Effect of Buerger Allen Exercise on Lower Extremity Perfusion among Patients with Type 2 Diabetes Mellitus

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Abstract

Background: Exercise is the fundamental principle for preventing the peripheral arterial diseases among diabetic patients; one of these exercises is Buerger Allen exercise. **Aim of the study:** Was to evaluate the effect of Buerger Allen exercise on lower extremity perfusion among patients with type 2 diabetes mellitus. **Design:** Quasi-experimental research design was utilized to achieve the aim of this study. **Setting:** The study was conducted in medical department affiliated to Benha University Hospital, Egypt. **Subjects:** A purposive sample consisting of 60 patients with diagnosis of type 2 diabetes mellitus included in the current study and divided into two groups, study (30) and control (30). **Tools:** Tool (I): Patient assessment questionnaire, Tool (II): Patient knowledge assessment questionnaire, Tool (III): Patients' observational assessment and Tool (IV): Assessment of lower extremity perfusion by measuring ankle brachial index and capillary refill time. **Results:** There were highly statistically significant differences at (p value ≤ 0.001) between both groups regarding total knowledge and practice through the study phases compared with pre-educational program. Furthermore, post- application of Buerger Allen exercise, there were statistically highly significant difference between both groups regarding Ankle brachial index and Capillary refill time at p value<0.001 and p value 0.036 respectively compared to pre application of exercise. **Conclusion:** Post program implementation, there was marked improvement in total knowledge and practice level of patients in study group compared to control group. Additionally, Buerger Allen exercise implementation was effective method for improving the lower extremities perfusion among patients with type 2 diabetes mellitus. **Recommendations:** Encourage health care providers especially nurses to integrate Buerger Allen exercise in the care protocols of patients with diabetes mellitus in different health care settings.

Keywords: Ankle Brachial Index score, Buerger Allen Exercise, Capillary Refill Time, Lower extremities perfusion, Type 2 Diabetes Mellitus.

Introduction:

Type 2 Diabetes Mellitus (T2DM) is a metabolic disorder, characterized by high blood glucose due to insulin resistance and also relatively reduced secretion of insulin from the beta cells of pancreas. Obesity, unhealthy dietary habits, sedentary lifestyle and genetic factors are considered as important risk factors in the development of T2DM **(Hafid et al., 2021).**

Diabetes Mellitus (DM) is a complex, fast-growing health problem with significant short-term and long-term complications which have an impact on patients' morbidity, and mortality. The global prevalence of diabetes in 2019 was estimated to be 9.3% (463 million people), rising to 10.2% (578

million) by 2030 and 10.9% (700 million) by 2045 worldwide. In Egypt, the prevalence of type 2 diabetes is around 15.6% of all adults aged 20 to 59 years **(Rashwan et al., 2022).**

Peripheral Arterial Disease (PAD) is a condition characterized by atherosclerotic occlusive disease of the lower extremities and gradual decrease in blood flow to one or more limbs secondary to atherosclerosis. The risk of PAD is increased in patients who are complains of DM, occurs earlier and is often more severe and diffuse. It may lead to injuries that do not heal, gangrene, and amputation (**El Sayed et al., 2021).**

Improve blood circulation of the lower extremity by exercise has been considered as one of the most effective non-pharmacological managements among patients with T2DM. There are many techniques to improve foot perfusion such as relaxation technique, warm feet technique and lower extremity exercise which helps to re-establish collateral blood flow to the legs and the heart **(Rushdy et al., 2021).**

Buerger-Allen Exercise (BAE) is an active postural exercise in which gravity alternatively fills and empties the blood vessels for preventing PAD and promoting collateral circulation in lower extremities. Also, is one of the most common practices used for patient with diabetes to drain engorged vessel by using postural changes and stimulated peripheral circulation by modulating gravity and applying muscle contraction for improving the lower extremity perfusion. Additionally, BAE encourages the wound healing process and decrease peripheral neuropathy symptoms among patients with DM **(Hassan, et. al 2020).**

It has been observed that the nurses have an effective role in prevention of foot ulcers and lower limb amputation by educational interventions, screening high-risk people and providing health care. Nurses can facilitate active participation of patients and family in care and they can also teach patients about the importance of regular visits and the primary principle of diabetes care and prevention of its complications (**Ammendola et al., 2017).**

Aim of the study:

The study aimed to evaluate the effect of Buerger- Allen exercise on lower extremity perfusion among patients with type 2 diabetes mellitus.

