

Implementation of Buerger Allen exercise in patients with diabetes mellitus type II to improve lower extremity circulation

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Abstract

Diabetes mellitus is a complex, chronic disease that requires continuous medical care with multifactorial, risk-reducing strategies beyond glycemic control. This study aimed to determine the effect of Buerger Allen Exercise on the circulation of the lower extremities in patients with type II diabetes mellitus. This research used Quasi-Experimental Design with a Pretest-Posttest approach with an experiment and control group. Research place in Kuningan, West Java, Indonesia. Respondents in this study were patients with diabetes mellitus totaling 42 respondents, which were divided into 21 intervention (experimental) groups and 21 control groups. Sampling using purposive sampling. The instruments used were Vascular Doppler and sphygmomanometer. Bivariate data analysis used is the Wilcoxon test. The results showed that the average pretest and post-test ABI values in the intervention group were 0.00 and 11.00, while in the control group, the averages were 11.00 and 0.00. Based on the results of the Wilcoxon test, a p-value of 0.000 (α 0.05) means that there is an effect of Buerger Allen exercise on the circulation of the lower extremities in patients with type II diabetes mellitus. Buerger Allen exercise positively impacts the circulation of the lower extremities in patients with diabetes mellitus.

Keywords: Buerger Allen; Exercise; Diabetes Mellitus; Patient; Lower Extremity Circulation

1. Introduction

Diabetes is a complex, chronic disease that requires continuous medical care with multifactorial, risk-reducing strategies beyond glycemic control [1,2]. Diabetes self-management education and support are critical to preventing acute complications that reduce the risk of long-term complications [3]. There is significant evidence supporting various interventions to improve diabetes outcomes. The International Diabetes Federation (IDF) stated that the prevalence of diabetes mellitus (DM) in the world in 2019 reached 463 million people and is predicted to increase in 2045 to 700 million people [4].

Complications of DM consist of 2, namely macrovascular and microvascular complications [5]. One of the macrovascular complications is a peripheral arterial disease, which usually occurs more frequently in those with diabetes mellitus. People with long-standing diabetes mellitus are at increased risk of developing complications of peripheral arterial disease. Peripheral artery disease causes complications such as gangrene in the lower extremities. The most common symptom is muscle pain in the lower extremities. In diabetic patients, reduced pain perception due to peripheral neuropathy. Therefore, patients with diabetes and peripheral arterial disease (PAD) are more likely to develop ischemic ulcers or gangrene than patients without diabetes. The brachial pressure index on the ankle in the clinic provides a measure of blood flow to the ankle. That can aid early detection, initiate early therapy, and thereby reduce the risk of critical ischemia and amputation of the leg [6].

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Microvascular complications attack small blood vessels, including the eyes, kidneys, and peripheral nerves, that can cause diabetic peripheral neuropathy (DPN). The incidence of diabetic peripheral neuropathy is between 60% and 70% in patients with type I and type II diabetes mellitus. Diabetic peripheral neuropathy, in general, will cause typical symptoms including paresthesias (tingling), the feet feeling cold, and the presence of specific pain described as burning pain or even prickling. Other signs and symptoms include reduced sensory sensations such as decreased touch or vibration stimuli, pain, and temperature [7].

The impact of diabetic peripheral neuropathy, one of which is a decrease in sensory sensation, will cause diabetes mellitus patients to have the opportunity to experience injuries to the foot area. Dochterman & Bulechek (2004) stated that actions that nurses can take include management of peripheral sensation and foot care [8].

Mellisha (2016) found that assessing the effectiveness of Buerger Allen exercise against peripheral perfusion disorders and lower extremity pain in patients with diabetes mellitus for six days. The results of the pre-test on the level of pain from 4.33 (SD 1.88) post-test to 1.30 (SD 1.34) with a statistical value (p -value = 0.001), and the initial value on the level of limb perfusion from 44.50 (SD 4,61) the final value becomes 52.00 (3.31) with (p -value = 0.001) [9].

