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Effect of Buerger Allen exercise on improving lower extremities perfusion among diabetic elderly patients: Randomized clinical trial

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Abstract

Background: Older adults with diabetes mellitus who have had the condition for a long time are more prone to develop peripheral artery disease. To encourage collateral circulation in the lower extremities, perform the Buerger Allen exercise, which involves dynamic postural exercises for both legs.

Aim: To evaluate the effect of Buerger Allen exercise on improving lower extremities perfusion among diabetic elderly patients.

Design: A quasi-experimental research design was utilized.

Setting: The current study was carried out in medical outpatient clinic and medical department of Minia University Hospital, Egypt.

Subjects: A purposive sample of (120) diabetic elderly patients.

Tools: First Tool: patient assessment sheet included two parts, demographic data and medical profile. Second Tool: peripheral circulation assessment tool.

Results: the means of age were (66.2 ± 3.74 & 65.9 ± 4.59) for the study and control groups respectively, and more than half of the both groups were females. Concerning the assessment of peripheral perfusion, the study group exhibited sufficient (good) peripheral perfusion at posttest with percentages of (65%) and (61.7%) for right and left leg respectively after 8 weeks of applying the Buerger Allen exercise as compared to (43.3% & 41.7%) before, with a highly statistical significance difference ($P \leq 0.01$) was detected between the two groups.

Conclusion: Implementation of Buerger Allen exercise positively enhanced the peripheral perfusion of lower extremities particularly (capillary refill time, peripheral pulses, temperature and skin color) among diabetic elderly patients.

Recommendations: Elderly diabetic patients should get ongoing instruction on the advantages and proper application of Buerger Allen exercise in all healthcare settings.

Keywords: Buerger Allen exercise, diabetic elderly, lower extremities, peripheral perfusion

Introduction

Diabetes mellitus (DM), usually referred to as a metabolic illness, is a form of endocrine disease marked by persistently elevated blood sugar levels. Related to either the body cells not responding to the effects of insulin or insufficient production of the hormone by the pancreas. If diabetes is not controlled, complications can worsen, harm the cardiovascular and neurological systems, reduce blood flow to different body parts, and raise the risk of ischemia and lower limb amputations (Ayieng'a 2023) [7].

A number of factors associated with aging and lifestyle choices make the elderly population more susceptible to Type 2 diabetes. The higher incidence is caused by age-related changes such as increased insulin resistance, decreased pancreatic insulin production, and changes in body composition, such as decreased muscle mass and increased belly fat (Lawler, *et al*., 2023) [20].

In Egypt the Central Agency for Public Mobilization and Statistics (CAPMAS) reports that 39 million people have been diagnosed with type II diabetes, with about 8.6 million of those people being senior. Egypt now ranks eighth globally in terms of diabetes incidence, and if proper health measures are not put in place, the number of cases might double by 2045, when it is predicted to rank sixth. (Central Agency for Public Mobilization and Statistics, 2019).

Atherosclerosis, which narrows arteries and raises the risk

of microvascular issues like retinopathy, neuropathy, and nephropathy as well as macrovascular issues like peripheral artery disease (PAD), coronary artery disease (CAD), congestive heart failure, and cerebrovascular disease (CVD), can be brought on by long-term uncontrolled hyperglycemia and poor management (Akhtar *et al*., 2023) [3].

Partial or complete blockage of the peripheral arteries in the upper and lower limbs is referred to as "peripheral arterial disease" (PAD). It typically appears as a part of systemic atherosclerosis in the coronary and cerebral arteries. Diabetes mellitus (DM) typically affects the arteries of the lower extremities; the distal arteries, particularly the dorsalis pedis artery, are eventually impacted by endothelial and smooth muscle cell loss in peripheral arteries (Lawler, *et al*., 2023) [20]**.** Because of the long-term effects of diabetes on peripheral arteries and age-related alterations to blood vessels, PAD is more common in older persons. Many problems, including non-healing ulcers, more hospitalizations, and higher death rates, can arise from PAD (Soyoye *et al*., 2021) [30].

According to estimates, 56% of people over 60 with type 2 diabetes mellitus had PAD, which destroys the nerves in the lower extremities, primarily in the feet and legs. Symptoms like numbness, tingling, pain, and weakness result in functional impairment and lower quality of life because of sensory loss, increased risk of falling, foot ulcers, and gangrene, which ultimately results in lower limb amputation (Jenabi *et al*., 2025) [18].

Older adults with diabetes frequently have foot problems because of the pathological changes in their feet brought on by the disease and the difficulties of not taking proper care of their feet. One of the main risks for getting foot ulcers is peripheral vascular disease. A new study in Egypt found that older adults with type 2 diabetes have a significant prevalence of foot ulcers, with 29.3% of them having the condition, 63.3% having vascular problems, and 88.0% having neuropathy (Galal *et al*., 2021) [12].

An essential component of nursing patient care is monitoring peripheral perfusion, which assesses blood flow in the skin, nail beds, and other tissues' peripheral microcirculation. In order to identify high-risk instances of PAD early on, nursing staff should continue to include peripheral perfusion measurement in their usual treatment for older diabetes patients. Pulse, capillary refill time (CRT), feeling, skin color, and temperature are all evaluated since they may be indicators of possible circulatory issues Jenabi *et al*., 2025 [18]. Coagulation failure brought on by endothelial cell damage can result in the development of microthrombi, which obstruct microvessels and impair peripheral perfusion. Warm pink skin, toenails, and a quick return to baseline after blanching with finger pressure are signs of healthy peripheral circulation (Wahyuni *et al*., 2022) [32].

