MEDIA KEPERAWATAN INDONESIA
Jl. Kedungmundu Raya No. 18 Semarang Gedung NRC Universitas Muhammadiyah Semarang Phone: 02476740287, Fax: 02476740287 Email: mki@unimus.ac.id

Review article

Buerger Allen Exercise In Type 2 Diabetes Mellitus Patients: A Literature Review

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Article Info

Article History:
Submitted: May 20th, 2023
Accepted: Nov 7th, 2024
Published: Nov 9th, 2024

Keywords:
Buerger Allen exercise; Peripheral perfusion; Type 2 diabetes mellitus

Abstract

An effort that might be made to prevent complications of Diabetes Mellitus (DM) is by increasing peripheral blood circulation through the Buerger Allen exercise (BAE). Previous studies recommend reviewing the standard procedure of the BAE. Research related to the review of the effectiveness of BAE application on type 2 DM, which is summarized from various studies in latest original research is still lacking. The aim of this study is to describe the standard form of the Buerger Allen implementation that has been evaluated its effectiveness in patients with type 2 DM patients with complications. This literature review was performed with PICO keywords in 4 databases, including PubMed, Springer Link, Wiley Online Library, and Google Scholar in 2011-2022. We have concluded that the standard procedure for implementing the BAE consists of 5 stages and three main steps for each cycle. The steps are supine position (pre-exercise), elevation, Hanging, flexion-extension, and horizontal (post-exercise) steps. Each session consists of at least 3 to 6 cycles with approximately 30 minutes. Fifteen articles analyzed showed significant changes in lower peripheral perfusion of patients with type 2 DM. BAE is a simple non-pharmacological intervention that is considered an effective method for managing lower peripheral perfusion.

INTRODUCTION

Diabetes Mellitus (DM) is one of the main types of Non-Communicable Disease (NCD) included in the Sustainable Development Goals (SDGs), namely by reducing the early death rate of NCD by 30% in 2030 [1,2]. The target of SDGs is in line with the high prevalence of DM, with its status as one of the leading causes of death in the world. The number of cases and the prevalence of diabetes have continued to increase over the last few decades [3]. International Diabetes Federation (2021) mentions that around 637 million adults worldwide have diabetes, and over 6.7 million adults will die from diabetes-related causes in 2021[4].

DM has various complications that might affect the quality of life of patients. Complications that occur include complications in the skin (skin infections), a complication in the eye (glaucoma, cataracts, neuropathy, complications in the

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Media Keperawatan Indonesia, Vol 7 No 2, Nov 2024
e-ISSN: 2615-1669
ISSN: 2722-2802
DOI: 10.26714/mki.7.2.2024.175-185

legs (foot ulcers), ketoacidosis, nephropathy, high blood pressure, and stroke. These complications can be divided into complications that are acute and chronic. Neuropathy is a form of chronic complication that often occurs in DM patients [5],[6]. The prevalence of peripheral neuropathy in diabetic patients reaches 72.2% and gets worse with increasing age [7].

The high complications of neuropathy in people with DM need to be accompanied by efforts to prevent the adverse effects of neuropathy. An effort often done is by doing diabetic foot exercises to regulate peripheral blood circulation [8]. Another effort that might be done to improve peripheral blood circulation is by doing the Buerger Allen exercise [9]. Another study also suggested that the Buerger Allen exercise is more effective in increasing the value of the ankle-brachial index than diabetic foot exercise [10].

A systematic review article compiled by C. Chang et al., (2015) provides further research recommendations to examine the standard procedure for the Buerger Allen exercise [9]. Moreover, based on researchers' observations, the application of the Buerger Allen exercise is still quite diverse in terms of its application. Thus, it has not shown the similarity or a standard used as a guide for implementation. In addition, research related to the review of the effectiveness of the application of BAE on type 2 diabetes mellitus which is summarized from various studies is still lacking, especially those that summarize the latest original research.

The literature review forms the basis for high-quality medical education research and helps maximize relevance, originality, generalizability and impact. Literature reviews provide context, inform methodologies, maximize innovation, avoid duplication of research, and ensure that professional standards are met [11]. Hence, to overcome this, the authors conducted a literature review to offer readers an overview or description of the standard form of the implementation of the Buerger Allen exercise that has been evaluated its effectiveness in patients with type 2 DM patients with complications. This research can add information related to evidence-based practice from BAE to be widely applied and taught as non-pharmacological therapy in patients with DM.