John and Rathiga (2015) showed that Buerger Allen exercise for 10-15 minutes 2 times a day and five days could improve blood circulation. Furthermore, the post-test was carried out on day 5 using a Vascular Doppler device. In the experimental group, there was a significant difference between the mean initial ABI value of 0.92 (SD 0.05) and the final 0.98 (SD 0.40), with a value (p -value 0.05). Meanwhile, the control group obtained an initial mean value of 0.84 (SD 0.07) and a final mean of 0.83 (SD 0.06) with an insignificant value (p -value 0.05) [6].

Lamkang (2017) said that the initial value of Buerger Allen Exercise on the extremities for the experimental group was 0.68 (SD 0.14), and the final mean value was 0.84 (SD 0.11) with (p -value = 0.001). Whereas in the control group, the initial value of lower extremity perfusion was 0.68 (SD 0.12), and the final mean value was 0.68 (SD 0.13) with (p -value = 0.096). That means that Buerger Allen's exercise effectively manages peripheral arterial disease in the lower extremities of DM patients [10].

The foot is a susceptible part in patients with diabetes mellitus. Patients with diabetes mellitus must always pay attention to and maintain foot hygiene and train them with physical activities or sports to prevent complications. If not treated properly, it is feared that one day the feet of DM patients will experience circulatory disorders and nerve damage which can cause reduced pain sensitivity, so diabetic patients are prone to injury [11].

Buerger Allen exercise is an intervention to stimulate blood circulation in the lower extremities or lower limbs. Providing primary care should focus on early prevention and prevention in those at increased risk. Awareness of diagnostic and treatment strategies allows primary care providers to inform patients, helping to improve treatment and prevention early on. Patients with diabetes mellitus should perform the Buerger Allen Exercise to improve circulation in the lower extremities [6].

The Buerger Allen exercise method is a variation of movement in the plantar area of the foot that meets the criteria for the continuous, interval, progressive and gravitational forces. Each stage of the action is carried out regularly. This exercise helps increase the demand for oxygen and nutrients in the arteries and veins. This exercise strengthens and maximizes the work of small muscles to prevent foot deformities and improve circulation. This exercise helps the healing process of diabetic foot wounds. It increases insulin production, which is used to transport glucose to cells, thereby helping to lower blood glucose in diabetic patients. While excellent and regular movement helps increase arterial and venous blood flow by opening capillaries (tiny blood vessels in muscles), this movement advances the vascularity of blood vessels to increase the supply of blood in the tissues [12]. This study aimed to determine the effect of Buerger Allen exercise on the circulation of the lower extremities in patients with type II diabetes mellitus.

2. Material and methods

This research used Quasi-Experimental Design with a Pretest-Posttest approach with an experiment and control group [13,14]. Research place in Kuningan, West Java, Indonesia. Respondents in this study were patients with diabetes mellitus totaling 42 respondents, which were divided into 21 intervention (experimental) groups and 21 control groups. Sample selection using: 1) Inclusion criteria: (a) Type II diabetes with full awareness. (b) Type II diabetes who are willing to be respondents. (c) Type II diabetes without ulcers. (d) Type II diabetes living in Kuningan district. (e) Type II diabetes with an ABI score of less than 1.0-1.2 mmHg. 2) Exclusion criteria are samples that cannot be included in the research. The exclusion criteria for this study were: (a) Type II diabetes who were not willing to be respondents. (b) Type II diabetes who were not at their residence or were traveling at the time of the study. (c) Type II diabetes who

cannot actively ROM. (d) Type II diabetes whose ABI value is less than 0.5 or more than 1.2. Data collection is divided into 2, namely demographic data and ABI score data. The ABI score was obtained by dividing the Ankle value (leg) by the Brachial value (arm) using Vascular Doppler and Sphygmomanometer. Interpretation of ABI Value: < 0.5 (severe PAD), 0.5 – 0.8 (moderate PAD), 0.8 – 0.9 (mild PAD) 1.0 – 1.2 (Normal), > 1, 2 (possibly calcified blood vessels). This Buerder Allen exercise intervention can be done 2 times a day in the morning and evening or in 6 hour intervals with a duration of 17-20 minutes for 2 weeks. The procedure consists of 3 stages: (1) the lower extremity is lifted up at an angle of 45°-90° and supported by a pillow or chair for 2-3 minutes or until the skin looks pale (pale white or tingling). (2) The patient sits at the side of the bed with the legs hanging down. The patient systematically flexes and extends the foot, then pronates and supinates and flexes and extends the toes. This phase lasts for 5-10 minutes until the skin looks red again. (3) the patient lies down for 10 minutes with both feet moving like dorsiflexion and plantarflexion in bed for a few minutes to improve circulation. Proof of this hypothesis using the Wilcoxon test.

