion among Clients With Type-2 Diabetes Mellitus in Selected Hospitals at Villupuram District, Tamilnadu. *International Journal of Research and Review*, *6*(March), 83–88.

Sherwood, L. (2016). *Fisiologi Manusia: Dari Sel ke Sistem* (8th ed.). Buku Kedokteran EGC.

Supriyadi. (2018). Pengaruh Buerger Allen Exercise Terhadap Ankle Brachial Index dan Kadar Gula Darah Sewaktu pada Penderita Diabetes Melitus Tipe 2 di Puskesmas Wilayah Kecamatan Nganjuk. *Research Repository UMY*.

Turan, Y., Ertugrul, B.M., Lipsky, B. A., & Bayraktar, K. (2015). Does Physical Therapy and Rehabilitation Improve Outcome for Diabetic Foot Ulcers. *World J Experimental Med*, *5*(2), 130–139.

wahyuni. (2013). *Ankle Brachial Index Sesudah Senam Kaki Diabetus Pada Penderita Diabetes Militus Tipe 2*. *2*(4), 143–151.

WHO. (2016). *Global Report On Diabetes. France: World Health Organization*. Diakses pada Februari,2021.