METHOD

Data Sources

Literature search was performed in four data-based settings namely PubMed, Springer Link, Wiley Online Library, and Google Scholar. Structured research questions using the PICO electronic method (patient, intervention, comparison, and outcome) [12]. The literature search was conducted by identifying relevant articles using specific keywords such as: P: Diabetic Type II OR Diabetic Foot Ulcer, I: Buerger Allen Exercise OR Buerger Exercise, C: none, O: Peripheral circulation.

Data Selection

The articles were selected based on inclusion and exclusion criteria. Article inclusion criteria include (1) focusing on the intervention of BAE, (2) written in English, (3) published from 2011-2022, and (4) research articles conducted on type 2 DM patients with or without complication. The article exclusion criteria are (1) Double publication, (2) No full text, and (3) Not a result of research (review), the publication is in the form of a thesis. Then to assess the eligibility of articles that have met the inclusion criteria, then filtered using The Critical Appraisal Skills Program (CASP) tools namely The Joanna Briggs Institute (JBI) [13].

Research flow in Figure 1 shows a total of 146 articles were identified from four database searches, namely PubMed, Springer Link, Wiley Online Library, and

Google Scholar which have been filtered with the limitation of publication in the last 12 years (2011-2022). However, after identifying the articles, Out of the 146 articles, 94 of them were found irrelevant. Thus, the remaining 52 articles included in this study for having similarities with the topic of this study. Therefore, there are only 15 articles that met the inclusion criteria.

