

## Effect of Buerger Allen Exercise on Lower Limb Perfusion and peripheral Neuropathy among Patients with Peripheral Vascular Diseases

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### Abstract:

**Background:** The risk of peripheral arterial disease and peripheral neuropathy is markedly increased among individuals with diabetes, Buerger Allen exercise is a simple intervention for improving peripheral circulation. **The study was aimed** to evaluate the effect of Buerger Allen exercise on lower limb perfusion and peripheral neuropathy among patients with peripheral vascular diseases. **Study design:** A quasi-experimental design was utilized to conduct this study. **Setting:** This study was conducted at cardiovascular and endocrinology departments affiliated to Ain Shams university hospitals, affiliated to Ain Shams University, Cairo, Egypt. **Sample:** A purposive sample of 62 adult patients were selected based on inclusion criteria. **Tools of data collection:** Patient's Interviewing questionnaire. Ankle Brachial Index scale. Assessment checklist for selected clinical features of peripheral vascular disease. Michigan Neuropathy Screening Instrument **Results:** The mean age of the studied patients was  $57.16 \pm 7.56$ ; males were more prevalent and constituted 69.4% of the studied patients. Also, 43.5% of them were obese. Moreover, there was an improvement in lower limb perfusion among the studied patients post implementation of Buerger Allen exercise with a highly statistically significant difference ( $P < 0.01$ ). Furthermore, there was an improvement in clinical features of peripheral vascular disease among the studied patients post implementation of Buerger Allen exercise with a highly statistically significant difference ( $P < 0.01$ ). Also, there was an improvement according to peripheral neuropathy history and symptoms among the studied patients post implementation of Buerger Allen exercise with a highly statistically significant difference ( $P < 0.01$ ). **Conclusion:** There was an improvement in ankle brachial index score and peripheral neuropathy symptoms after implementation of Buerger Allen exercise. **Recommendations:** health education sessions based on evidence guidelines regard Buerger Allen's exercise for improvement of lower peripheral circulation.

**Keywords:** Buerger-Allen exercise, lower limb perfusion, peripheral vascular diseases, neuropathy symptoms.

### Introduction:

Peripheral vascular disease (PVD) and peripheral neuropathy (PN), both lower-extremity diseases, are the leading cause of non-injury-related disabilities, declines in physical functioning and loss of independence later in life are additional complications of these conditions (Kerr et al., 2019). Peripheral vascular disease and PN are two distinct but related conditions. They are associated because they both affect similar populations and cause some of the same complications, but this has led to some confusion circling around the disease definitions (Campia et al., 2019). Diabetes (DM) is one of the strongest predictors for PVD and its associated complications including higher mortality and amputation; the latter is predicted by the presence of neuropathy, low

ankle brachial index (ABI) (Lin et al., 2020). Peripheral vascular disease also known as peripheral arterial disease (PAD), arteriosclerosis obliterans, is primarily the result of atherosclerosis. It commonly affects people with DM, who are also prone to high cholesterol and heart disease. According to the American Diabetes Association, about 1 in 3 people with DM over the age of 50 have PAD (Janas et al., 2020). Peripheral neuropathy is a type of nerve damage that typically affects the feet and legs and sometimes affects the hands. This type of neuropathy is very common. About one-third to one-half of people with DM have PN (Lehmann et al., 2020). Buerger Allen exercise (BAE) is a system of exercises for arterial insufficiency of lower limbs to improve circulation to the feet and legs. This exercise

produces gravitational changes in positions which aid in increasing blood flow rate, removal of stagnant blood and create collateral circulation to the ischemic area (**Treat-Jacobson et al., 2019**). Buerger Allen exercise is an ideal and noninvasive physical therapy for patients with DM combined with Peripheral artery disease as it is an easy to learn, low cost, and low risk physical activity (**Lavie et al., 2019**).

Also, it is one of the most common practices used for patients with DM to drain engorged vessels. It is performed to lower limb perfusion (LEP) by using postural changes and stimulated peripheral circulation by modulating gravity and applying muscle contraction for improving the LEP (**Hassan, et. al 2020**). Primary Care Providers should focus on prevention by early recognition and prevention of PAD to those at increased risk. An awareness of diagnostic and treatment strategies will enable primary care providers to educate patients. This will help to improve both concordance with treatment and disease outcome (**Afida et al., 2022**).