3. Results and discussion

3.1. The characteristics of respondents

Based on the results of research data processing, the following are the characteristics of respondents with Diabetes Mellitus Type II in Kuningan, West Java, Indonesia.

Table 1 The characteristics of respondents

Characteristics		Buerder Allen Exercise	
		F	%
Gender	Male	23	54.8
	Female	19	45.2
Age	≤45	6	14.3
	≥45	36	85.7
Duration of DM Type II	1 to 5 years	18	42.9
	More than 5 years	24	57.1
Smoker	Yes	24	57.1
	No	18	42.9

Table 1 above shows that the frequency of age of clients with diabetes mellitus who are less than 45 years is 14.3% (6 respondents), while the age of patients with diabetes mellitus who are more than 45 years is 85.7% (36 respondents). The characteristic frequency of diabetes mellitus occurring from 1 to 5 years was 42.9% (18 respondents), while the duration of diabetes mellitus occurring more than five years was 57.1% (24 respondents). The characteristic frequency of respondents who have a history of smoking habits is 57.1% (24 respondents), while respondents who do not have a history of smoking habits are 42.9% (18 respondents).

The average age of respondents with diabetes showed 45 years old, around 85.7% (36 respondents). Research conducted by Marius et al (2014) stated that diabetes mellitus often occurs between the ages of 45-50 years [15]. In line with the study results, Jannoo et al (2015) said that there was a significant correlation between age and the incidence of diabetes mellitus in the 45-year age group [16]. The aging process causes a decrease in physiological function, a decrease in pancreatic function, and retention of the hormone insulin so that the ability of the blood glucose regulation function is not effective. Uncontrolled hyperglycemia (high blood sugar) causes an increased risk of chronic complications.

This study shows that the average respondent who has had a history of diabetes for more than five years is around 57.1% (24 respondents). Clients who have had a history of DM for more than 5 years have a high risk of atherosclerosis, mainly in the foot area. The research of Alvarsson, et al (2012) showed a fairly strong relationship between the length of time a person had diabetes mellitus and the level of risk of complications of diabetes mellitus [17].

The results of this study indicate that respondents who have a history of smoking habits are 24 respondents (57.1%). Research by Chang et al, (2015) said that peripheral perfusion disorders will worsen in diabetic patients who have a history of smoking habits [18]. The longer a diabetic patient smokes, the worse the Brachial Ankle Index (ABI) value will be. Toxic substances in cigarettes will cause damage to the endothelium of blood vessels, which increases the risk of atherosclerosis. Nicotine in cigarettes causes an increase in the hormone adrenaline. The hormone adrenaline can change fat metabolism in the blood, lowering HDL levels. The increase in the hormone adrenaline results in decreased heart performance and damage to the blood endothelium so that the coronary arteries of the heart become narrow. Not only that, adrenaline plays a vital role in the formation of platelets in the blood, which results in constriction of blood vessels, both macrovascular and microvascular [17]. The conclusion that can be drawn is that the nicotine in cigarettes impacts damage to the walls of blood vessels (endothelium), which can increase the risk of atherosclerosis. If you have atherosclerosis, it can facilitate the occurrence of peripheral perfusion disorders of the feet in diabetic patients, resulting in reduced circulation in the feet and making it easier for the feet to become diabetic ulcers (diabetic foot wounds).

Based on the information above, factors such as age, duration of diabetes mellitus, and smoking habit status can cause circulation in the lower extremities to be not smooth.

3.2. The value of lower extremity circulation before and after the Buerder Allen exercise therapy

Based on the results of research data processing, the following is the value of lower extremity circulation before and after the Buerder Allen exercise therapy.