Study hypotheses:

To achieve this aim, the following study hypotheses were formulated:

H1: The total knowledge and practice scores will significantly improve among study group patients than the control group patients after educational program implementation.

H2: The lower extremity perfusion will significantly improve among study group patients than the control group patients after Buerger-Allen exercise implementation.

Subject and methods

Study design:

A quasi-experimental research design was utilized to achieve the aim of the present study.

Study setting: The study was conducted in medical department affiliated to Benha University Hospital, Egypt.

Sampling technique:

A purposive sample consisting of 60 adult patients from both genders with diagnosis of type 2 diabetes who attended to the above mentioned setting were participated in the current study and were divided randomly into two equal groups control (n=30) and study (n=30).

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- **Inclusion criteria:** Patients who diagnosed as type 2 DM more than 7 years with mild or moderate peripheral arterial disease "Patients with claudication which is a pain in the lower extremity muscles brought on by walking and relieved with rest and has Ankle Brachial Index between 0.5 and 0.9 ", and willing to participate in the study.

- **Exclusion Criteria:** Patients who diagnosed with chronic diabetes mellitus with foot ulcer and gangrene, critically ill patients, patients with severe peripheral arterial disease and patients with Deep Vein Thrombosis were excluded from the study.

Data collection tools:

Three tools were used to collect data to fulfill the study's aim as following:

Tool (I): Patient assessment questionnaire:

This tool was modified by the researcher based on reviewing the related recent literature and scientific references. It was adapted from **El-Fattah et al, (2019)** and filled once by the researcher. It included two parts as the following:

Part (I): Patient's personal data: This part aimed to assess patient's personal data which involved (6) closed ended multiple of choice questions.

Part (II): Patient's medical data: It aimed to assess data regarding family history, history of smoking, body mass index (BMI), duration of T2DM, chronic diseases, periodical follow up, type of treatment and pain in lower extremity while walking.

Tool (II): Patient knowledge assessment questionnaire:

This tool was designed by the researcher based on review **Dinesh et al, (2016) and** **Saber & Daoud (2018)** to assess patient's knowledge regarding diabetes mellitus, its complications & management and knowledge related to buerger-allen exercise.

Tool (III): Patient's observational assessment:

This tool designed by the researcher based on related literature review **Mohammad & Khresheh, (2018) to assess** patients' practice level. The researcher observed the patient during preforming learned exercises and sign if it was preformed correctly or not performed. It was (8 steps) divided into 3 parts assessment & planning steps, implementation steps and evaluation steps.

Tool (IV): Assessment of lower extremity perfusion:
This tool designed by the researcher based on related literature review **Kumari et al., (2019)** to assess patient's lower extremity perfusion. It included two parts: Ankle Brachial Index score & Capillary Refill Time.

Part (I): Ankle Brachial Index score:

Ankle Brachial Index is the systolic pressure at the ankle, divided by the systolic pressure at the arm. It has been shown to be a specific and sensitive metric for the diagnosis of Peripheral arterial disease.

Scoring system: Normal Ankle brachial index ranges from 0.9 - 1.3.

Values below 0.9 considered mild to moderate peripheral arterial disease.

Ankle brachial index values less than 0.5 suggests severe peripheral arterial disease.

Part (II): Capillary Refill Time:

It refers to the time needed for the capillary to refill after pressing the great toe for 2-3 seconds and then releasing it and measured by noting the time needed for the color to return.

The CRT can help assess a patient's blood volume and peripheral perfusion.

Scoring system:

Normal Capillary Refill Time ≤ 3 seconds.

Capillary Refill Time > 3 seconds is a subjective sign of poor perfusion.

Educational program booklet regarding diabetes and Buerger-Allen exercise:

The educational booklet developed by the researcher in Arabic language based on reviewing the related recent literature and scientific references and adapted from **Azar et al., (2020) & Feather et al., (2020) & Ferri (2020).** It aimed to improve patient's knowledge about diabetes, its complications, management and BAE to prevent health problems related diabetes.