### **Significance of the study:**

In 2019, an appraised 1.5 million deaths were straight produced by DM. About 422 million adults are living with DM, people worldwide (WHO, 2021). Currently, the prevalence of type II DM is around 15.6% of diabetic Egyptian adults aged twenty to seventy-nine years of age (**Hassan et al., 2020**).

The American Heart Association estimates that the worldwide prevalence of PAD is 202 million individuals. PAD is a common sequela in diabetic individuals with 3-4 times higher prevalence than non-diabetic individuals (**Shukla et al., 2018**). Additionally, approximately 50% of adults with DM will be affected by PN in their lifetime, more diligent screening and management are important to reduce the complications and health care burden associated with the disease (**Haque et al., 2023**).

### **Aim of the study:**

The present study aimed to evaluate the effect of Buerger Allen exercise on lower limb

perfusion and peripheral neuropathy among patients with peripheral vascular diseases. It was conducted through the following:

- 1- Assess lower limb perfusion and neuropathy among patients with peripheral vascular diseases.
- 2- Apply Buerger Allen exercise for patients with peripheral vascular diseases.
- 3- Evaluate the effect of Buerger Allen exercise on lower limb perfusion and peripheral neuropathy among patients with peripheral vascular diseases.

### **Research Hypotheses**

The current study hypothesized that the implementation of Buerger Allen exercise was affect positively on lower limb perfusion and peripheral neuropathy among patients with peripheral vascular diseases.

### **Subjects and methods:**

**Research design:** A quasi-experimental research design (pre and post) design was utilized to conduct this study.

**Study setting:** The study was conducted at cardiovascular and endocrinology departments affiliated to Ain Shams University Hospitals, affiliated to Ain Shams University, Cairo, Egypt. The cardiovascular unit consists of 4 rooms. The 1st and 2nd room contain 4 beds for each of them, and 3rd and 4th room contain 3 beds for each of them. The endocrinology department consists of five rooms, each room includes 8 beds and 2 rooms for isolation.

**Sample:** A Purposive sample of 62 patients with DM receiving care at the previously mentioned setting.

The sample size calculated based on a study carried out by (El Sayed et al., 2021). By estimating an effect size 0.51, based on the mean number of lower extremities perfusion score pre intervention was  $9.0 \pm 4.49$  and post intervention was  $4.74 \pm 3.32$  and statistical power of 90%, level of confidence (1-Alpha Error): 95%, Alpha 0.05, Beta 0.1. The sample size determines at group is 56 patients. Considering

10% sample attrition (6 patients), the final sample size in the group is 62 patients. Sample size calculates using test comparing two means through Kane SP.

#### **Inclusion criteria:**

The study subjects were selected according to the following criteria:

- Patients who were medically diagnosed with diabetes mellitus.
- Willing to participate in the study.
- Both sexes.
- Never receive Buerger Allen exercise intervention before.

#### **Exclusion criteria:**

- Patients have severe foot ulcers or amputation.
- Ankle brachial index within normal or severe.
- Unconscious or disoriented patients
- Patients diagnosed as deep venous thrombosis.

**Tools:** Three tools were used for data collection

**Tool (I) Patient's Interviewing questionnaire.** It was developed by the investigator based on review of relevant literatures as (Lemone et al.,2015; Lewis et al.,2016; Stromberg, 2020) and it consisted of three parts:

**Part (1):** Patients' demographic characteristics assessment: this part was used to assess demographic characteristics of patients under study.

**Part (2):** Patients' anthropometric measurements :This part was used to assess weight, height, and body mass index for patients under study.

**Part (3):** Patients clinical data assessment: this part concerned with assessment of patients' clinical data. It included Present, past and family history.

**Tool (II): Assessment of lower limb perfusion through the following:**

#### **1) Ankle Brachial Index scale.**

This scale adopted from (Baby, 2015) to calculate the perfusion of lower limbs right and left. The manual Ankle-Brachial Index (ABI) was performed by a researcher using standard manual sphygmomanometer for the measurement of lower extremity pressure (LEP). For calculating the ABI, each ankle systolic pressure was distributed by the brachial systolic pressure and the greater of the two systolic pressures for each leg was distributed by the greater of the two arm pressures to acquire the right and left ABI based on the following equation:

ABI= Highest ankle pressure \ Highest brachial arm pressure

#### **❖ Scoring system for Ankle Brachial Index scale.**

The score was interpreted as above 0.9 (normal perfusion), 0.71–0.90 (mild impaired perfusion), 0.41–0.70 (moderate impaired perfusion), 0 -0.40 (severe impaired perfusion).