In order to enhance peripheral circulation in the lower extremities and reduce symptoms related to peripheral neuropathy, Buerger-Allen exercise is a commonly used non-pharmacological therapeutic technique for diabetic patients. It aims to facilitate the drainage of engorged vessels through postural adjustments that enhance peripheral circulation in the lower extremities by manipulating gravity and applying muscle contractions (Zaki *et al*., 2023) [33].

One active postural exercise that is targeted to enhance blood flow to the feet is the Buerger-Allen exercise. Three stage positions are included in this exercise: Position 1 (elevation), in which the patient lies supine with the leg raised to an angle of 45 to 90 degrees, should be maintained for 2 to 3 min until the foot's skin turns pale, a process called blanching. Position 2 (dependency): Sit with your legs hanging below your torso until the skin turns red, which should take three to five minutes. Make sure the back of your knee is not under any pressure. The legs must remain flat on the bed for three to five minutes in position three (horizontal), which is a supine position with horizontal legs. It is advised to do each workout two to six times a day at a frequency of one to five cycles for optimal results (Hassan *et al*., 2020) [15].

Nursing care for diabetic elderly patients must include assessment of peripheral circulation, improvement of peripheral perfusion of lower limbs, and reduction of foot issues. This can be accomplished by offering a training session on the value of ongoing Buerger-Allen exercises to all elderly diabetic patients and their caregivers (Afida *et al*., 2022) [2]. Buerger-Allen exercises have been shown in numerous recent studies to be useful for diabetic elders because they are a simple, safe, affordable, and non-pharmacological method of improving lower extremity peripheral perfusion. Therefore, the purpose of our study was to evaluate the beneficial impact of Buerger-Allen exercises on the perfusion of the lower extremities in senior diabetic patients (Hosney SH. 2025 & Haque, *et al*., 2023) [16, 14].

Significance of the Study

Approximately 422 million older people worldwide have diabetes mellitus. It was estimated that 15.6% of 72-year-old Egyptian seniors had type II diabetes. Peripheral artery disease, which results in reduced circulatory perfusion to the lower extremities and can lead to vascular insufficiency, foot ulcers, and decreased wound healing, is among the most prevalent consequences of diabetes mellitus in older persons (Adel Ebada El Sayed, *et al*., 2021) [11]. Diabetic elderly persons are exhibiting a prevalence rate of peripheral artery disease 3 to 4 times higher than that of non-diabetic individuals. About 60% of older adults with diabetes have the potential to develop PAD at any time, and the risk increases with age and the length of diabetes. It additionally, accounts for over 85% of lower limb amputations, with a higher mortality rate in older adults ranging from 24.6% to 45.4% (Saleh *et al*., 2024) [27].

One important non-pharmacological strategy for improving lower peripheral circulation and preventing peripheral vascular disorders in older diabetes patients is Buerger Allen exercise. Buerger Allen exercise has been shown to strengthen lower extremity perfusion in a number of recent national and international studies (Rumagit *et al*., 2023; Saleh *et al*., 2024; Hosney SH., 2025) [26, 27, 16]. However, there is no place in our governorate dedicated to teaching diabetic elderly patients about this exercise, and few studies have addressed this health issue. Thus, this study was carried out.

Aim of the Study

The aim of the study was to evaluate the effect of applying

Buerger's Allen Exercise on improving peripheral perfusion of lower extremities among elderly patients with type 2 diabetes mellitus.

Hypothesis

H1: The mean score of lower extremities perfusion will be increased after application of Burger Allen Exercise among the study group compared to the control group.

Operational definition

- **Peripheral perfusion:** is the movement of blood via the blood vessels found in the skin and hand, foot, finger, and toe. It is a crucial sign of the circulatory system's ability to supply the body's peripheral tissues with nutrients and oxygen. Non-healing foot ulcers can form in diabetes individuals due to poor peripheral tissue perfusion, this increases the chance of amputation of the lower extremities.

Subjects and Methods

Research Design

The present research employed a quasi-experimental research design (study/control).

Setting of the Study

The study was carried out in the medical outpatient clinic and medical department at Minia University Hospital, Minia governorate, Egypt.

Sampling and Sample Size

A purposive sample of (120) elderly patients selected by non-probability sampling technique were estimated centered on (Isaac and Michael 1995) [17] formulation which is calculated as (N=nx30/100) in which:

N= Sample size

n= Overall number of 400 diabetic elderly patients admitted to Minia University Hospital during the last year.

N=400x30/100=120 patient.

Then the researcher divided them into two equal groups study and control, (60) patients for each group.

Inclusion Criteria

1) Patients irrespective of gender, aged 60 years or older who have type II diabetes mellitus.

Exclusion Criteria

1. Individuals who declined to take part in the current research.
2. Incapable of communication.
3. An existing diabetic foot ulcer or one that has previously healed.
4. Patients with a history of receiving instruction on the Buerger's Allen Exercise.

Study Duration

The collecting of all the data took place over a ten-month period, beginning in December 2023 and ending in September 2024.

Study Tools

A pair of tools were used to gather data for the current study; the researcher examined the tools following a pilot study, and the tools' content was determined following a thorough literature analysis before being edited by jury members who are subject-matter experts**.**

Tool (I): Patient Assessment Sheet

It was created by the researcher following a review of relevant literature and comprised the two following parts:

- **Part 1:** Presented the demographic data of the patient such as (patient's age, gender, marital status, education, residence, and occupation).
- **Part 2:** Presented medical data such as (The day of admission, duration of diabetes mellitus, family history and medication used).

Tool (II): Peripheral Circulation Assessment Tool

This tool, which was adopted from (Priya, 2016) [23], assessed the perfusion of the lower limbs in patients with diabetes. Capillary refill time, peripheral pulses, edema, pain, temperature, and skin color are among its six parameters. The four responses for each measure were as follows: mild circulatory insufficiency (1), moderate circulatory insufficiency (2), severe circulatory insufficiency (3), and normal perfusion (0).