Content validity and reliability:

Tool validity: The face and content validity of the tools were checked through a panel of five experts; (4) assistant professor in (Medical-Surgical Nursing department) from the Faculty of Nursing, Benha University and (1) assistant professor in endocrinology from Faculty of Medicine, Beni-suef University. The experts reviewed the tools for clarity, relevance, comprehensiveness, simplicity and appropriateness.

Tool Reliability: All tools of the study were tested statistically for its reliability. Reliability of **knowledge questionnaire** was determined using Cronbach's alpha coefficient which was 0.906. For the second tool **practice**, reliability was 0.820. This only proves that this tool is an instrument with good reliability.

Ethical consideration:

The researcher clarified the aim of the study to patient before obtaining consent to participate in the study. The researcher assured confidentiality of the patient data. Patients were informed that they are allowed to choose either to participate or withdraw from the study at any time.

Pilot study

A pilot study was conducted on 10% of the study patients (6 patient with T2DM) to assess feasibility of the study, the clarity and applicability. Based on the results of the pilot study the necessary modifications were done to have more applicable tools for data collection. Patients selected for the pilot study were excluded from the study patients.

The field work:

The collection of data and application of educational program & buerger- allen exercise lasted over a period of six months; starting at 1 December 2021 to ending in May 2022.

The study was carried out through four phases that include assessment, planning, implementation and evaluation.

Assessment phase:

The researcher introduced herself to the patients, explained the aim of the study and got consent. diabetic patients who met sampling criteria and accepted to participate in the study were individually interviewed.

Patients who met inclusion criteria divided to control and study group. An initial assessment of both groups was carried out before implementing exercises guidelines to obtain baseline data but initially, the researcher interviewed the control group patients who received routine hospital care.

Each patient interviewed individually to obtain data regarding patient's personal data, medical data and self-care practices using Tool (I).

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The researcher assessed patient's knowledge regarding diabetes mellitus, complications and management in addition to assessed patient's knowledge about BAE using Tool (II). Also, patients assessed for level of practice regarding buerger-allen exercise using Tool (III).

Finally, the researcher assessed patient's lower extremity perfusion using Tool (IV).

Lower extremity perfusion assessed by the researcher measuring Ankle Brachial Index score & Capillary Refill Time.

Planning phase: Based on the findings of the assessment phase, the researcher identified the important needs of target group, set priorities and defined goals and objectives of educational guidelines. In addition to preparation of booklet that were used for teaching.

Implementation phase: Once the pre assessment and educational program was planned and completely designed, the implementation phase was started.

During this phase, the researcher applied two interventions for the study group only: educational program (booklet) represented in theoretical sessions and application of buerger-allen exercise by researcher represented in practical sessions.

The researcher was available at the previously mentioned setting 6 days per week in morning and afternoon shift.

Each patient received 12 sessions, the duration of each session was 30 minutes minimally, two sessions per day for six days based on patient's needs and tolerance. Each patient received 2 theoretical sessions in the first day followed by 10 practical sessions over 5 days.

Regarding educational guidelines (Theoretical session):

The educational program was implemented through seminars, group discussion and using audiovisual aids (booklet).

The content of the sessions was divided as follow:

Session one: The first session is an orientation of educational program. Furthermore, this session included knowledge about DM.

Session two: The patient was introduced to peripheral arterial disease and buerger-allen exercise.

Concerning Buerger-Allen exercise (practical session):

As regards to Buerger-Allen exercise, it was administered to each patient (individualized) by the researcher along with the routine nursing care for patients in study group.

Buerger- Allen exercise consists of three steps:

Step 1 Elevation; the lower extremities were elevated to 45-degree angle and supported in this position until the skin blanches (appears dead white) (2-3 minutes).

Step 2 Dependency; the feet and legs were lowered below the level of the rest of the body until redness appears (care should be taken that there is no pressure against the back of the knees) (5-10 minutes).

Step 3 Horizontal; the legs were placed flat on the bed for (10 minutes).

Buerger- Allen Exercise administered by the researcher two times a day for 5 days. One time comprises of 5 cycles of Buerger Allen Exercise, based on **Kumari et al., (2019) & Rashwan et al., (2022).** The researcher teaching patient how to perform this exercises

at home and patient was encouraged to perform it daily as possible.

Evaluation phase:

The evaluation phase emphasized on determining the effect of the educational program on knowledge and practices and the effect of buerger-allen exercise on improving lower extremity perfusion.