#### **2) Assessment checklist for selected clinical features of peripheral vascular disease.**

This checklist was used to assess the symptoms level of peripheral vascular disease. It was adopted by Priya, (2016). It includes six (6) parameters (Peripheral pulse, Capillary refill, Edema, Temperature, Pain, Skin color).

#### **❖ Scoring system for checklist for selected clinical features of peripheral vascular disease.**

Assess dorsalis pedis pulse (normal, weak, non-palpable, or absent pulse). Capillary refill Time by using capillary refill test (1-2 sec., 3 sec., 4 sec. & >4 sec.), presence of edema (No edema, (+1) < 2 mm pitting that disappeared rapidly, (+2) 2 to < 4 mm pitting that disappeared in 10- 15 sec. & (+3) 4 to < 6 mm pitting that disappeared in 10-15 sec.), Temperature by using dorsum of hand (Warm, Mild, Moderate & Cold), pain by using numerical scale (Jensen et al., 2001). Zero mean No pain, from 1-3 Mild pain, from 4-6 Moderate pain & from 7-10 Severe pain) and observation of skin color (pink, Pale, Black, Reddish).

**The total Scoring was as following:**

Grade	Score	Interpretation
1	0-4	Adequate perfusion (good blood circulation)
2	5-9	slightly inadequate perfusion (slightly poor blood circulation)
3	10-14	Inadequate perfusion (poor blood circulation)
4	15-18	Severe inadequate perfusion (very poor blood circulation)

**Tool (III): Michigan Neuropathy Screening Instrument (MNSI)**

This scale adopted from (Herman, 2022), it was used for the evaluation of distal symmetrical peripheral neuropathy in DM. The MNSI includes two separate assessments, a 15-item was filled out for each patient by investigator, questionnaire that is scored by summing abnormal responses, and a lower extremity examination that includes inspection and assessment of vibratory sensation and ankle reflexes and is scored by assigning points for abnormal findings.

**❖ Scoring system for Michigan Neuropathy Screening Instrument**

The MNSI questionnaire, Responses are added to obtain a total score. 'Yes' responses to questions 1–3, 4, 5, 6, 8, 9,10, 11–12, 14–15 is each counted as one point. 'No' responses to questions 7 and 13 each count as one point. A score of  $\geq 7$  is taken as positive for DPN.

During the MNSI examination, a health professional inspects each foot for deformities of skin, dry skin, calluses, infections, and fissures. Each foot with any abnormality receives a score of 1. Each foot is also inspected for ulcers and each foot with an ulcer receives a score of 1.

The ankle reflexes are also elicited by using the ankle jerk reflex. If the reflex is absent, the patient is asked to perform the Jendrassic maneuver, if present, the reflex is designated as present with reinforcement and is scored as 0.5. If the reflex is absent with the Jendrassic maneuver, the reflex is designated as absent and is scored as 1. Vibration sensation is then tested in the great toe by using tuning fork. Vibration is scored as present if the examiner senses the vibration on finger for  $< 10$  s longer

than the subject feels it in the great toe, decreased if sensed for 10 s (scored as 0.5) or absent (scored as 1). The total possible score is 8 points and, in the published scoring algorithm, a score 2.5 or more is considered abnormal and less than 2.5 consider normal.

**Field work:**

The collection of data and application of BAE exercise started at November 2022 up to the end of March 2023, through the following phases:

**A-Assessment and planning phase**

The baseline assessment: The first time; individualized interview session was conducted to each participant by the researchers to collect demographic data, medical history & clinical variables, and peripheral circulation assessment of both lower extremities. The researcher also clarified to the participants that the peripheral circulation assessment would be assessed two times. The first time for measuring their perfusion level without any intervention (1st measurement).

**B-Implementation phase**

The researchers demonstrated the BAE as an intervention to improve circulation to the feet and legs, encourage participants to re-demonstrate the following three steps.

Step 1: Elevation. The lower extremities were elevated to 45-degree angle and supported in this position until the skin blanches (3 minutes) .

Step 2: Dependency. The feet and legs are then lowered below the level of the rest of the body until redness appears (10 minutes).

Step 3: Horizontal. The legs were placed flat on the bed for 10 minutes. The Buerger Allen Exercise can be repeated 3 times per session and each session can be repeated 3 times per day for the period of 5 days.