Scoring system for 6 peripheral circulation parameters

First parameter is dorsal pedis pulse with four responses are (normal, weak, non-palpable, or absent pulse). 2nd one is Capillary refill time assessed via utilizing capillary refill test with categories of (1-2 seconds, 3-4 seconds, and >4 seconds).The third parameter is presence of edema was categorized as no edema, pitting that was (+1) less than 2 mm and vanished quickly, pitting that was between (+2) 2 and 4 mm and vanished in 10 to 15 seconds, and pitting that was (+3) 4 to < 6 mm and vanished in 10 to 15 seconds. The forth is skin temperature that examined by using dorsum of hand with responses of (warm, mild, moderate & cold). The fifth item is pain which evaluated by using numerical scale (Jensen *et al*., 2001) and interpreted in to four responses (Zero mean No pain, from 1-3 Mild pain, from 4-6 Moderate pain & from 7-10 Severe pain), and the last parameter was observation of skin color with the four responses of (pink, Pale, Black, Reddish).

Total Score Interpretation of Peripheral Circulation Assessment

Grade	Score	Interpretation
1	0-4	Good blood perfusion (sufficient blood supply)
2	5-9	Slightly Poor blood Perfusion (slightly insufficient)
3	10-14	Poor blood perfusion (insufficient)
4	15-18	Very poor blood perfusion (very insufficient)

Tools Validity

Three experts from Minia University's medical surgical nursing staff and geriatric nursing staff panel assessed the tools to ascertain their validity, and any required modifications were made.

Tools Reliability

The study tools' consistency was evaluated using the Cronbach Alpha test, and the peripheral circulation perfusion of the lower extremities test produced a

trustworthy result of 0.897.

Pilot study

A pilot study was carried out to assess the study's feasibility and the appropriateness of the instruments. Since no major adjustments were needed, twelve patients (10%) of the entire sample were employed in the study.

Ethical Consideration

- The study was implemented following formal approval from the head of Minia University Hospitals' ethical committee and the faculty of nursing's ethical committee. Each patient and their family members gave the researcher their verbal consent to participate voluntarily**.**
- Data confidentiality was maintained, and the patient was made aware of their right to withdraw from the study at any moment by the researcher. By encrypting all data and safeguarding the collected information, each subject's confidentiality and anonymity were guaranteed. Participants and their caregivers were given an explanation of the study's purpose by the researcher, along with the possible advantages of continuing the study.

Statistical analysis

The Statistical Package for Social Science (SPSS) version 27 was used to categorize, arrange, and analyze the collected data. The mean, standard deviation, frequency, and percentage were the descriptive statistics that were employed. When comparing variables with categorical data, the chi-square test (or Fisher's exact test, if available) was employed. To determine whether three or more variables differed significantly, the Friedman test was employed. Pearson's correlation coefficient was used to establish a relationship between numerical variables. A significant level value was considered when $p<0.05$. If a discovery's p-value was less than 0.001, it was considered extremely significant (*). The more significant the result, the lower the p-value.

Study Procedure (Field work)

There were three phases to the field work: preparatory, implementation, and outcomes evaluation.

I: Preparatory and administrative phase

- This study was carried out with official consent from the relevant authorities. After receiving formal approval, the researcher visited Minia University Hospital in Egypt's medical department and outpatient clinics, which are open six days a week from 9 a.m. to 1 p.m., to begin gathering data. Researchers collected data during morning shifts on three different days of the week.
- After being informed about the current study's goal and their freedom to withdraw at any moment, each participant gave their informed consent to meet the study's requirements.
- Nursing educational brochure was prepared after reviewing recent related literature in basic Arabic and with colored pictures given to the patients of the study group, which included steps of Buerger Allen exercise (definition, benefits, and technique of exercise).

II-Implementation

- During this phase, the researcher conducted interviews with patients and their families while they were working the morning shift at the medical outpatient clinics. She introduced herself, described the study's nature and goal, and then got both written and verbal consent from those who agreed to participate.
- First, the control group, which received standard hospital nursing care, was interviewed in-person by the researcher to begin gathering data. The first tool was used to collect demographic and medical data, and the second tool was used to examine the peripheral circulation of both lower extremities. Each patient needed fifteen to thirty minutes to finish the entire questionnaire assessment sheet.
- Once the control group's data collection was complete, the researcher began collecting data from the study group using the identical 1st and 2nd tools as baseline data, which took each patient 20 to 30 minutes to complete. The researchers then started conducting the instructive nursing sessions.
- Two planned educational sessions divided into
- 1st session designed to cover for the theoretical part through using face to face lecture, posters, videos, discussion, and handouts with coloured images as teaching methods covered the following information (diabetes definition, manifestations, complications, peripheral artery disease definition and manifestations, Burger Allen exercise description and its benefits). It took about 20-40 minutes.
- 2nd second planned for the practical part concerned Burger Allen exercise by utilizing PowerPoint, discussion, demonstration and re-demonstration as teaching methods, as well as, an educational brochure in simple Arabic language with colored pictures given to each patient of the study group, which included steps of Buerger Allen exercise to ensure that patients and their relative well understood the steps and right technique to perform it independently and perfectly at home.
- Buerger-Allen exercise involves a series of postural changes to improve blood circulation in the lower extremities. The exercise consists of three steps: elevation, dependency, and rest. The patient elevates their legs, then lowers them to encourage blood flow, and finally rests with legs horizontal. The experimental group recommended that the exercise must be performed (5-6) times per day, each time (12-15 minutes), duration of exercise continued for 8 weeks. The technique of the exercise simply explained

Elevation step

It is the beginning step in which he patient instructed to lie on back and raises their legs at a 45-90 degree angle, habitually supported by a chair of pillows. The legs are held in this position till the skin on the feet and toes becomes pale. This is usually taking 2-3 minutes, but can fluctuate.