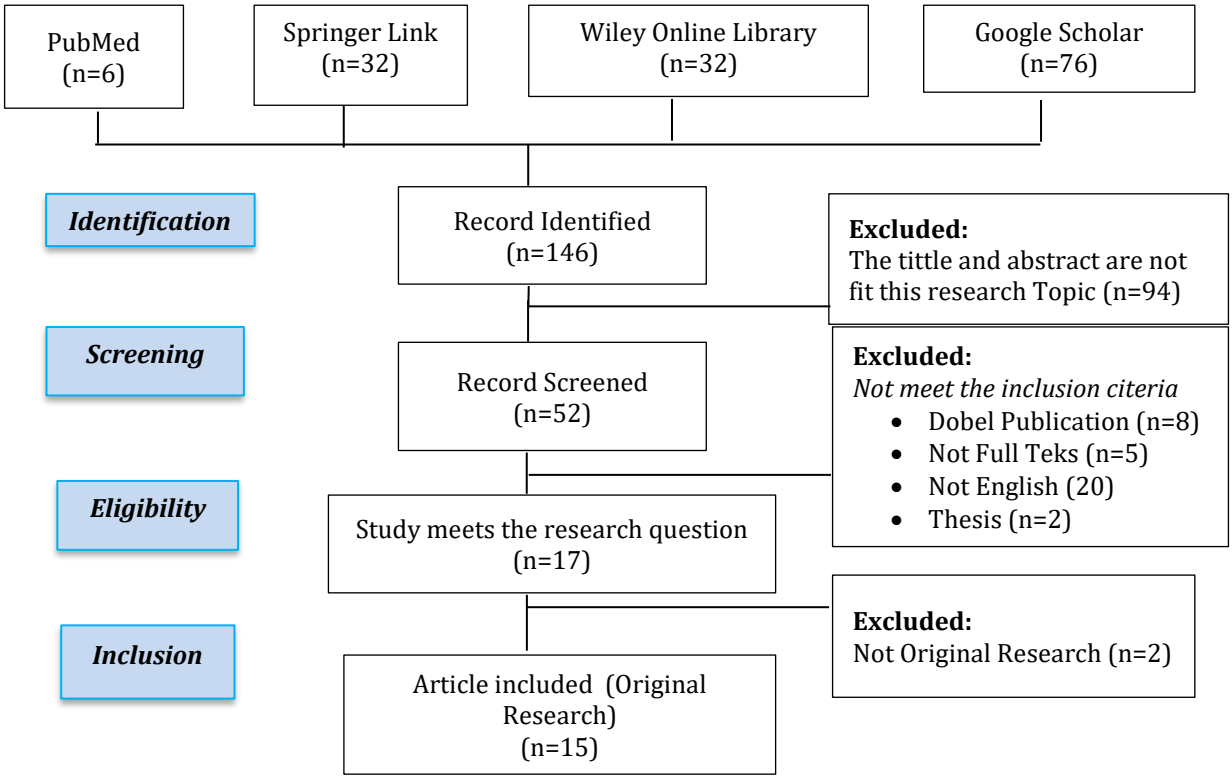

Figure 1
Research Flow

RESULTS

Based on 15 articles selected, there were 3 designs used. True experimental studies was conducted in India (n=2). Quasi-experimental studies (n = 11) were each conducted in India (n = 6), Taiwan (n=2), Egypt (n=2), and Indonesia (n=1). Cohort study (n = 2) each was conducted in Taiwan (n=2). The article (15 articles) was conducted an eligibility assessment and evidenced-based using critical appraisal (critical assessment).

Buerger Allen Exercise Steps

Out of 15 have been analyzed, only 9 articles mention Standard Operating Procedure (SOP) of BAE. Therefore, only 9 articles were included for analysis based on standard procedures. One article describes 6 steps, 2 articles describe 5 steps, and 6 articles describe 3 steps. The difference between the various articles is in the presence or absence of the 5 stages of exercise that must be passed, but the core of the exercise for all articles shows the same thing, which consists of 3 steps, namely

elevating the legs, hanging the legs on the side of the bed, and the horizontal position (supination in bed). Another article adds 1 stage each in pre and post exercise, namely starting with a supine position and ending with a straight position on the bed using a blanket. The following table describes the step of implementation of BAE from various articles.

Effectiveness of Buerger Allen Exercise

The 15 articles analyzed showed significant changes in lower peripheral perfusion of patients with type 2 DM. The majority of studies used the ABI score as an indicator to assess lower peripheral perfusion with the highest score increasing up to +0.4. Other indicators used include Skin Perfussion Pressure (SPPs), total hemoglobin, clinical features of peripheral vascular disease, and assessment scale of lower extremity perfusion. The following table describes the value of effectiveness BAE (significant changes).

Table 1
Buerger Allen Exercise Steps from Several Articles

Researcher	Step 1	Step2	Step3	Step4	Step5	Step 6	Description of the Intervention
Chang (2016) Taiwan	Feet elevation with an angle of 45^{o} (until the skins turn pale)	The patient does sitting position and legs hanging under the body. Then do flexion/extension and pronation/ supination for 3 minutes or until redness appears.	The patient lies with both feet resting on the bed with a warm blanket until 5 minutes.	None	None	None	Duration: ± 11 minutes (1 cycle). Implementation: 3 times a day. Evaluation: immediately after BAE (post exercise real time).
Kumari (2019) India	Feet elevation with an angle of 45° using a footboard.	Feet hanging at 90°.	The horizontal leg position forms an angle of 180°.	None	None	None	Duration: 7-11 minutes (1 cycle) and 1 session:5cycle. Implementation: 2 times a day. Evaluation: On fifth day.
Chen (2017) Taiwan	Supine position initially (pre-exercise).	Feet elevation 45-60° using pillow support for 3 minutes.	The patient sits on the edge (side) of the bed with his feet below.	Next, do dorsal- and plantar-flexion together with inward and outward movements for 3 minutes.	The patient lies with a blanket covering his legs for 3 minutes (post-exercise step).	None	Duration: ±10 minutes . Implementation: None. Evaluation: Real time (during exercise).
Chang (2015) Taiwan	Supine position with feet elevation at 45°–60° supported by	The patient sits on the bed or chair with feet hanging down, and do dorsiflexion and plantar-flexion positions, moves	The patient lies for 3 minutes.	None	None	None	Duration: 30 minutes (1 cycle) and 1 session:3-6 cycle. Implementation: 3 times a day.