Table 2 The value of lower extremity circulation on the intervention group

ABI (Ankle Brachial Index)	Before Buerder Allen Exercise		After Buerder Allen Exercise	
	F	%	F	%
Normal (1,0-1,2)	0	0	17	81
Soft PAD (0,8-0,9)	17	81	4	19
Medium PAD (0,5-0,8)	4	19	0	0

The results in Table 2 before the Buerder Allen Exercise intervention show that respondents with soft PAD were 81% (17 respondents), 19% with medium PAD (4 respondents), and 0% normal. The results in Table 2 after the Buerder Allen Exercise intervention show the ABI value in the normal category as much as 81% (17 respondents), the soft PAD category as much as 19% (4 respondents), and the medium PAD category as 0%.

The research data shows that Buerder Allen exercise has a good impact on the circulation of the lower extremities. The effect felt by the client after doing Buerder Allen exercise therapy is reduced tingling, numbness, and even pain.

Movement of the ankle in the foot can increase the strength of the ankle joint muscles and increase the contraction of small muscles in the calf so that venous pumping occurs, increasing venous return to the heart. A squeeze that occurs in the small muscles of the calf can increase the supply of blood containing oxygen and nutrients circulating by the heart to the leg veins [12].

Research conducted by Chang et al. (2016) stated that Buerder Allen exercise positively impacts circulation, improves blood flow, improves walking ability, reduces necrosis, prevents embolism and cyanosis in blood vessels, and reduces pain in the lower extremities [19].

Based on the description above, the researcher assumes that the increase in the ABI value in the intervention group indicates that Buerder Allen exercise increases the circulation of the lower extremities in patients with type II diabetes mellitus in Kuningan, West Java, Indonesia.

3.3. The value of lower extremity circulation on the control group

Based on the results of research data processing, the following are the pre-post test lower extremity circulation values for respondents who did not do Buerder Allen exercise therapy.

Table 3 The value of lower extremity circulation on the control group

ABI (Ankle Brachial Index)	Pre-test		Post-test	
	F	%	F	%
Normal (1,0-1,2)	0	0	0	0
Soft PAD (0,8-0,9)	13	61.9	12	57.1
Medium PAD (0,5-0,8)	8	38.1	9	42.9

Table 3 shows that the ABI Pre-test and Post-test scores for respondents who did not do Buerder Allen exercise showed that the pre-test data for the soft PAD category was 61.9% (13 respondents), the medium PAD category was 38.1% (8 respondents). The post-test data for the soft PAD category was 57.1% (12 respondents), and for the medium PAD, category was 42.9% (9 respondents).

Respondents in the control group tend to have an ABI value lower than the normal value. If it is not handled correctly, it can result in injury to the feet and can even be amputated so that there is no foot injury or amputation. The prevention is by physical activity, one of which is the Buerder Allen exercise.

Peripheral perfusion disorders in the feet experienced by patients with diabetes mellitus often cause nerve death (neuropathy) in the feet. Decreased or loss of tactile sensation in the feet can cause the client not to realize that there is a neuropathic foot ulcer. If not treated properly, an infection can occur, eventually spreading to the bone and becoming osteomyelitis (infection and bone damage) that requires amputation [20].

3.4. The differences in ABI Values in the intervention group and the control group.

The following are the results of data processing using SPSS to prove the hypothesis using the Wilcoxon test on the intervention and control group data.

Table 4 The results of Wilcoxon test

Group	Mean Rank		Sum of Rank		Z	P-Value
	pre-test	post-test	pre-test	post-test		
intervention	0.00	11.00	0.00	231.00	-4.022 ^b	0.000
control	11.00	0.00	231.00	0.00	-4.055 ^c	0.000

* Significant level 0.05; * b, c based on ranks

Based on the results of the Wilcoxon test in table 4, it shows that the p-value of the ABI value in the intervention group and control group is 0.000 (p-value 0.05). This means that H₀ is rejected and H₁ is accepted. It can be concluded that there is a difference in the ABI value between the groups given the Buerder Allen exercise and the group that was not given the Buerder Allen exercise. Thus, it can be concluded that there is an effect of Buerder Allen exercise on the circulation of the lower extremities in patients with DM type II in Kuningan, West Java, Indonesia.