Immediate post implementation of educational guidelines & Buerger-Allen exercise, post-assessment was done by using the previously mentioned tools, concerning knowledge using (tool II), Practice (Tool III) and lower extremity perfusion(tool IV).

A follow up assessment one month later was also conducted. During this period (between post and follow up assessment), the patient adherence to home exercise was ensured.

After one month, reassessment was done by using previously mentioned tools. For control group, Reassessment was done using previously mentioned tools after 6 days in addition to one month later.

Statistical analysis:

The data were collected, coded and entered into a suitable excel sheet. The collected data were organized, analyzed using appropriate statistical significance tests. Data analysis was performed using the SPSS software (version 25). For determining the normal distribution of quantitative variables was used to Kolmogorov-Smirnov test. Chi-square tests were used to compare nominal variables in the two groups. Fisher's exact test was applied on smaller sample sizes, alternative to the chi-square test, when the frequency count is < 5 for more than 20% of cells.

Results:

Table (1) shows that 56.7% of the control group and 53.3% of study group were aged ≥

50 years with mean age of control and study group were 48.23±0.97 and 49.23±1.04 respectively. As regards to gender, 60% of control group and 56.7% of study group were females. Regarding level of education 30% of control group compared to 33.3% of study group were illiterate. Lastly, no statistically significant differences were revealed between both groups regarding personal data.

Table (2) reveals that 43.3% of control and 50% of study group had family history of DM. Concerning smoking, 26.7% of control group compared to 36.7% of study group were smokers. Also this table displays that 33.3% of control group and 36.7% of study group were overweight. Moreover46.7% of control group had DM for >15 years, while 40% of study group had DM for 7 <10 years. Regarding comorbid diseases, 53.3% of studied groups had hypertension. Lastly, there were no statistically significant differences between both groups regarding medical data.

Figure (1) illustrates that there were no statistically significant differences between both groups regarding total knowledge pre guidelines implementation at (p value 0.351). But, there were statistically highly significant differences at (p value ≤ 0.001) between both groups' immediate post guidelines implementation and post 1 month.

Figure (2) illustrate that 100% of both studied groups had poor practice level during pre-guidelines implementation and the differences between both groups regarding patients' total practice level of BAE were statistically highly significant at p-value<0.001 during immediate post guidelines implementation as well as post 1 month.

Table (3) displays that during pre-implementation of guidelines and BAE, there

were no statistically significant differences between both group regarding ABI & CRT at p value 0.859 and 0.893 respectively. As regards to Ankle brachial index, immediate after implementation of guidelines and buerger-allen exercise ABI mean score in control group was 0.713+ 0.16 compared to 0.876+0.16 in study group. Therefore, there were statistically highly significant between both groups at p value<0.001. Additionally, post 1 month of implementation ABI mean sore was 0.710+ 0.16 compared to 0.810+0.19 therefore, there were statistically significant differences between both groups at p value 0.035. Concerning CRT, the differences between both groups' immediate post & post 1 month of implementation of guidelines and BAE were statistically significant at p value 0.036 and 0.020 respectively. Program among studied patients at (P=≤ 0.001**).

Table (1): Distribution of the studied patients (both groups) according to their personal data (N=60).

Patients' personal data	Variables	Control group N=30		Study group N=30		X^2 tests P Value	
		No.	%	No.	%	X^2	P
Age (year)	20-<30 years	3	10.0	2	6.7	0.418	0.936ns
	30-<40 years	4	13.3	5	16.7		
	40-<50 years	6	20.0	7	23.3		
	≥ 50 years	17	**56.7**	16	**53.3**		
	Mean ± SD	**48.23±0.97**		**49.23±1.04**		t= 0.000	1.000 n.s
Gender	Male	12	40.0	13	43.3	0.069	0.793 n.s
	Female	18	**60.0**	17	**56.7**		
Marital status	Single	3	10.0	1	3.3	2.706	0.439 n.s
	Married	24	**80.0**	22	**73.3**		
	Widowed	2	6.7	5	16.7		
	Divorced	1	3.3	2	6.7		
Occupation	Not Working	11	36.7	9	30.0	0.351	0.950 n.s
	Worker	12	**40.0**	13	**43.3**		
	Retired	3	10.0	3	10.0		
	Free business	4	13.3	5	16.7		
Educational level	Illiterate	9	**30.0**	10	**33.3**	0.279	0.964 n.s
	Read and write	7	23.3	6	20.0		
	preparatory qualification	8	26.7	9	30.0		
	University qualification	6	20.0	5	16.7		
Residence	Urban	9	30.0	8	26.7	0.082	0.774 n.s
	Rural	21	**70.0**	22	**73.3**		

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Table (2): Distribution of studied patients (both groups) regarding previous medical data (N=60).