Dependency step

The patient then allows the feet and legs to become reliant by sitting at the edge of the bed chair with their legs dangling down. Until the skin turns pink or red again, the

legs and feet are lowered below the rest of the body. Avoiding pressure behind the knees is crucial, and this process usually takes five to ten minutes.

Horizontal step

The last step in which the patient then lies flat on his/her back with legs extended horizontally on the bed and the limbs are kept horizontal for around 5 to10 minutes, under the warmth of a blanket.

The participants were split up into small groups by the researchers, with three to four examples per group. Each session lasts roughly 20 to 40 minutes, and the length of time varies based on the patient's tolerance. It is advised that patients do the exercise two to five times a day for 12 to 15 minutes each time, for a total of eight weeks.

III-Evaluation

The outcome of performing Burger Allen's exercises for peripheral circulation was re -assessed after 2 months by using the 2nd tool (peripheral circulation assessment scale of both lower extremities) at the previously mentioned settings for both study & control groups.

The researcher followed the patients of the study group in outpatient clinics and via telephone weekly after being discharged to ensure the compliance to Buerger Allen exercise and to the given instructions at home. The researcher offered medications that prescribed by the physician in the department and outpatient clinics for patients to enhance a continuous follow up. After finishing the study the researcher gave the nursing educational brochure to the patients of the control group.

Results

Table 1: Percentage Distribution of Study and Control Group Regarding their Demographic Data (n=120)

Demographic Data	Study Group (n=60)		Control Group (n=60)		Sig test (P value)
	No	%	No	%	
Age					
60 to 64 years	15	21.7	21	35.0	F = 5.11 (0.056)
65 to70 years	38	63.3	30	50.0	
More than 70	7	11.6	9	15.0	
Mean of age	66.2 ± 3.74		65.9 ± 4.59		
Gender					
Male	21	35	24	40	X^2 = 0.320 (0.706)
Female	39	65	36	60	
Marital status					
Single	1	1.7	0	0	F = 1.81 (0.729)
Married	46	76.7	50	83.3	
Widow	10	16.7	8	13.3	
Divorced	3	5	2	3.3	
Education					
Illiterate	29	48.3	24	40	F = 4.85 (0.305)
Read & write	7	11.7	16	26.7	
Primary	11	18.3	8	13.3	
Secondary	10	16.7	8	13.3	
University	3	5	4	6.7	
Residence					
Urban	17	28.3	26	43.3	X^2 = 2.93 (0.127)
Rural	43	71.7	34	56.7	
Occupation					
Farmer	4	6.7	7	11.7	F = 2.99 (0.579)
House wife	31	51.7	32	53.3	
Unemployed	12	20	6	10	
Retired	5	8.3	5	8.3	
Commercial work	8	13.3	10	16.7	
Monthly income					
Sufficient	14	23.3	8	13.3	X^2 = 2.04 (0.238)
Not sufficient	46	76.7	52	86.7	
Who is live with you?					
Alone	3	5	9	15	F = 4.26 (0.928)
With husband/wife	47	78.3	30	50	
With the children	10	16.7	21	35	

*Statistical significant difference ($P \leq 0.05$), F (Fisher exact), X^2 (Chi square)

Table (1): Illustrated that (63.3% and 50.0%) of the study & control group were aged from 65 to70 years and (65%) and (60%) of both groups respectively were females. Also, it was found that (76.7%) of study group and (83.3%) of the control group were married, (48.3%) & (40%) of both groups respectively were illiterate. Additionally, (71.7%) & (56.7%) of them respectively had lived in rural regions. Regarding occupation, (51.7%) & (53.3%) of study & control group were house wives respectively, and the highest percentages of both groups had insufficient monthly income. Finally, no statistical significant differences were found between the study & control groups regarding their

socio-demographic data.

Table 2: Percentage Distribution of Study and Control Group Regarding their Medical Data (n=120)

Medical Data	Study Group (n=60)		Control Group (n=60)		Sig test (P value)
	No	%	No	%	
Duration of diabetes					
from 1 to 5 years	13	21.7	8	13.3	$X^2 = 0.594$ (0.747)
from 6 to 10 years	23	38.3	20	33.3	
More than 10 years	24	40	32	53.3	
Diabetes treatment					
Oral hypoglycemic agents	14	23.3	9	15	$X^2 = 1.41$ (0.523)
Insulin	36	60	42	70	
Insulin and oral hypoglycemic	10	16.7	9	15	
Compliance of used medications					
Yes	42	70	38	68.3	$X^2 = 0.333$ (0.701)
No	18	30	22	36.7	
Chronic disease added to diabetes ≠					
No	19	31.7	16	26.7	F = 2.38 (9.821)
Yes	41	86.3	44	73.3	
Types of chronic disease	**No (41)**	**%**	**No (44)**	**%**	
Hypertension	16	26.7	20	33.3	
Chronic Respiratory disease	6	10	3	5.0	
Hepatic disease	3	5	1	1.7	
Renal disease	4	6.7	2	3.3	
Cardiac disease	5	8.3	6	10	
Osteoarthritis	13	21.7	11	18.3	
Osteoporosis	5	8.3	7	11.7	
Smoking					
Yes	13	21.7	9	15	$X^2 = 0.891$ (0.480)
No	47	78.3	51	85	
Family history of peripheral artery disease					
Yes	12	20	8	13.3	$X^2 = 0.960$ (0.327)
No	48	80	52	86.7	
Family History of Diabetes					
Yes	25	41.7	32	53.3	$X^2 = 1.63$ (0.273)
No	35	58.3	28	46.7	