Researcher	Step 1	Step2	Step3	Step4	Step5	Step 6	Description of the Intervention
	pillows, tables, or walls for 3 minutes.	feet in and out, then flexes and extends for 3 minutes.					Evaluation: 1 year (cohort).
Hassan (2020) Mesir	Feet elevation at an angle of 45 to 90 degrees (until pale for 2-3 minutes).	The feet and legs are then lowered at the other lower body level until redness appears for 3-5 minutes.	Feet flat on the bed for 3-5 minutes.	None	None	None	Duration: ± 13 minutes. Implementation: 2 times a day. Evaluation: On sixth weeks.
Sasi (2020) India	Feet elevation 45 degrees (until pale or at most 2 minutes).	The patient sits on the bed with the feet hanging down. Next, do exercises include dorsiflex, plantar flex, then inward and outward movement, toe flexion and extension for 2 minutes.	The patient lies (supine) with legs closed with warm blanket (5 minutes).	None	None	None	Duration: 12-13 minutes. Implementation: None. Evaluation: On third day
Lin (2018) Taiwan	Supine position	Feet elevation at 45° –60° supported by the object for 3 minutes.	The patient sits end of the bed with the feet hanging.	Repeated leg flexion/ extension and then pronation/ supination for 3 minutes.	The patient lies and rest the feet in a warm blanket for 5 minutes.	None	Duration: ±11 minutes. Implementation: 3 times a day. Evaluation: On eighth weeks.
Thakur & Sharma (2019) India	Feet elevation 45-90 degrees (until pale or at most 2 minutes).	Rest for 1 min	Dependency; The feet and legs are then lowered at the other lower body level until redness appears. Next, move the finger aout 2 minutes.	Rest for 1 min	The legs are placed horizontal position in the bed. Put the towel under the knees andn apply pressure on the towel for 2 minutes.	Rest for 1 min	Duration: 20 minutes. Implementation: 2 times a day. Evaluation: On third day.
El-Fattah (2019) Mesir	Feet elevation 45-90 degrees (until pale).	Dependency; The feet and legs are then lowered at the other lower body level until redness appears, next do flexion, extension, and circumduction.	The lower extremities are placed horizontal position in the bed for a few minutes.	None	None	None	Duration: 12-15 minutes. Implementation: 2 or 3 times a day. Evaluation: after fifteenth day.

Table 3
Effectiveness of Buerger Allen Exercise.

No	Researcher	Item Outcomes	Pre Intervention	Post Intervention	Improvement	P Value
1.	Chang (2016) Taiwan	Skin Perfussion Pressure (SPPs)	58.3	70.0	+11.7	<0.01
2.	Kumari (2019) India	ABI	0.84 (R) 0.83 (L)	0.95 (R) 0.94 (L)	+0.11 +0.11	0.001*
3.	Satyha & Karthi (2019) India	ABI	0.710	0.921	+0.211	<0.05
4.	Chen (2017) Taiwan	Dorsal Blood Circulation: HbT	121.03	123.67	+2.64	0.007
5.	Mellisha (2016) India	Lower Extremity Perfussion (assessment scale)	44.50	52.00	+7.5	0.001*
6.	Chang (2015) Taiwan	ABI	0.6 (R) 0.5 (L)	0.9 (R) 0.9 (L)	+0.3 +0.4	<0.01 <0.01
7.	Hassan (2020) Mesir	Clinical Features of Peripheral Vascular Disease	20% (Normal)	58% (Normal)	+38%	<0.01*
8.	Sasi (2020) India	ABPI	0.07 (Day 1)**	0.19 (Day 3)**	+0.12	0.001
9.	Radhika (2020) India	ABI	0.73 (R) 0.79 (L)	0.83 (R) 0.84 (L)	+0.1 +0.05	<0.001 <0.001
10.	Lin (2018) Taiwan	Haemoglobin Total Concentration in Tissue	0.130 (Stage 1) 0.132 (Stage 2)	0.159 (Stage 1) 0.162 (Stage 2)	+0.029 +0.03	0.023 0.02
11.	Lamkang (2017b) India	ABPI	0.68	0.84	+0.16	0.0001
12.	Thakur & Sharma (2019) India	ABI	2.5	1.4	1.1	<0.001
13.	Bhuvaneshwari & Tamilselvi (2018) India	ABI	0.7	0.9	+0.2	<0.05
14.	El-Fattah (2019) Mesir	ABI	0.885 (R) 0.937 (L)	1.097 (R) 1.086 (L)	+0.212 +0.149	0.001
15.	Mayangsari & Lutfi (2021) Indonesia	ABI	0.737	0.913	+0.176	<0.05

Description:
*Comparison of the effectiveness of the control and intervention groups.
**Mean and standard deviation of Ankle brachial pressure index among control and experimental group.