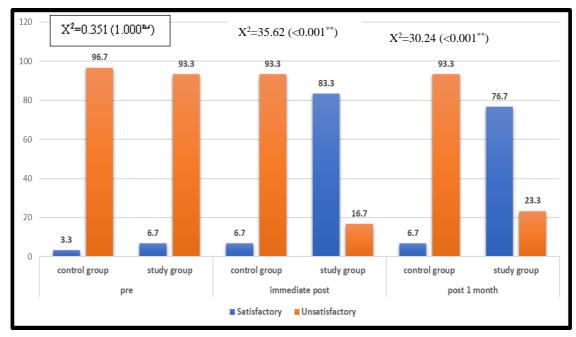| Medical data	Variables	Control group N=30		Study group N=30		X^2 test	P value
		No.	%	No.	%		
Family history of DM	Yes	13	**43.3**	15	**50.0**	0.268	**0.605** n.s
	No	17	56.7	15	50.0		
Family history of peripheral arterial disease	Yes	3	10.0	1	3.3	1.071	**0.301**n.s
	No	27	**90.0**	29	**96.7**		
History of smoking	Yes	8	**26.7**	11	**36.7**	0.693	**0.405** n.s
	No	22	73.3	19	63.3		
Body Mass index	Underweight <18.5	4	13.3	6	20.0	0.840	**0.840** n.s
	Normal weight (18.5–24.9)	9	30.0	8	26.7		
	Overweight (25–29.9)	11	**33.3**	11	**36.7**		
	Obesity (30 or greater)	7	23.3	5	16.7		
Duration of Type 2 diabetes mellitus	7-<10 years	11	36.7	12	**40.0**	0.737	**0.692** n.s
	10-15 years	5	16.7	7	23.3		
	>15 years	14	**46.7**	11	36.7		
	Mean ± SD	**10.10±0.92**		**9.97±0.89**		-0.570	**0.571** n.s
Presence of comorbid disease	Yes	20	66.7	17	56.7	0.635	**0.426** n.s
	No	10	33.3	13	43.3		
		N= 20		N= 17			
Chronic disease (Accompanied medical illness with diabetes II) #	Hypertension	16	**53.3**	16	**53.3**	0.000	**1.000** n.s
	Cardiac disease	3	10.0	2	6.7		
	Renal disease	14	46.7	14	46.7		
	Neurological disease	4	13.3	7	23.3		
Periods of follow up	Every one month	0	0.0	0	0.0	1.071	**0.301** n.s
	3 months	0	0.0	0	0.0		
	6 months	3	10.0	1	3.3		
	No follow up	27	**90.0**	29	**96.7**		
Type of treatment #	Diet modification only	30	**100.0**	30	**100.0**	0.089	**0.766** n.s
	Oral Hypoglycemic agents	19	**63.3**	23	**76.7**		
	Insulin only	3	10.0	0	0.0		
	Both Oral hypoglycemic agents and insulin	8	26.7	7	23.3		
lower extremity pain while walking	Yes	22	**73.3**	22	**73.3**	0.000	**1.000** n.s
	No	8	26.7	8	26.7		

Fig (1): Comparison between control and study groups related to their total knowledge level during pre, immediate post and post one month of guidelines implementation (N=60)
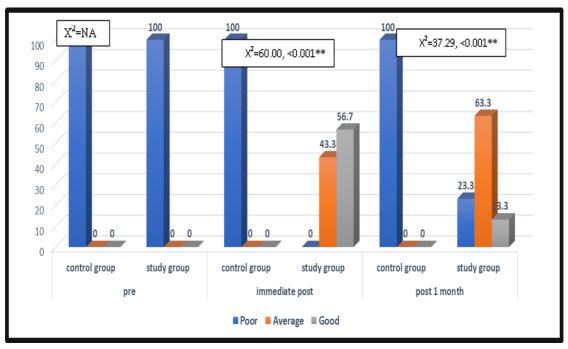

Fig (2): Comparison between control and study groups related to their total practice level during pre, immediate post and post one month of guidelines implementation (N=60)

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Table (3): Comparison of patients' lower extremity perfusion level (both groups) during pre, immediate post and post one month of guidelines implementation (N=60).