≠ means more than one answers, F (Fisher exact), X2 (Chi square), *Statistical significant difference ($P \leq 0.05$)

Table (2): Revealed that (40% and 53.3%) of the study & control groups had diabetes for more than ten years. Also, 60% and 70% treated with insulin, (70%) & (68.3%) of them respectively complied with their medication. Regarding chronic diseases, it was found that (86.3%) & (73.3%) of study and control group had chronic diseases plus to diabetes and (40% & 53.3) of both groups had diabetes for more than ten years. Also, it was observed that (78.3%) & (85%) from study & control group were none smoker, and (80%) & (86.7%) of them didn't have family history of peripheral artery disease. Furthermore, it was shown that both the study and control groups, respectively, had a family history of diabetes mellitus in 41.7% and 53.3% of cases. Regarding their medical data, there were no statistically significant differences between the study and control groups.

Table 3: Comparison between Study and Control Group Regarding their total score of Peripheral Circulation Assessment scale for Right Leg before and after application of Buerger Allen Exercise (n=120)

Peripheral Circulation (Right Leg)	Study group (N=60)		Control group (N=60)		Friedman test (P value)
	Pre exercise	Post 2 months	Pre exercise	Post 2 months	
	No (%)	N (%)	No (%)	N (%)	
Pulse (Posterior tibial and Dorsal Pedis)					
Normal (0)	18 (30)	32 (30)	14 (23.3)	10 (16.7)	8.21 (0.016*)
Mild (1)	28 (46.7)	30 (50)	37 (61.7)	35 (58.3)	
Moderate (2)	8 (13.3)	8 (13.3)	6 (10)	5 (8.3)	
Severe (3)	6 (10)	4 (6.7)	3 (5)	10 (16.7)	
Capillary refill					
Normal (0)	17 (28.3)	42 (70%)	25 (41.7)	22 (36.7)	14.7 (0.001**)
Mild (1)	32 (53.3)	15 (25%)	26 (43.3)	27 (45)	
Moderate (2)	11 (18.4)	3 (5%)	9 (15)	11 (18.3)	
Edema					
Normal (0)	55 (91.7)	58 (96.7)	48 (91.7)	41 (68.3)	5.66 (0.039*)
Mild (1)	5 (8.3)	2 (3.3)	12 (8.3)	16 (26.7)	

Moderate (2)	0 (0.0)	0 (0.0)	0 (0.0)	3 (5)	
Temperature					
Normal (0)	32 (53.3)	48 (80)	38 (63.3)	32 (53.3)	14.9 (0.001**)
Mild (1)	19 (31.7.)	9 (15)	20 (33.3)	20 (33.3)	
Moderate (2)	9 (15)	3 (5)	12 (20)	8 (13.3)	
Pain					
Normal (0)	34 (56.7)	45 (75)	43 (71.7)	44 (0)	4.59 (0.049*)
Mild (1)	16 (26.7)	10 (16.7)	17 (28.3)	13 (8.3)	
Moderate (2)	5(8.3)	3 (5.0)	0 (0.0)	0 (0.0)	
Severe (3)	5 (8.3)	2 (3.3)	0 (0.0)	3 (21.7)	
Color of skin					
Normal (0)	18 (23.3)	45 (75)	33 (55)	40 (66.7)	7.96 (0.019*)
Mild (1)	46 (76.7)	15 (25)	27 (45)	20 (33.3)	

** Highly Statistical significant difference ($P \leq 0.01$) **Statistical significant difference ($P \leq 0.05$)

Table (3): Showed there was a positive improvement in all items of circulation assessment scale for the study group at right leg after two months of applying the exercise than before with statistical significance differences detected between the study & control group regarding all items of peripheral circulation assessment at posttest.

Table 4: Comparison between Study and Control Group Regarding their total score of Peripheral Circulation Assessment scale for (Left Leg) before and after application of Buerger Allen Exercise (n=120).

Peripheral Circulation (Left Leg)	**Study group (N=60)**		**Control group (N=60)**		**Friedman test (P value)**
	Pre	**Post**	**Pre**	**Post**	
	No (%)	**No (%)**	**No (%)**	**No (%)**	
Pulse (Posterior tibial and Dorsal Pedis)					
Normal (0)	22 (36.7%)	44 (73.3%)	17 (28.3%)	19 (31.7%)	77.9 (0.001**)
Mild (1)	25 (41.6%)	10 (16.7%)	34 (56.7%)	32 (53.3%)	
Moderate (2)	7 (11.7%)	4 (6.7%)	4 (6.7%)	3(5.0%)	
Severe (3)	6 (10%)	2 (3.3%)	5 (8.3%)	6 (10%)	
Capillary refill					
Normal (0)	25 (28.3%)	46 (76.7%)	24 (40%)	22 (36.7%)	64.7 (0.001**)
Mild (1)	22 (58.3%)	9 (15%)	26 (43.3%)	27 (45%)	
Moderate (2)	13 (13.3%)	5 (8.3%)	10 (16.7%)	11 (18.3%)	
Edema					
Normal (0)	45 (75%)	50 (83.3%)	52 (86.7%)	47 (78.3%)	14.6 (0.041*)
Mild (1)	15 (25%)	10 (16.7%)	8 (13.3%)	10 (16.7%)	
Moderate (2)	0 (0.0)	0 (0.0)	0 (0.0)	3 (5%)	
Temperature					
Normal (0)	24 (40%)	46 (67.7%)	28 (86.7%)	30 (50%)	68.9 **(0.001**)**
Mild (1)	36 (60%)	14 (23.3%)	32 (13.3%)	30 (50%)	
Pain					
Normal (0)	33 (55%)	48 (80%)	40 (66.7%)	39 (65%)	49.3 **(0.001**)**
Mild (1)	14 (23.3%)	6 (10%)	10 (16.7%)	12 (20%)	
Moderate (2)	8 (13.3%)	4(6.7%)	6 (10%)	6 (10%)	
Severe (3)	5 (8.3%)	2 (3.3%)	4 (6.6%)	3 (5%)	
Color of skin					
Normal (0)	16 (26.6%)	45 (75%)	21 (35%)	24 (40%)	7.42 **(0.024*)**
Mild (1)	44 (73.3%)	15 (25%)	39 (65%)	36 (60%)	