DISCUSSIONS

The 15 articles analyzed showed significant changes in lower peripheral perfusion of patients with type 2 DM. The majority of studies used the ABI score as an indicator to assess lower peripheral perfusion with the highest score increasing up to +0.4. Other indicators used include Skin Perfusion Pressure (SPPs), total hemoglobin, clinical features of peripheral vascular disease, and assessment scale of lower extremity perfusion. The following table describes the value of effectiveness BAE (significant changes).

All the articles that have been analyzed show that the application of BAE effective in increasing peripheral perfusion of the lower limb in patients with type 2 DM or with DFU complications. The majority of research articles employed a quasi-experimental research design. Quasi-experimental

research design does not have random assignments but instead lead to conditions (treatment or intervention vs. nontreatment or intervention, or both) by self-selection (participants choose to care for themselves) or selection by the administrator, or by both [29]. The quasi-experiment method is often seen as the second-best design option when the true experiment method is not feasible [30].

The results of the literature study found the number of samples used varied from 14, 30, 60, 66, to 100 people, and majority divided into two groups, intervention and control groups, . However, there was a study that used one group only (intervention only). The average number of samples often used was 60 samples divided into two groups. According to Faber & Fonseca (2014), 60 subjects (30 patients in each group) are needed to ensure sufficient power to be able to estimate the results of statistical analysis for the overall population of the target study [31].

The analysis of the characteristics of respondents most frequently contained in the article is that the characteristics of type 2 DM patients who have the risk of developing DFU in this case experience peripheral problems in the lower extremities. Study shows that DFU is caused by inflammation and internal trauma resulting from neuropathy (35%), PAD (15%), or both PAD and neuropathy (50%) [32].

We further determine the standard implementation procedure as the essence of several articles that have been reviewed. Standard operational procedures are standard procedures (based on evidence-based) consisting of steps that must be passed to complete a particular work process [33]. The standard implementation procedures of Buerger Allen exercise are as follows (based on 15 articles were analyzed). Patient Preparation: (1) Criteria for type 2 DM patient (prevention of complications in the lower extremities); (2)Criteria for type 2 DM patients with complications, specifically those who have tissue perfusion problems in the lower extremities as well as those who have DFU (who can still tolerate exercise). Tool preparation: footrests: pillows/ tables/ walls and blanket.

Stage: Pre-exercise: The patient starts in the supine/lying position (initial preparation). Step 1: Elevation, the patient legs/lower extremities are elevated to an angle at 45–60° (or 90°, if possible) supported by the object (pillow/table/wall) for 3 minutes or until the skin looks pale. Step 2: Hanging, the patient sits on the side of the bed/chair in a relaxed position with legs rested and hung at an angle of 90°. Step 3: Flexion-Extension, leg flexion extensions and pronation-supination were performed repeatedly for 3-5 minutes or until the skin looks reddish. Post-exercise: Horizontal, the patient lies on his back with a blanket (using a warm blanket if possible) covering both legs for 3-5 minutes. Precautions: if at any time the patient feels discomfort (e.g. pale), the exercise should be stopped or there is a need to change the position as soon as possible. The length of time for each position can vary with the patient's tolerance and the speed of skin discoloration.

Criteria for patients who can be given BAE treatment were dominated by criteria for type 2 DM patients (without injury) [9,19,22,24,28,34–36]. Other criteria may also be given to patients with DFU (Diabetic Foot Ulcer) [14,16,20], or ABI score < 0.9 [9,19,22]. The duration of exercise given for one cycle of BAE ranges from 10 minutes to 13 minutes with each session consisting of 3-6 cycles [9,36]. The recommended duration for each session is 30 minutes [17].