**C-Evaluation phase**

This phase started immediately after the proposed intervention was implemented for each patient, the researcher assessed effect of BAE on patients' peripheral circulation level of the lower limbs by comparing the results pre and post measurement on the fifth day of administering BAE by using Peripheral

Circulation Assessment tool, after the intervention.

#### **Validation of tool:**

Tools of data collection were investigated for their content validity by panel of five experts 5 professors from Medical Surgical Nursing department at the Faculty of Nursing, Ain Shams University, who are selected to test content validity of the tools and to judge its clarity, relevance, comprehensiveness, understanding and applicability. The opinion was elicited regarding the layout, format and sequence of the questions and all of their remarks were taken into consideration and the tools were regarded as valid from the experts' point of view.

#### **Reliability of the tool:**

Reliability of tools was applied by the researcher for testing the internal consistency of the tools by administrating of the same tool to the same subjects under similar condition. Internal consistency reliability of all items of the tools was assessed using Cronbach's alpha coefficient. It was 0.853 for ankle brachial index Tool, 0.827 for Assessment checklist for selected clinical features of peripheral vascular disease, 0.819 for Michigan Neuropathy Screening Instrument.

#### **Methods:**

**Administrative and ethical considerations:** An official approval was taken from the Dean of the Faculty of Nursing, Ain Shams University to the director of Ain Shams University hospital, affiliated to Ain Shams University. A clear explanation was given about the nature, importance and expected outcomes of the study to carry out the study with minimal resistance.

**Pilot study:** A pilot study was conducted on 10% (6) patients of the total sample. To test the applicability of the constructed tools and the clarity of the included questions. The pilot has also served to estimate the time needed to fill in the questions by researcher for each subject and to identify the problems that may be encountered during the study. All participants in the pilot study were included into the sample.

#### **Statistical analysis:**

The statistical analysis of data was done by using the computer software of Microsoft Excel Program and Statistical Package for Social Science (SPSS) version 25. Data were presented using descriptive statistics in the form of frequencies and percentage for categorical data, the arithmetic mean (X) and standard deviation (SD) for quantitative data. Qualitative variables were compared using chi square test (X<sup>2</sup>). Difference between the group during the two visits were assessed by paired t test. In addition, R- test were used to identify the correlation between the study variables.

#### **Degrees of significance of results were considered as follows :**

-P-value  $\geq$  0.05 Not significant (NS)

-P-value  $<$  0.05 Significant (S)

- P-value  $<$  0.01 Highly Significant (HS).

#### **Results:**

**Table (1):** shows that, 54.8% of the studied patients their age ranged between 51-65 years old, the mean  $\pm$  SD of age was 57.16  $\pm$  7.56 years; males were 69.4% of the studied patients. Also, 72.6% of them were married. Moreover, 38.7% of them were employed, as 54.2% of them had moderate work. Furthermore 33.9% of the studied patients were illiterate, and 33.9% of them had secondary education. While 29.0% of them read and write.

In terms of reporting adverse events, more than half of the nurses reported experiencing adverse events 1 to 5 times within the past 12 months, while only 7.7% reported experiencing 6 to 10 adverse events.

**Table (2):** shows that, 62.9% of the studied patients their weight was  $>$  80, the mean  $\pm$  SD of weight was 83.23  $\pm$  14.8. Also, 43.5% of the studied patients their height ranged between 165- $<$ 175, with mean  $\pm$  SD of height was 168.7  $\pm$  8.13. Moreover, 43.5% of studied patients were obese.

**Table (3):** shows that, there was an improvement in lower limb perfusion among the studied patients post implementation of Buerger Allen exercise compared to pre-intervention phase with a highly statistically significant difference (P  $<$  0.01). As evidence,

71.0% of the studied patients had moderately diminished perfusion of right limb at pre implementation of Buerger Allen exercise which changed to 58.1% of them had normal perfusion at post intervention phase. Also, 67,7% of the studied patients had moderately diminished perfusion of left limb at pre implementation of Buerger Allen exercise which changed to 61,3% of them had normal perfusion at post intervention phase.

**Table (4):** shows that, there was an improvement in clinical features of peripheral vascular disease among the studied patients post implementation of Buerger Allen exercise compared to pre-intervention phase with a highly statistically significant difference ( $P < 0.01$ ). As evidence, 53.2% of the studied patients had moderately diminished in clinical features of peripheral vascular disease of right limb at pre implementation of Buerger Allen exercise which changed to 53.2% of them had normal clinical features of peripheral vascular disease at post intervention phase. Also, 62.9% of the studied patients had moderately diminished clinical features of left limb at pre implementation of Buerger Allen exercise which changed to 53.2% of them had normal perfusion at post intervention phase.