Practice items	Variables	Control group (n=30)						Study group (n=30)						X^2 test P value (1)	X^2 test P value (2)	X^2 test P value (3)
		(pre guidelines)		(immediate post guidelines)		(post one month of guidelines)		(pre guidelines)		immediate post guidelines		(post one month of guidelines)				
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			
Ankle Brachial Index (ABI)	Normal (0.9 - 1.3)	5	16.7	5	16.7	5	16.7	7	23.3	16	53.3	14	46.7	0.417 FE 0.748	8.86 FE 0.006*	6.86 0.032*
	Mild to Moderate (< 0.9-0.5)	25	83.3	25	83.3	24	80.0	23	76.7	14	46.7	16	53.3			
	Severe (< 0.5)	0	0.0	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0			
	Mean ± SD	0.700±0.14		**0.713±0.16**		**0.710±0.16**		0.693±0.14		**0.876±0.16**		**0.810±0.19**		T=-.178 0.859 n.s	T=3.799 <0.001**	T=2.155 0.035*
		T4=-2.11 p= 0.063 ⁿ·ˢ, T5=-1.140 p= 0.264 n.s						T4=-16.95 p=<0.001**, T5=-0.085 p=<0.001**								
Capillary Refill Time (CRT)	Normal (≤ 3 seconds)	17	60.0	17	56.7	14	46.7	17	56.7	25	83.3	24	80.0	0.069 FE 1.000	5.07 FE 0.047*	7.17 FE 0.015*
	Abnormal (> 3 seconds)	12	40.0	13	43.3	16	53.3	13	43.3	5	16.7	6	20.0			
	Mean ± SD	3.33±0.95		3.40±0.93		3.53±0.97		3.30±0.95		2.93±0.73		3.00±0.74		T=-.135 0.893 n.s	T=-.148 0.036*	T=-.386 0.020*
		T4=-2.11 p= 0.063 ⁿ·ˢ, T5=-1.140 p= 0.264 n.s						T4=-16.95 p=<0.001**, T5=-0.085 p=<0.001**								

(FE) p value for Fisher exact for chi square   Not significant (p > 0.05)   (*) Statistically Significant at ≤0.05   ** Highly significant (p ≤ 0.001)

(1) control group (pre guidelines) vs study group (pre guidelines)
(2) control groups (immediate post guidelines) vs study groups (immediate post guidelines)
(3) control groups (post 1 month of guidelines) vs study groups (post 1 month of guidelines)
(4) Difference between pre and immediate post periods within the same group
(5) Difference between pre and post one-month period
(6) within the same group

Discussion:

The results of the present study showed that, regarding **patients' age**, The results of the present study revealed that, more than half of the studied patients' age was slightly more than 50 years old with mean age of 48.23±0.97 years and 49.23±1.04 years for the study and control group respectively, this related to increasing the risk of PAD among type II diabetes mellitus with the aging process.

This finding was in the same line with **Prakash et al., (2022) who** mentioned that, the majority of the respondents in both the experimental and comparison group were in the age group of 56–60 years.

On the other hand, this result disagreed with what was reported by **Mayangsari & Lutfi (2021)** who illustrated that the average age of respondents in both groups shows an age range of 45-50 years. Related to **gender**, the results of the current study found that, more than half of study group and two thirds of the control group were females, this can be discussed as decline level of estrogen at menopause cause increased risk for diabetes mellitus because estrogen produce several anti-aging effects including anti oxidative properties as oxidative stress is considered the most important cause in micro vascular diseases. This result agreed with **Kumari et al., (2019)** who reported that half of the patients in experimental group and in control group were females. This finding contradicted with **international diabetes federation atlas, (2021)** which stated that "In 2021, there are 17.7 million more men than women living with diabetes".