The recommended frequency of exercise is twice a day or 3 times a day. Exercising twice a day can be divided into 6-hour to 12-hour intervals [18,23] . Meanwhile, exercise 3 times a day is divided into 4-hour intervals [24]. As for the time of effectiveness

assessment also varies. The increase in peripheral tissue perfusion in real-time extremities directly during exercise can be assessed using near-infrared spectroscopy (NIRS) [16], proven to be effective. Several other studies predominantly assessed changes in the 5th day after [23,24,35], and the longest was done for a 1-year assessment (cohort study) [17]. All of them show good effectiveness in enhancing limb perfusion.

The measuring instrument for evaluating the effectiveness of the Buerger Allen exercise also varied. However, it was dominated by measuring the value of the ankle-brachial index (ABI) using Doppler and blood pressure cuff [9,19,21–23,25,27,28,35,36]. ABI is a test that can be applied in clinical applications to assess vascular function in a patients' limb. ABI examination can assess the level of obstruction in the arteries of the lower limb [37]. Other measuring instruments used were assessing capillary refilling time (CRT) [15], hemoglobin total [20], foot assessment instruments [24], and checklist for checking for symptoms of PVD [18].

BAE have shown good effects in improving lower peripheral tissue perfusion. BAE is a simple non-pharmacological intervention that is considered an effective method for the management of lower limb perfusion. BAE has a significant impact on ABI values [38]. The results of this study are similar to previous studies that Buerger Allen exercises make ABI in patients with diabetes mellitus normal. Ankle movements can increase muscle strength and ankle joints can increase spasm of the small muscles of the calf veins, causing the pump to rise back to the heart of the veins. Contractions occur in small areas of diabetes muscles can increase the amount of oxygenated blood and nutrients in the leg circulation [39].

BAE is a simple exercise that is easy to do and does not require difficult and expensive equipment. This exercise can be done anytime and can be done independently by the patient. This exercise is an independent nursing intervention that can be applied in health services, especially in health centers and hospitals.

CONCLUSION

This literature review concludes that BAE is a simple non-pharmacological intervention that is considered an effective method for the management of lower limb perfusion. BAE is effective in increasing peripheral perfusion of the lower extremities in type 2 DM patients as well as complications of DFU. This review in the form of the standard procedure of the BAE can be a reference guide for practitioners that can be applied in health services, especially in health centers and hospitals. The standard procedure for implementing the BAE has 5 stage and 3 main steps, namely supine position (pre-exercise), step 1: elevation, step2: hanging, step 3: flexion-extension, and horizontal (post-exercise). Each session consists of at least 3-6 cycles with a duration of approximately 30 minutes. This research uses a literature review method that is still basic. In addition, references related to the Buerger Allen exercise are still lacking, especially in randomized control trials. Future research can develop a method with a systematic review.

ACKNOWLEDGEMENT

We especially acknowledge the invaluable insights and scholarly works of previous researchers in the fields of diabetes management and rehabilitation, whose contributions have greatly informed this study. Additionally, we are grateful for the support of our institution, whose resources and encouragement made this work possible.

BIBLIOGRAPHY

[1] United Nations. UN health agency calls for global action to halt rise in and improve care for people with diabetes 2016. https://www.un.org/sustainabledevelopme

nt/blog/2016/04/wolrdhealthday2016/ (accessed October 10, 2021).

[2] WHO. Noncommunicable diseases. Newsroom 2021. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases (accessed October 10, 2021).

[3] WHO. Diabetes. Health Topics 2021. https://www.who.int/health-topics/diabetes#tab=tab_1 (accessed October 10, 2021).

[4] IDF. IDF Diabetes Atlas 10th Edition. 2021.

[5] IDF. Diabetes Complications. About Diabetes 2020. https://www.idf.org/aboutdiabetes/complications.html (accessed October 10, 2021).

[6] Goyal R, Jialal I. Diabetes Mellitus Type 2. Statpearls 2021. https://www.statpearls.com/ArticleLibrary/viewarticle/36052#ref_32090126 (accessed October 10, 2021).

[7] Amour AA, Chamba N, Kayandabila J, Lyaruu IA, Marieke D, Shao ER, et al. Prevalence , Patterns , and Factors Associated with Peripheral Neuropathies among Diabetic Patients at Tertiary Hospital in the Kilimanjaro Region : Descriptive Cross-Sectional Study from North-Eastern Tanzania. Int J Endocrinol 2019;2019. https://doi.org/10.1155/2019/5404781.