**Table (5):** shows that, there was an improvement according to peripheral neuropathy history among the studied patients post implementation of Buerger Allen exercise compared to pre-intervention phase with a highly statistically significant difference ( $P < 0.01$ ). As evidence, 64.5% of the studied

patients had positive history at pre implementation of Buerger Allen exercise which changed to 27.4% of them had positive history at post intervention phase. Also, the mean  $\pm$  SD  $6.40 \pm 2.84$  pre implementation of Buerger Allen exercise which changed to mean  $\pm$  SD  $4.53 \pm 2.48$ .

**Table (6):** shows that, there was an improvement according to peripheral neuropathy symptoms among the studied patients post implementation of Buerger Allen exercise compared to pre-intervention phase with a statistically highly significant difference ( $P < 0.01$ ). As evidence, 58.1% of the studied patients with normal peripheral neuropathy examination at pre implementation of Buerger Allen exercise which changed to 19.4% of them with normal peripheral neuropathy examination at post intervention phase. Also, the mean  $\pm$  SD  $2.17 \pm 0.815$  pre implementation of Buerger Allen exercise which changed to mean  $\pm$  SD  $1.78 \pm 0.669$ .

**Table (7):** reveals that, there was highly significant statistical negative correlation between patients' Ankle Brachial Index and total clinical features of peripheral vascular disease, total peripheral neuropathy history and Total peripheral neuropathy symptoms at pre and post intervention at  $p < 0.01$ . While there was highly significant statistical positive correlation between total patients' clinical features of peripheral vascular disease and total peripheral neuropathy history, total peripheral neuropathy symptoms at pre and post intervention at  $p < 0.01$ .

**Table (1):** Frequency and percentage distribution of the studied patients according to their demographic data (n=62).

Items	No.	%
<b>Age (years)</b>		
20 - 34	2	3.2
35 - 50	11	17.7
51 - 65	34	54.8
>65	15	24.2
<b>Mean ± SD</b>	<b>57.16 ± 7.56</b>	
<b>Gender</b>		
Male	43	69.4
Female	19	30.6
<b>Marital status</b>		
Single	0	0.0
Married	45	72.6
Divorced	7	11.3
Widow	10	16.1
<b>Occupation</b>		
Working	24	38.7
Not working	38	61.3
<b>*Type of work (n=24)</b>		
Clerical work	3	12.5
Moderate work	13	54.2
Heavy work	8	33.3
<b>*Educational level (n=62).</b>		
illiterate	21	33.9
Read and write	18	29.0
secondary	21	33.9
High education	2	3.2

**Table (2):** Frequency and percentage distribution of the studied patients according to their Anthropometric measurement (n=62).

Items	No.	%
<b>Weight (Kg)</b>		
60-<70	9	14.5
70-<80	14	22.6
≥ 80	39	62.9
<b>Mean SD</b>	<b>83.23 ± 14.8</b>	
<b>Height (cm)</b>		
155-<165	17	27.4
165-<175	27	43.5
≥ 175	18	29.0
<b>Mean SD</b>	<b>168.7 ± 8.13</b>	
<b>Body mass index</b>		
Underweight	0	0.0
Normal weight	15	24.2
Pre-obesity	20	32.3
Obesity	27	43.5

**Table( 3):** Comparison between the studied patients according to Ankle Brachial Index at pre and post implementation of Buerger Allen exercise (n=62).

Levels of Ankle Brachial Index	Right limb				X <sup>2</sup>	p-value	Left limb				X <sup>2</sup>	p-value
	Pre intervention		Post intervention				Pre intervention		Post intervention			
	No.	%	No.	%			No.	%	No.	%		
Normal perfusion	0	0.0	36	58.1			0	0.0	38	61.3		
Mild diminished perfusion	18	29.0	17	27.4	<b>52.74</b>	<b>0.000**</b>	20	32.3	16	25.8	<b>52.92</b>	<b>0.000**</b>
Moderate diminished perfusion	44	71.0	9	14.5			42	67.7	8	12.9		
Severe diminished perfusion	0	0.0	0	0.0			0	0.0	0	0.0		
<b>x<sup>-</sup>S. D</b>	<b>0.593±0.14</b>		<b>0.851±0.11</b>		<b>t=18.24</b>	<b>0.000**</b>	<b>0.621±0.14</b>		<b>0.860±0.09</b>		<b>t=17.73</b>	<b>0.000**</b>

t= Paired t. test. X2: Chi-square. \*\*highly significant at p < 0.01.