Concerning previous medical data between study and control groups, the current study showed that there was no statistically significant difference between the two groups regarding their previous medical data (family history of DM, family history of PVD, history of smoking, BMI, duration of T2DM,

comorbid diseases, follow up, type of treatment and pain in lower extremity while walking). These findings were consistent with **Rushdy et al., (2021)** who reported that there was no statistically significant difference in family history of PVD, BMI, duration of T2DM, past medical history and diabetes treatment between study and control groups. Furthermore, these findings were in disagreement with by **Mayangsari & Lutfi (2021)** who illustrated that there was statistically significant difference in duration of T2DM between study and control groups.

As regards to **family history of diabetes mellitus**, the results of the present study revealed that, about half of the studied patients in study and control groups had family history of DM because family history (parental or sibling) of diabetes is a strong risk factor for type 2 diabetes. This finding was congruent with **El Sayed et al., (2021)** who reported that about two thirds of studied patients had family history of type 2 diabetes. This finding contradicted with **Zahran et al., (2018)** who found that the majority of studied patients in study group had family history of DM and all patients in control group had family history of DM.

Regarding **History of smoking,** the results of the present study revealed that only one third of study group and one quarter of control group were smokers. This finding may be due to the proportion of females in study sample more than males and in our community the majority of females don't smoke. These findings consistent with **Bhuvaneshwari &Tamilselvi, (2018)** who found that about tenth of experimental and control group were smokers. As well, this finding was incongruent with **Wahyuni et al., (2022)** who reported that about two thirds of studied patients were smokers and this may be due to the majority of this research sample were males.

Concerning **body mass index,** the results of the present study showed that, about two-

thirds of the studied samples were overweight/obese in both groups, due to lack of compliance with a healthy diet for diabetic patients and exercise. This finding in the same line with **El Fattah et al., (2019)** who reported that more than half of participants were overweight. In contrast to the current study, results from **Prakash et al., (2022)** who found that the majority of study participants in both the groups (63.3% and 70%) had normal BMI.

Concerning **patient's knowledge about diabetes mellitus,** the present study revealed that **pre guidelines implementation;** there was no statistically significant difference between study group and control group and there was only one quarter of study group and one tenth of control group had satisfactory level of knowledge regarding diabetes mellitus this may be due to age and level of education.

This finding consistent with **Pereira et al., (2012)** who reported that at the beginning of the study, both groups presented similar knowledge when they responded to the questionnaire and about one quarter of interventional group had satisfactory level of knowledge while this finding disagreed with **Salahen et al., (2020)** who reported that concerning knowledge before the application of the program, the general knowledge of the participants regarding the disease is relatively good.

Immediate post guidelines implementation and post 1 month of guidelines implementation, the results of the present study showed that there was statistically highly significant difference between study group and control group as, the majority of studied patients in study group had satisfactory level of knowledge while, in control group only one tenth of studied patients had satisfactory level of knowledge

regarding diabetes. This can be explained that educational program improves level of knowledge in study group and the patients benefit from the educational program. This finding supported with **Chawla et al., (2019)** mentioned that there was a significant increase in mean knowledge score of case group compared to control group at the final follow-up (P = 0.004).

Concerning **patient's total practice level of BAE**, the present study showed that that 100% of both studied groups had poor practice level during pre-guidelines implementation however, during immediate post guidelines implementation more than half of study group had good practice level compared to 100% poor practice level in control group. Therefore, there were statistically highly significant difference between both groups at p-value<0.001 during immediate post guidelines implementation as well as post 1 month of guidelines implementation.

This finding congruent with **El Banna et al., (2021)** who reported that all subjects of both study and control group had bad performance score pre intervention but two and four weeks post exercise implementation there were significant improvement of performance score of study group while control group remained with poor performance score.

Regarding **ankle brachial index,** the present study revealed that during pre-implementation of BAE, nearly one quarter of studied patients in study and control group had normal ABI and there were no statistically significant differences between both groups regarding ABI. On the other hand after implementation of BAE, it was noted that the study group show significant improvement along the study period as level of lower limb impairment improved to reach

more than half of patients with normal lower extremity perfusion in immediate post-test and nearly half normal perfusion in follow up test. Compared with control group there was not significant change in level of lower extremity perfusion impairment from beginning to the end of the study therefore: there was highly statistically significant difference between both groups regarding ABI immediate post implementation of BAE as well, 1 month later.