** Highly Statistical significant difference ($P \leq 0.01$) **Statistical significant difference ($P \leq 0.05$)

Table (4): Showed there was a positive improvement in all items of circulation assessment scale after two months applying the exercise particularly in temperature, capillary refill time, and skin color for left leg among the study group of than before with statistical significance differences detected between the study & control group regarding all items of peripheral circulation assessment at posttest.

Table 5: Comparison between the Study and Control Group Regarding to Total Score of Peripheral Perfusion Assessment for Lower Extremities (n=120)

	Before Intervention		Post 2 months		Friedman test (P value)
	Study Group	Control Group	Study Group	Control Group	
	No=60 (%)	No=60 (%)	No=60 (%)	No=60 (%)	
Total score of right Leg Perfusion assessment scale					
Good (0 - 4)	26 (43.3%)	23 (38.3%)	39 (65%)	27 (45%)	9.13 **(0.001*)**
Slightly Poor (5 - 9)	25 (41.7%)	30 (50%)	18 (30%)	26 (43.3)	
Poor (10 - 14)	9 (15%)	7 (11.7%)	3 (5%)	7 (11.7)	
X^2 (p value)	4.03 (0.257)		90.7 **(0.001**)**		
Total score of left leg perfusion assessment scale					
Good (0 - 4)	25 (41.7%)	23 (38.3%)	37 (61.7%)	28 (48.7%)	12.17 **(0.001**)**
Slightly Poor (5 - 9)	29 (48.3%)	32 (53.3%)	19 (31.7%)	28 (46.7%)	
Poor (10 - 14)	6 (10%)	b	4 (6.7%)	4 (6.7%)	
X^2 (p value)	0.033 (0.855)		84.4 (0.001**)		

** Highly Statistical significant difference ($P \leq 0.01$) **Statistical significant difference ($P \leq 0.05$)

Table (5): Represents that the study group exhibited sufficient (good) peripheral perfusion with percentages of (65%) and (61.7%) for right and left leg respectively after 8 weeks of applying the Buerger Allen exercise as compared to (43.3% & 41.7%) before, with a highly statistical significance difference ($P \leq 0.01$) was detected between the two groups.

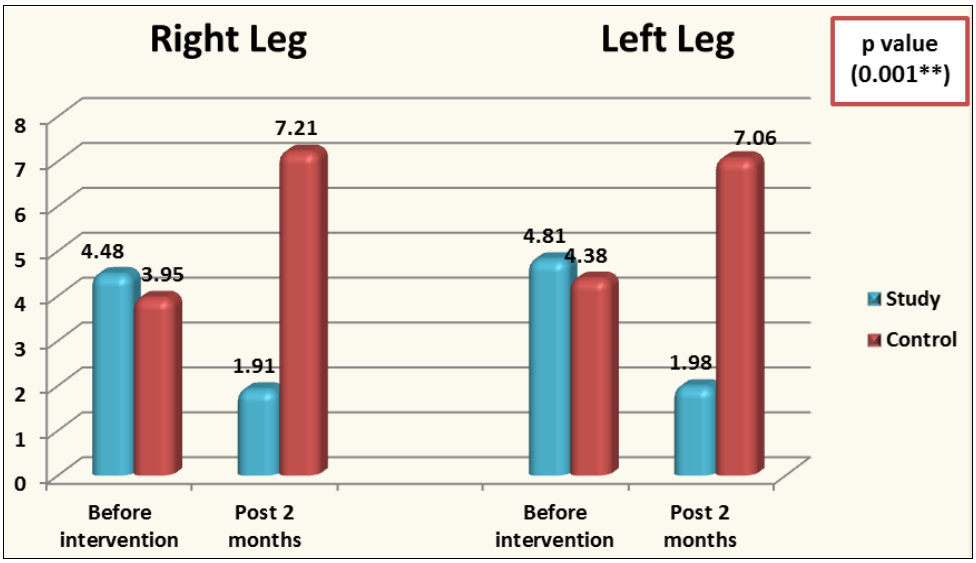

Fig 1: Mean Score of Study and Control Group Regarding their Peripheral Circulation Assessment for Lower Extremities (n=120)

Figure (1): According to peripheral circulation perfusion assessment of both legs, it was found that the mean score of perfusion insufficiency of right leg was 4.48 for the study group before the application of the exercise and this mean declined to be 1.91 after 2 months of the intervention, as well as for the left leg, the mean of perfusion insufficiency was 4.81 among the study group at pretest and improved to be 1.98 at posttest with high statistical significant differences between both groups. This indicates the positive effect of Buerger Allen Exercise in reducing peripheral perfusion insufficiency and this answered the research hypothesis.