Lamkang T. S (2017) research states that Buerder Allen exercise effectively increases peripheral blood circulation. The effect felt by diabetic patients after being given the Buerder Allen exercise intervention was to reduce tingling & cramping in the leg area, reduce pain (intermittent claudication), and increase peripheral circulation from changes in the value of the ankle brachial index (ABI) [10]. In line with previous research, Vijayarathy (2014) concluded that Buerder Allen exercise plays an essential role in the healing process of diabetic foot wounds. Buerder allen exercise can increase peripheral blood vessel circulation by changing the technique of gravity in the lower limbs (lower extremities) accompanied by muscle contraction through variations in dorso flexion and plantar flexion movements at the ankles [21].

Buerder Allen exercise was carried out in this study 2 times a day for five days for two weeks. According to John and Rathiga (2015), Buerder Allen can be taught two times a day with an interval of 6 hours, showing a significant improvement in the circulation of the lower extremities [6]. Elevating the legs for approximately 15 minutes every 6 hours repeatedly with Buerder Allen exercise can increase circulation and greatly benefit lower extremity venous

insufficiency. Meanwhile, this Buerder Allen exercise is very beneficial to increase arterial insufficiency for oxygenation needs. Increased tissue perfusion due to postural changes. Modulating gravity and setting muscle contractions can increase lower extremity perfusion and help process circulation and dilate blood vessels so that blood flows easily [22,23].

There was a significant difference in the ABI value in the intervention and control groups. Research conducted by Aruna and Thenmozi (2015) said an increase in Nitric Oxid levels played an essential role in increasing peripheral perfusion in the legs after three months of Buerder Allen exercise [24]. Supported by research by Chang et al. (2015), the obstruction of blood flow in diabetic feet due to diabetes mellitus can be overcome with Buerder Allen exercise [18].

Buerder Allen exercise that is done consistently can relieve and improve peripheral perfusion disorders in the feet of diabetic patients. Buerder Allen exercise improves blood vessel walls (endothelium) by increasing Nitric oxide (NO) and ultimately improves atherosclerosis and increases the ability of blood vessels to adapt to the risk of recurrent atherosclerosis [21].

4. Conclusion

The results showed that the average pretest and post-test ABI values in the intervention group were 0.00 and 11.00, while in the control group, the averages were 11.00 and 0.00. Based on the results of the Wilcoxon test, a p-value of 0.000 (α 0.05) means that there is an effect of Buerder Allen exercise on the circulation of the lower extremities in patients with type II diabetes mellitus. Buerder Allen exercise positively impacts the circulation of the lower extremities in patients with diabetes mellitus.

Based on the study results, regular Buerder Allen exercise can improve the circulation of the lower extremities. Dietary management such as monitoring blood sugar levels and pharmacological therapy are suggested results of this study. Researchers provide suggestions for controlling blood sugar levels and meeting proper nutrition so that the disease does not develop more severely.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

- [1] Shen X, Shen X. The role of occupational therapy in secondary prevention of diabetes. *International Journal of Endocrinology*. 2019; 2019(Jul 24): 1–7
- [2] Ozturkmen YA, Avci S, Calim A, Cetin EG, Demir N, Mazi EE, et al. The Effect of Type and Daily Doses of Insulin to Treatment Success in Type 2 Diabetes Patients who are Receiving Basal-bolus Insulin Therapy. *The Medical Bulletin of Sisli Etfal Hospital*. 2020; 54(4):416.
- [3] Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National standards for diabetes self-management education and support. *Diabetes Care*. 2017; 40(10):1409–19.
- [4] Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice*. 2019; 157(107843):1–10.
- [5] Black JM, Hawks JH, Keene AM. *Clinical management for positive outcomes*. Medical-Surgical Nursing 7th ed St Louis: Saunders Elsevier. 2009; 227–80.