**Table (4):** Comparison between the studied patients according to clinical features of peripheral vascular disease at pre and post implementation of Buerger Allen exercise (n=62).

Items	Right limb				X <sup>2</sup>	p-value	Left limb				X <sup>2</sup>	p-value
	Pre-intervention		Post intervention				Pre-intervention		Post intervention			
	No.	%	No.	%			No.	%	No.	%		
Normal	4	6.5	33	53.2			3	4.8	33	53.2		
Mild	15	24.2	18	29.0	<b>36.00</b>	<b>0.000**</b>	13	21.0	16	25.8	<b>37.67</b>	<b>0.000**</b>
Moderate	33	53.2	8	12.9			39	62.9	10	16.1		
Severe	10	16.1	3	4.8			7	11.3	3	4.8		
<b>x<sup>-</sup>S. D</b>	<b>11.15±3.4</b>		<b>6.21±3.40</b>		<b>t=14.17</b>	<b>0.000**</b>	<b>11.13±2.88</b>		<b>6.24±3.45</b>		<b>t=15.29</b>	<b>0.000**</b>

t= Paired t. test. X2: Chi-square. \*\*highly significant at p < 0.01.

**Table (5):** Comparison between the studied patients according to total peripheral neuropathy history at pre and post implementation of Buerger Allen exercise (n=62).

Items	Pre-intervention		Post intervention		X2	p-value
	No.	%	No.	%		
Positive	40	64.5	17	27.4		
Negative	22	35.5	45	72.6	<b>14.78</b>	<b>0.000**</b>
<b>x<sup>-</sup>S. D</b>	<b>6.40 ± 2.84</b>		<b>4.53 ± 2.48</b>		<b>t=8.283</b>	<b>0.000**</b>

t= Paired t. test. X2: Chi-square test. \*\*highly significant at p < 0.01.

**Table (6):** Comparison between the studied patients according to total peripheral neuropathy symptoms at pre and post implementation of Buerger Allen exercise (n=62).

Items	Pre-intervention		Post intervention		X <sup>2</sup>	p-value
	No.	%	No.	%		
Normal	26	41.9	50	80.6		
Abnormal	36	58.1	12	19.4	<b>14.98</b>	<b>0.000**</b>
<b>x<sup>-</sup>S. D</b>	<b>2.17±0.815</b>		<b>1.78±0.669</b>		<b>t=5.717</b>	<b>0.000*</b>

t= Paired t. test. X2: Chi-square test. \*\*highly significant at p < 0.01.

**Table (7):** Correlation between total Ankle Brachial Index, total clinical features of PVD, total peripheral neuropathy history and total peripheral neuropathy symptoms among the studied patients at pre and post intervention (n=62).

Variables	Total Ankle Brachial Index				Total clinical features of peripheral vascular disease				Total peripheral neuropathy history				Total peripheral neuropathy symptoms			
	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
	r	P	r	P	r	P	r	P	r	P	r	P	r	P	r	P
Total Ankle Brachial Index	1	0	1	0	-0.477	0.000	-0.792	0.000	-0.374	0.007	-0.665	0.000	-0.301	0.009	-0.386	0.002
Total clinical features of peripheral vascular disease	-0.477	0.000	-0.792	0.000	1	0	1	0	0.331	0.009	0.632	0.000	0.390	0.007	0.392	0.009
Total peripheral neuropathy history	-0.374	0.007	-0.665	0.000	0.331	0.009	0.632	0.000	1	0	1	0	0.644	0.000	0.622	0.000
Total peripheral neuropathy symptoms	-0.301	0.009	-0.386	0.002	0.390	0.007	0.392	0.009	0.644	0.000	0.622	0.000	1	0	1	0

R= correlation coefficient test. (-) negative correlation. P= p-value \*\*highly significant at  $p < 0.01$

## Discussion:

Regarding demographic data, the present study revealed that more than half of the studied patients their age ranged between 51-65 years old, the mean  $\pm$  SD of age was  $57.16 \pm 7.56$  years. This result may be due to increasing the risk of peripheral arterial disease among type II DM with the aging process. This result agreed with **Sasi et al., (2020)** who evaluate LEP among Patient with Type 2 DM a Tertiary Care Hospital, revealed that the average age of experimental group in their study of LEP with Type 2 DM was  $55.30 \pm 4.58$ .