Table 6: Total Mean Score of Study and Control Group Regarding their Peripheral Circulation Assessment for Lower Extremities (n=120)

	Total mean Score of peripheral circulation assessment	
	Study Group (n=60)	Control Group (n=60)
	Mean ± SD	
Before Intervention	9.30 ± 3.48	8.33 ± 2.92
t (P value)	1.64 (0.102)	
Post 2 months	3.90 ± 3.52	14.2 ± 2.84
t (P value)	17.7 (0.001**)	

** P value is highly statistical significant

Table (6): Results reflected that the total mean score of circulatory insufficiency among the study group was high as base line data at pretest (9.30 ± 3.48) and this mean score positively declined after the application of Buerger Allen

Exercise to be (3.90 ± 3.52) diversely to the control group who displayed no improvement in their peripheral circulation with highly statistically significant difference (p=0.001**). This reflects the positive effect of Buerger Allen Exercise in improving the peripheral perfusion and this answered the research hypothesis**.**

Table 7: Relation between Total Mean Score of Study and Control Group Regarding Peripheral Circulation Assessment for Lower Extremities and their Demographic Data (n=120)

Demographic Data	Pre exercise		F (P)	Post 2 months		F (P)
	Study Group (n=60)	Control Group (n=60)		Study Group (n=60)	Control Group (n=60)	
	Mean ± SD			Mean ± SD		
Age						
60 to less than 65 years	8.91 ± 3.20	8.25 ± 2.85	2.33 (0.102)	3.65 ± 3.62	14.1 ± 2.63	3.95 (0.036*)
65 to less than 70 years	11.8 ± 4.14	8.65 ± 2.99		4.91 ± 3.17	14.4 ± 3.24	
70 years and above	6.000	4.000		4.41 ± 2.17	14.000	
Gender						
Male	10.4 ± 3.42	7.62 ± 3.10	0.025)	3.71 ± 3.52	13.3 ± 2.63	0.097 (0.756)
Female	8.89 ± 3.49	8.80 ± 2.73		4.00 ± 3.56	14.8 ± 2.84	
Marital status						
Single	5.000	8.000	2.96 (0.035*)	1.000	14.000	2.883 (0.025*)
Married	8.97 ± 2.98	8.09 ± 2.79		3.89 ± 3.55	14.3 ± 2.87	
Widow	10.6 ± 4.90	9.87 ± 3.60		4.54 ± 3.50	14.00 ± 2.97	
Divorced	14.000	……		0.0000	……	
Education						
Illiterate	9.75 ± 4.07	8.91 ± 3.10	1.12 (0.347)	5.06 ± 4.12	14.5 ± 2.48	2.751 (0.049*)
Read & write	7.71 ± 2.13	8.37 ± 3.32		1.85 ± 1.06	14.3 ± 2.98	
Primary	9.27 ± 2.83	8.37 ± 2.66		3.45 ± 3.41	13.5 ± 0.925	
Secondary	9.80 ± 3.25	7.00 ± 1.60		3.30 ± 1.82	14.00 ± 4.17	
University	7.00 ± 1.73	7.25 ± 2.62		1.00 ± 1.00	14.2 2.84	
Residence						
Urban	9.00 ± 2.87	7.92 ± 2.97	1.40 (0.239)	3.29 ± 3.44	14.1 ± 3.17	0.988 (0.320)
Rural	9.41 ± 3.72	8.64 ± 2.88		4.13 ± 3.56	14.4 ± 2.59	
Occupation						
Farmer	9.75 ± 1.89	7.71 ± 3.14	2.09 (0.086)	5.75 ± 3.77	14.00 ± 1.41	0.508 (0.730)
House wife	9.16 ± 3.83	8.43 ± 2.27		4.00 ± 3.97	14.5 ± 2.95	
Unemployed	10.08 ± 3.62	11.1 ± 4.44		4.33 ± 3.14	15.8 ± 2.40	
Retired	7.25 ± 1.50	6.60 ± 2.70		2.25 ± 2.06	14.00 ± 4.30	
Commercial work	9.44 ± 3.32	7.60 ± 3.06		2.88 ± 3.51	12.9 ± 2.46	
Monthly income						
Sufficient	8.31 ± **2.05**	6.75 ± 1.58	3.05 (0.083)	2.93 ± 2.95	12.6 ± 3.73	7.23 (0.008**)
Not sufficient	9.65 ± 3.83	8.57 ± 3.01		4.25 ± 3.67	14.5 ± 2.63	

* P value is statistical significant

Table (7): Documented that age, marital status, educational level and monthly income were significantly affected the improvement of lower extremities perfusion, in which high educated and married cases with sufficient income exhibited low score of circulatory insufficiency than others.

Discussion

Diabetic foot can result from diabetes mellitus (DM), which is still a significant risk factor for peripheral artery disease (PAD), especially in elderly persons. Exercise known as Buerger-Allen Exercise (BAE) is essential for raising Lower Extremity Perfusion (LEP) and lowering symptoms of peripheral neuropathy in diabetics. In order to avoid peripheral vascular disorders and promote collateral circulation of the lower limbs, this dynamic postural exercise applies gravity to alternately fill and empty the blood vessels (Jenabi Ghods, *et al*., 2025) [18]. There for this study was established to evaluate the effect of effect of Buerger Allen Exercise on improving lower extremities Perfusion among diabetic elderly Patients.

As regards to demographic characteristics and medical data of the studied sample

The results of the current study revealed that the majority of the elderly participants were aged between (65) and (70) years. This can be explained by the fact that type II diabetes is increasingly common as people age due to a combination of variables associated with aging and lifestyle modifications. As people age, they are more likely to show signs of insulin hormone resistance, decreased muscle mass, and less physical activity, all of which raise the risk of developing the condition compared to other age groups. This was strongly backed by Azmi *et al*. (2020) [8], who noted that because muscle plays a fundamental role in glucose uptake and utilization, losing muscle mass can clearly impair the body's ability to effectively manage blood sugar. This is also in line with Sasi *et al*. (2020) [28] and Garbuja & Ranamagar (2023) [13], who found that older patients with type II DM who are over 65 have a higher risk of peripheral arterial disease.