[8] Katuuk ME, Mulyadi. Pengaruh senam kaki diabetes terhadap nilai ankle brachial index pada pasien diabetes mellitus tipe II Rumah Sakit Pacaran Kasih GMIM Manado. Jurnal Keperawatan 2017;5. https://doi.org/10.35790/jkp.v5i1.25150.

[9] Chang C, Chang C, Chen M. Effect of Buerger ' s Exercises on Improving Peripheral Circulation : A Systematic Review. Open J Nurs 2015;5:120–8. https://doi.org/10.4236/ojn.2015.52014.

[10] Sari A, Wardy A, Sofiani Y. The Comparison Effectiveness of Buerger Allen Exercise and Foot Gymnastics on ABI Value in Type II DM Patients. Journal of Telenursing 2019;1:1–16. https://doi.org/10.31539/joting.v1i1.492.

[11] Maggio LA, Sewell JL, Artino AR. The Literature Review: A Foundation for High-Quality Medical Education Research. Journal of Gradute Medical Education 2016;8:297–303. https://doi.org/10.4300/JGME-D-16-00175.1.

[12] Eriksen MB, Frandsen TF. The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. Journal of the Medical Library Association 2018;106. https://doi.org/10.5195/jmla.2018.345.

[13] Joanna Briggs Institute. Critical Appraisal Tools 2020. https://joannabriggs.org/ebp/critical_appraisal_tools.

[14] Chang CC, Chen MY, Shen JH, Lin Y Bin, Hsu WW, Lin BS. A quantitative real-time assessment of Buerger exercise on dorsal foot peripheral skin circulation in patients with diabetes foot. Medicine (United States) 2016;95:1–5. https://doi.org/10.1097/MD.0000000000005334.

[15] Kumari A, Rai K, Kumari V, Sarin J. A Study to Assess the Effectiveness of Buerger Allen Exercise on Foot Perfusion among Patients with Diabetes Mellitus Admitted in Selected Hospital of Ambala, Haryana. Int J Health Sci Res 2019;9.

[16] Chen ML, Lin BS, Su CW, Lin Y Bin, Chen MY, Shen JH, et al. The application of wireless near infrared spectroscopy on detecting peripheral circulation in patients with diabetes foot ulcer when doing Buerger's exercise. Lasers Surg Med 2017;49:652–7. https://doi.org/10.1002/lsm.22667.

[17] Chang CF, Chang CC, Hwang SL, Chen MY. Effects of Buerger Exercise Combined Health-Promoting Program on Peripheral Neurovasculopathy Among Community Residents at High Risk for Diabetic Foot Ulceration. Worldviews Evid Based Nurs 2015;12:145–53. https://doi.org/10.1111/wvn.12091.

[18] Hassan ZM, El-din SAB, Elrasek A, Mohammed I. Impact of Buerger Allen Exercise on Improving Selected Clinical Features of Peripheral Vascular Disease among Diabetic Patients. Journal of Nursing and Health Science 2020;9:4–13. https://doi.org/10.9790/1959-0902070413.

[19] Sasi RK, Islam R, Sunil A, Markose A. Lower Extremity Perfusion among Patient with Type 2 Diabetes Mellitusin a Tertiary Care Hospital, Kochi. Indian J Public Health Res Dev 2020;11:319–24. https://doi.org/10.37506/v11/i1/2020/ijphrd/193837.

[20] Lin B-S, Chang C-C, Su C-L, Li J-R, Chen M-L, Chen M-Y, et al. The assessment of Buerger's exercise on dorsal foot skin circulation in patients with vasculopathic diabetic foot ulcer by using wireless near-infrared spectroscope: a cohort prospective study. Lasers Med Sci 2018;33:977–82.

https://doi.org/10.1007/s10103-017-2420-6 LK.

[21] Thakur P, Sharma K. A Study to Assess the Effectiveness of Buerger Allen Exercise in Improving the Peripheral Circulation among Patients with Diabetes Mellitus Admitted in Sharda Hospital, Greater Noida. International Journal of Nursing Education 2019;11:27–31. https://doi.org/10.5958/0974-9357.2019.00034.5.

[22] El-Fattah HSA, Garas AF, Hanna NE, Elsayed NM. 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 J Public Health Res Dev 2019;10:719–24.