This result was also in contradicted with **Bhuvaneshwari & Tamilselvi (2018)** who conduct the study to assess Effectiveness of Buerger Allen Exercise on Lower Extremity Perfusion among Patients with DM in Saveetha Medical College revealed that more than one third of the patients with diabetes age group were above 60 years old.

Concerning gender, the study shows that, more than two thirds of patients were male, less than three quarters of them were married because men are more likely to receive a diagnosis of diabetes than women. However, some Source suggests that women with diabetes may be more likely to develop complications than men.

This result agreed with **Latha & Gifty, (2019)** who Assess the Effectiveness of Buerger Allen Exercise on Lower Extremity Perfusion

among Patients with Type 2 DM in selected hospitals at Kanyakumari District, conduct that studied Patients of Maximum in experimental group, said that less than three quarter of studied patients in experimental group were male.

In contrary to the current study findings **suza et al., (2020)** who assess effect of lower extremity exercises on ankle-brachial index values among type 2 diabetes mellitus patients. illustrated that more than half of the patients were females.

As regards occupation, the result of the current study showed that more than one third of the studied patients were working, more than half of them had moderate work. These results may be related to the diabetic patients were less mobile, which lead to a slowing of lower peripheral blood circulation. These results supported by **Srivastava et al., (2022)** who study effectiveness of Buerger Allen exercise on lower extremity perfusion among diabetes mellitus patients in Coimbatore and revealed that that one third of experimental and control group were unemployment.

In contrast to the current study findings **Bhuvaneshwari, & Tamilselvi, (2018)** who illustrated that two thirds of studied patients were employees.

The current study revealed that less than one third of the studied patients were illiterate and secondary education. This result may

indicate that, this may be rationalized as in the past there was no interest in education so, illiteracy was common among diabetic patients that lead to lack of health awareness about diabetes, which can be converted into complication leads to peripheral vascular disease.

Regarding body mass index, the present study shows that Mean SD of weight was  $83.23 \pm 14.8$ , Mean SD of height was  $168.7 \pm 8.13$ , and less than half of the studied patients were obese. This is due to lack of compliance with healthy diet for diabetic patients and exercise. An increase in body fat is commonly related to increased risk of metabolic illnesses such as type II DM. This result is consistent with **El-Fattah et al., (2019)** who inferred that nearly two thirds of the patients with DM had high B.M.I.

In contrast to the current study results **Tawabini, (2020)** who evaluate the effectiveness of Buerger Allen exercise in improving peripheral vascular tissue perfusion among clients with type II DM reported that, nearly half of the subjects were in the normal range of BMI.

Concerned to lower extremities perfusion, the current study proved that, more than half and less than two thirds of studied patients had a normal ankle brachial index in right and left leg respectively in immediate post-test with highly statistically significance, it may be attributed to that these postural exercises with alternating emptying and filling of the blood vessels increase circulatory efficiency and local collateral circulation through stimulation of peripheral vascular system.

Furthermore, **El Sayed., et al., (2021)** stated that there was a highly statistically significant difference between pre-exercise and five days post exercise regarding the mean scores of ABI in both legs. Also, there were statistically significant differences regarding the mean scores of ABI in both legs post five and fifteen days of Buerger Allen exercise implementation.

Also, **Radhika, et al (2020)** who evaluate effectiveness of Buerger Allen exercise on lower extremity perfusion and peripheral neuropathy symptoms among patients with diabetes mellitus, revealed that there is a significant improvement in (ABI) score in improving the level of lower extremities perfusion among people with DM after receiving Buerger Allen exercise at the level of  $P < 0.05$ .

In contrary to the current study findings, **Kumar, (2018)** who establishes a study on study to evaluate the effectiveness of Buerger Allen Exercise in improving peripheral vascular tissue perfusion among clients with type II diabetes mellitus in selected hospital at Maharashtra, found that the pre- test of ankle brachial index (ABI) scores regarding the peripheral vascular tissue perfusion among clients with type II diabetes mellitus shows that more than two thirds of clients had moderate reduction in peripheral vascular tissue perfusion.

Moreover , the current study showed a highly significant improvement in all clinical features checklist for PVD, as evidenced by, more than half of studied patients had an improvement in the lower extremities perfusion in right and left leg respectively in immediate post-test, This finding is due to doing Buerger Allen exercise which use gravity to empty and fill blood vessels alternately to drain congested vessels, which finally improves blood transportation, stimulate and promote collateral circulation.