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. The increase in the ABI value in the study group indicates that BAE increases the circulation of the lower extremities in patients with type II diabetes mellitus. These findings supported the hypothesis that stated there will be significant statistical differences in lower extremity perfusion among patients with type 2 diabetes mellitus after implementing of BAE. This result was consistent with many studies as **El Banna et al., (2021)** who showed that there were no statistical significant differences between both groups pre exercise for both right and left limbs but there were highly statistically significant improvements of ABPI mean scores between study and control groups after two and four weeks of exercise implementation in both limbs.

Also, this result was in agreement with **El- Fatah et al., (2019)** who revealed that there were highly statistical significant differences between the mean score of ABI of both legs post Buerger Allen exercise than pre exercise.

Concerning **capillary refill time**, the present study findings showed that, pre implementation of BAE, nearly half of studied patients in both groups had normal CRT< 3 seconds and there was no statistically significant difference between both groups. However, immediately after implementation of BAE and one month later, the majority of studied patients in study group had normal CRT compared to half of control group. This reflected that, the difference between the two groups immediately after implementation of BAE & one month later was statistically significant at P < 0.05 and the proportion of cases with normal CRT in study group was higher than control group. The improvement from the researcher's opinion may be due to sufficient period of exercise performance that helps in promoting the development of collateral circulation in lower extremity that improve the peripheral blood flow.

This result supported with **El Banna et al., (2021)** assured that two and four weeks post exercise implementation, 14% and 4% of study group respectively still had delayed capillary time compared to 100% and 100% of control group. However results was contradicted with **Hassan et al., (2020)** reported that, there were no significant differences among both groups regarding capillary refill time after six weeks application of BAE.

Conclusion:

The current study concluded that, implementation of BAE is effective in improving the peripheral circulation of the lower extremities among patients with type 2 diabetes mellitus. Additionally, implementation of nursing program has been proven to be a significantly effective in improvement of patient total knowledge regarding diabetes mellitus.

Recommendations:

- Organizing patient's centered workshops about BAE.

- An educational program should be applied about BAE for all nurses working in medical unit to provide them with the necessary and required knowledge and skills

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- Encourage health care providers especially nurses to integrate BAE in the care protocols of patients with DM in different health care settings.
- A comparative study may be conducted to evaluate the effectiveness of BAE with other non-pharmacological measures for improving the level of lower extremity perfusion.

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تأثير تمارين بيرجر الن على تحسين الدورة الدموية للأطراف السفلية لمرضى السكر من النوع الثاني

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التمرين هو المبدأ الأساسي للوقاية من أمراض الشرايين الطرفية بين مرضى السكر. أحد هذه التمارين هو تمرين بيرجر الن. لذا هدفت هذه الدراسة إلى تقييم تأثير تمرين بيرجر الن على تحسين الدورة الدموية للأطراف السفلية لمرضى السكر من النوع الثاني وقد أجريت هذه الدراسة في قسم الباطنة التابع لمستشفى جامعة بنها. وقد اشتملت العينة على 60 مريض سكر من النوع الثاني وتم تقسيمهم الى مجموعتين. وأوضحت النتائج وجود فروق ذات دلالة إحصائية عالية بين المجموعتين فيما يتعلق بمستوى المعرفة والممارسة خلال مراحل الدراسة مقارنة بما قبل البرنامج التعليمي. علاوة على ذلك ، بعد تطبيق تمرين بيرجر الن، كان هناك فرق ذو دلالة إحصائية عالية بين المجموعتين فيما يتعلق بمؤشر الكاحل العضدي ووقت إعادة ملء الشعيرات الدموية وكان تنفيذ تمرين بيرجر الن طريقة فعالة لتحسين الدورة الدموية للأطراف السفلية بين مرضى السكر من النوع الثاني. و أظهرت النتائج أنه في مجموعة الضابطة توجد علاقة ذات دلالة إحصائية بين الحالة الاجتماعية ومستوي معرفة المريض. ومع ذلك، في مجموعة الدراسة لم تكن هناك علاقة ذات دلالة إحصائية بين عمر المريض والجنس والحالة الاجتماعية والمهنة والمستوى التعليمي والإقامة ومستوى المعرفة الكلي للمريض. وقد أوصت نتائج الدراسة بتشجيع مقدمي الرعاية الصحية وخاصة الممرضات على دمج تمرين بيرجر الن في بروتوكولات رعاية مرضى السكر في أماكن الرعاية الصحية المختلفة.