[23] Satyha, Karthi. 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 2019;6:83–8.

[24] Mellisha MSES. Effectiveness of Buerger Allen Exercise on Lower Extremity Perfusion and Pain among Patients with Type 2 Diabetes Mellitus in Selected Hospitals in Chennai. International Journal of Science and Research (IJSR) 2016;5:1822–6.

[25] Radhika J, Poomalai G, Nalini S, Revathi R. Effectiveness of buerger-allen exercise on lower extremity perfusion and peripheral neuropathy symptoms among patients with diabetes mellitus. Iran J Nurs Midwifery Res 2020;25:291–5. https://doi.org/10.4103/ijnmr.IJNMR_63_19.

[26] Lamkang TS, Aruna, Gowri M. Effectiveness of Buerger Allen Exercise on Level of Lower Extremity Perfusion among Patient with Type 2 Diabetes Mellitus Saveetha Medical College and Hospital. International Journal of Development Research 2017;7:14723–6.

[27] Bhuvaneshwari S, Tamilselvi. A study to assess the effectiveness of Buerger Allen exercise on lower extremity perfusion among patients with type 2 diabetes mellitus in Saveetha Medical College and Hospital in Chennai. International Journal of Advance Research and Development 2018;3:15–20.

[28] Mayangsari M, Lutfi M. The Effectiveness Of Buerger Allen Exercise On Decreasing ABI Value In Diabetes Mellitus Patients With Virginia Henderson ' s Nursing Model Theory Approach In The Covid-19 Pandemic. Strada Jurnal Ilmiah Kesehatan 2021;10:1541–6. https://doi.org/10.30994/sjik.v10i2.860.

[29] White H, Sabarwal S. Quasi-Experimental Design and Methods 2014.

[30] Bärnighausen T, Tugwell P, Røttingen J-A, Shemilt I, Rockers P, Geldsetzer P, et al. Quasi-experimental study designs series-paper 4: uses and value. Journal of Clininal Epidemiology 2017;89:21–9. https://doi.org/10.1016/j.jclinepi.2017.03.012.

[31] Faber J, Fonseca LM. How sample size influences research outcomes. Dental Press J Orthod 2014;19:27–9. https://doi.org/10.1590/2176-9451.19.4.027-029.ebo.

[32] Benskin L. Diabetic Foot Ulcers and Peripheral Arterial Disease: Clinical Education. USA: Ferris Mfg. Corp; 2018.

[33] Potter, Perry, Stockert, Hall. Fundamentals of Nursing. Ninth edit. St. Louis, Missouri: Elsevier; 2017.

[34] Hassan ZM, EL-Din SAB, ElRasek A, Mohammed, Mohammed I. Impact of Buerger Allen Exercise on Improving Selected Clinical Features of Peripheral Vascular Disease among Diabetic Patients. IOSR Journal of Nursing and Health Science (IOSR-JNHS) 2020;9:4–13. https://doi.org/10.9790/1959-0902070413.

[35] Kumari A, Rai K, Kumari V, Sarin J. A Study to Assess the Effectiveness of Buerger Allen Exercise on Foot Perfusion among Patients with Diabetes Mellitus Admitted in Selected Hospital of Ambala, Haryana. Int J Health Sci Res 2019;9.

[36] Lamkang TS, Aruna, Gowri M. Effectiveness of Buerger Allen Exercise on Level of Lower Extremity Perfusion among Patient with Type 2 Diabetes Mellitus Saveetha Medical College and Hospital. International Journal of Development Research 2017;7:14723–6.

[37] Buso G, Aboyans V, Mazzolai L. Lower Extremity Artery Disease in Patients with Type 2 Diabetes. Eur J Prev Cardiol 2019;26:114–24. https://doi.org/10.1177/2047487319880044.

[38] Qomariyah SN, Lin C-H. The Effect of Buerger Allen Exercise Towards Physical Health Performance of Peripheral Neuropathy Patients. Critical Medical and Surgical Nursing Journal 2023;12.

[39] Trisnawati I, Sudiana IK, Supriyanto S. Effect of Leg Exercise on the Lower Limb

Circulation of Patients with Diabetes Mellitus: A Systematic Review. Jurnal Ners 2020;15.