These finding in the same line with **Wahyuni et al., (2022)** who built study on implementation of Buerger Allen exercise in patients with diabetes mellitus to improve lower extremity circulation post, and follow up test for experimental and control groups, confirmed that, nearly half of patients with normal lower extremity perfusion in immediate post-test and more than half normal perfusion in follow up test.

Also, This finding is congruent with **Priya.N (2016)** who study effectiveness of Buerger Allen exercise on levels of lower

extremity perfusion among patients with selected non-communicable diseases (NCDs) in Vellore and mentioned that after practicing Buerger Allen exercise the posttest mean value for selected clinical features of PVD was greater than pretest mean value this shows that Buerger Allen Exercise is effective in improving lower extremity perfusion among patients with selected NCD.

The current study showed an improvement in PN with a highly statistically significant difference ( $P < 0.01$ ). As evidence, less than three quarters of the studied patients had negative history at post intervention phase.

This results on the same hand with **Radhika et al., (2020)** who mentioned that there was a statistically considerable difference in the mean score for exercise effect on LEP of patients with DM between the pretest and posttest at the level of  $p < 0.001$ . On the posttest, the number of patients with no significant PNS was increased.

But on the other hand, based on research conducted by **Di Raimondo, et al (2018)** who investigate role of regular physical activity in neuroprotection against acute ischemia, stated that performing physical activities such as foot exercises will emit stimulants that will help restore motor nerve function. However, it should last a long period, at least 13 weeks due to nerve damage.

The current study showed an improvement in PNS with a highly statistically significant difference ( $P < 0.01$ ). As evidence, the majority of the studied patients had normal examination score for PNS at post intervention phase.

A similar result was also proved by research of **Zahran, et al (2018)**, who assess the effect of Buerger Allen exercise on lower limb perfusion among patients with type 2 diabetes mellitus, mentioned that there is a significant effect of foot exercise on peripheral neuropathy symptoms.

But on the other hand, based on research conducted by **Lazzarini, et al (2018)** who

stated that performing physical activities such as foot exercises will emit stimulants that will help restore motor nerve function. However, it should last a long period, at least 13 weeks due to nerve damage.

According to correlation between variables of the study, revealed that, there was highly significant statistical negative correlation between patients' Ankle Brachial Index and total clinical features of peripheral vascular disease, total peripheral neuropathy history and Total peripheral neuropathy symptoms at pre and post intervention at  $p < 0.01$ .

These results supported by **Patidar, (2018)** who found that, there were significant negative correlation between performance of mean scores of ABI score and clinical feature of PVD and PNS in both limbs at two weeks post exercise among study group before and after performing Buerger Allen exercises.

While there was highly significant statistical positive correlation between total patients' clinical features of peripheral vascular disease and total peripheral neuropathy history, total peripheral neuropathy symptoms at pre and post intervention at  $p < 0.0$ . This may be due Burger Allen exercises which improve vascularity to lower limbs and consequently it will help to improve perfusion and PNS.

This findings at the same line with **Vijayarathi, (2016)** who conduct a study to assess the effectiveness of Buerger - Allen Exercise on Wound Healing Process among the Diabetic Foot Ulcer Patients, found that there was positive relation between clinical feature of PVD and PNS before and after implementation of Buerger Allen exercise.

### **Conclusion:**

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Based upon the current study hypotheses, the implementation of Buerger Allen exercise affected positively on lower limb perfusion and peripheral neuropathy among patients with peripheral vascular diseases through the following:

There was an improvement in ankle brachial index score, and reduction of clinical feature of peripheral vascular disease after application of Buerger Allen exercise. Which enhanced the perfusion of lower extremities, Also, there was an improvement in peripheral neuropathy symptoms after application of Buerger Allen exercise.

### Recommendation:

**In the light of the findings of the current study the following recommendations for future research and practice can be suggested:**

- Patients must attend health education sessions based on evidence guidelines regard Buerger Allen exercise for improvement of lower peripheral circulation.
- Planning a program that helps patients to enhance self-care management of peripheral vascular disease.
- Encourage health care providers, especially nurses to integrate Buerger Allen exercise in the care protocols of patients with peripheral artery disease in different health care settings.
- Training course for nursing about proper implementation of Buerger Allen exercise.
- A comparative study conducted to evaluate the effectiveness of Buerger Allen Exercise with other non-pharmacological measures for improving the level of lower extremity perfusion.
- The study can be repeated by using a large sample to generalize the findings .

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