The current study found that more than half of the patients in both groups were female. In our opinion, this is because

women are more likely than men to establish type 2 diabetes and a high incidence of PAD due to their high levels of fatty tissue and overweight, as well as hormonal changes that occur after menopause, especially the drop in estrogen levels, which are strongly known to have anti-aging and antioxidant properties. This was largely consistent with the findings of Amini *et al*. (2023) [5], but it differed from those of Al-Mohaithef *et al*. (2022) [4], who found that male sex accounted for the largest percentage of their study and talked about how smoking cigarettes puts men at higher risk for complications associated to diabetes than women.

Additionally, the results showed that both groups had large percentages of illiteracy, which might be explained by the fact that in the past, most people were not interested in education, which led to a general lack of knowledge and literacy among diabetic patients. Diabetes complications, especially peripheral vascular disease, which can eventually result in amputations, have increased as a result of this lack of knowledge about the disease and its critical management**.** Bundó *et al*. (2023) [9] and Takabini (2020) provided support for this conclusion.

It was evident that there were more elderly diabetics living in rural areas than in metropolitan ones, and that over half of them had low incomes and little education. Studies carried undertaken in Ethiopia, Malaysia, and Egypt by Seid & Tsige (2015) [29]**,** Azmi *et al*. (2020) [8], and Mohamed *et al*. (2024) [21] correspondingly provided comparable results. This can be explained by the fact that older residents of rural areas with lower levels of education have less access to health services and health education regarding preventive measures and self-care practices.

Concerning medical data; it was conveyed that about three quarter of the participants had chronic illnesses plus to DM. Hypertension represented the highest percentages. Additionally, about half of the patients had DM for more than ten years with the vast majority on insulin regimen. Comparable findings were recounted by (Patel *et al*., 2022, Mohamed *et al*., 2024 & Hosney *et al*., 2025) [2, 21, 16] who clarified the prevalence of peripheral vascular disease and other chronic disorders with longer duration of diabetes.

Discussion for the effect of applying Burger Allen exercise (BAE) on of lower Peripheral Circulation among diabetic elderly patients

The current study explored that over two-thirds of the studied sample had a significant enhancement in total score of peripheral perfusion assessment for lower extremities perfusion following two months of implementing exercise for both left and right legs particularly in pulses, capillary refill time, skin color. This outcome was in line with El Sayed *et al*.'s (2021) [11] findings, which demonstrated that after eight weeks of following BAE, over three-quarters of the participants had acceptable pulses, capillary refill, and feeling, with a greater increase in the means scores of circulation evaluation for both legs.

This finding answered the current research hypothesis and reflected the positive effect of Buerger Allen exercise on improving/ enhancing peripheral circulation among diabetic elderly with type 2. This supports previous research by Purqoti and Arifin (2023) [24] and Kawasaki (2019) **[19]** that showed the Buerger Allen exercise is essential for improving lower limb perfusion and lowering the risk of diabetic foot. By changing the gravitational method in both lower extremities, it improves circulation in peripheral blood vessels and stimulates muscle contractions by causing deviations in the ankles' plantar flexion and dorsiflexion movements.

In addition to (Afida, *et al*., 2022) [2] who conveyed significant improvement in capplilary refill time, pedals pulses, skin color and temperature following establishment of BAE for duration of two months and recommended the continuity of applying this exercise is very beneficial in prevention and management of peripheral artery disease among diabetics. Our opinion that the received good education about postural period of exercise performance was very helpful in improvement of collateral circulation perfusion of lower extremity which and decrease appearance of peripheral neuropathy symptoms among diabetic elderly patients.

The current study was supported by another study conducted by Abbass *et al*. in 2024 [-], which was named "Comparative Effect of Buerger-Allen Exercise and Intra-neural Facilitation on Lower Extremity Perfusion and Peripheral Neuropathy Symptoms among Patients with Type II Diabetes Mellitus." Peripheral circulation perfusion significantly improved following the Buerger-Allen Exercise, going from 0.6883 ± 0.10980 to 1.0250 ± 0.10968 after the intervention.

The study conducted by Hassan *et al*. (2020) [15] on the "Impact of Buerger Allen Exercise on improving selected clinical features of peripheral vascular disease among diabetic patients" found a highly significant relationship between the study group and their post-assessment of the selected clinical feature of peripheral vascular disease PVD levels after six weeks of Buerger Allen exercise. Furthermore, Buerger Allen exercise was found to be beneficial in improving foot sensitivity, decreasing the incidence of foot ulcers, improving walking capacity, and reducing discomfort, tingling, and edema (Radhika, 2022).

Conclusion

According to the results of the current study, older patientss with type 2 diabetes mellitus benefited more from the use of Buerger Allen Exercise in improving peripheral circulation perfusion in their lower extremities.

Recommendations

- It is advised that diabetic older patients receive ongoing education on the advantages and proper technique of performing the Buerger Allen exercise, as well as the significance of maintaining adherence to the exercise as part of care in all medical settings.
- It is crucial to encourage medical staff, and nurses, to include the Buerger Allen exercise in the treatment plans for diabetic patients with peripheral artery disease in a variety of healthcare settings.
- To guarantee the proper use of the Buerger Allen exercise, a training course is recommended for nursing staff in Minia University Hospital's medical department and outpatient clinics.
- The results have to be repeated to a large probability sample size that included nurses and people from different parts of Egypt.

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