- [6] John J, Rathiga A. Effectiveness of Buerger Allen exercise to improve the lower extremity perfusion among patients with type 2 diabetes mellitus. *Int J Curr Res Acad Rev*. 2015; 3:358–66.
- [7] SUYANTO S. CHARACTERISTICS OF DIABETIC PERIPHERAL NEUROPATHIC. *NURSCOPE: Jurnal Penelitian dan Pemikiran Ilmiah Keperawatan*. 2017; 3(1):1–6.
- [8] Butcher HK, Bulechek GM, Dochterman JM, Wagner CM. *Nursing interventions classification (NIC)-E-Book*. USA: Elsevier Health Sciences; 2018. p. 290-291
- [9] Mellisha M, Sc MN. 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(7):1822–6.
- [10] Lamkang A. Gowri. Effectiveness of Buerger Allen Exercise on Level of Lower Extremity Perfusion among Patient with Type 2 Diabetes Mellitus Saveetha Medical College and Hospital. *Int J Dev Res*. 2017; 7(8):14723–6.
- [11] Hidayat AR, Nurhayati I. Perawatan kaki pada penderita diabetes militus di rumah. *Jurnal Permata Indonesia*. 2014; 5(2):49–54.
- [12] Jannaim J, Dharmajaya R, Asrizal A. Pengaruh buerger allen exercise terhadap sirkulasi ektremitas bawah pada pasien luka kaki diabetik. *Jurnal Keperawatan Indonesia*. 2018; 21(2):101–8.
- [13] Hidayat A. Kemampuan Biostatistik melalui Pendekatan Investigasi pada Materi Regresi Sederhana. *Syntax Literate; Jurnal Ilmiah Indonesia*. 2018 Mar 27;3(3):1-1.
- [14] Hidayat A, Perdana FJ. Media Hippo Animator pada Pembelajaran Statistika dalam Upaya Meningkatkan Kemampuan Statistik dan Self-confidence Mahasiswa di Era Pandemi Covid 19. *JUMLAHKU: Jurnal Matematika Ilmiah STKIP Muhammadiyah Kuningan*. 2021 Dec 15;7(2):100-26.
- [15] Marius R-A, Iliuta L, Guberna SM, Sinescu C. The role of ankle-brachial index for predicting peripheral arterial disease. *Maedica*. 2014; 9(3):295.
- [16] Jannoo Z, Yap BW, Musa KI, Lazim MA, Hassali MA. An audit of diabetes-dependent quality of life in patients with type 2 diabetes mellitus in Malaysia. *Quality of Life Research*. 2015; 24(9):2297–302.
- [17] Alvarsson A, Sandgren B, Wendel C, Alvarsson M, Brismar K. A retrospective analysis of amputation rates in diabetic patients: can lower extremity amputations be further prevented? *Cardiovascular diabetology*. 2012; 11(1):1–11.
- [18] Chang C, Chang C, Hwang S, Chen M. Effects of Buerger Exercise Combined Health-Promoting Program on Peripheral Neurovasculopathy Among Community Residents at High Risk for Diabetic Foot Ulceration. *Worldviews on Evidence-Based Nursing*. 2015; 12(3):145–53.
- [19] Chang C-C, Chen M-Y, Shen J-H, Lin Y Bin, Hsu W-W, Lin B-S. A quantitative real-time assessment of Buerger exercise on dorsal foot peripheral skin circulation in patients with diabetes foot. *Medicine*. 2016; 95(46).
- [20] Tandra H. *Segala sesuatu yang harus anda ketahui tentang diabetes*. Jakarta: Gramedia Pustaka Utama; 2017.
- [21] Vijayarathy M. Hermavathi V. Buerger Allen Exercise for type 2 Diabetes Mellitus Foot Ulcer Patients. *International Journal of Innovative Research, Engineering, and Technology*. 2014; 3(12):243–50.
- [22] Mataputun DR, Prabawati D, Tjandrarini DH. Efektivitas Buerger Allen exercise dibandingkan dengan Rendam Kaki Air Hangat terhadap Nilai Ankle Brachial Index dan Gula Darah pada Pasien Diabetes Mellitus. *MPPKI (Media Publikasi Promosi Kesehatan Indonesia): The Indonesian Journal of Health Promotion*. 2020; 3(3):253–66.
- [23] Hafid MA, Ilmi AA, Hasnah H. Buerger allen exercise review on peripheral circulation in diabetes mellitus patients: a literature review. *Jurnal Kesehatan*. 2020; 13(1):28–38.
- [24] Aruna S, Thenmozhi P. Effectiveness of Allen Buerger exercise in preventing peripheral arterial disease among people with Type II diabetes mellitus. *International Journal of Pharma and Bio Sciences*. 2015; 6(2):966–70.