Effect of Modified Buerger-Allen Exercises on Physiological Leg Edema during the Third Trimester of Pregnancy

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Abstract

Background: The third trimester of pregnancy often leads to leg edema that can cause discomfort, reduce mobility, and affect a woman's quality of life. The Modified Buerger-Allen Exercise is a series of movements designed to improve circulation and venous return, helping to reduce fluid retention in the lower extremities. **Aim:** To assess effect of Modified Buerger-Allen Exerciseson physiological leg edema during the3rd trimester of pregnancy**. Design:** A quasi-experimental design as employed. **Subjects and Methods: Setting:** The antenatal clinic of the National Medical Institute atDamanhour, El-Beheira Governorate Egypt. **Subjects:** A purposive sample of 90 pregnant women who met the inclusion criteria. **Tools**: Four Instruments were employed. These included a structured interview schedule for demographic and obstetric information, a chart to assess the presence and severity of pitting edema, the non-elastic tap measure and figure of eight measurement of ankle swelling. **Results:** At 10 days post-intervention, experimental group 1 showed a significant reduction in edema severity and circumferences, with 26.7% of participants improving to grade +1 edema and significant decreases in ankle and instep circumferences. By 20 days, experimental group 2 demonstrated even greater improvements, with 63.3% showing grade +1 edema and significant reductions in ankle, instep, and metatarsal–phalanges joint circumferences compared to the control group. **Conclusion:** Modified Buerger-Allen exercises method is an effective, non-invasive method for managing edema and enhancing maternal comfort. **Recommendations**: Modified Buerger-Allen Exercisesshould be incorporated into prenatal care routines for pregnant women particularly during the third trimester to manage leg edema.

Keywords: *Buerger-Allen, Leg Edema, pregnancy.*

Introduction:

The third (3rd) trimester of pregnancy is the final phase of pregnancy, from 28 to 40 weeks of gestation. It could be marked by significant physiological changes and increased fluid retention **Nissen, Johnson & Lavoie, 2023;Bhat &Kushtagi, 2024)**. Edema is one of the most common issues experienced during pregnancy. Swelling in the legs and ankles can affect up to 80% of pregnant women to varying extents and is not necessarily a sign of preeclampsia or pregnancy-induced hypertension. It can be a physiological leg edema **(Mollaelah&Shahali, 2022)**.

Physiological leg edema means swelling in the lower extremities, including ankles, feet, and legs. It occurs due to fluid retention, commonly occurringduring pregnancy's third trimester. This condition is primarily caused by an increase in blood volume and hormonal changes that enhance vascular permeability, leading to fluid leakage into the surrounding tissues. Additionally, the expanding uterus exerts pressure on the inferior vena cava and pelvic veins—major vessels responsible for returning blood from the lower body thereby, restricting blood flow from the legs **(Dalio, Rahimi & Jafari, 2022; Mollaelah& Shahali, 2022)**.

The lymphatic vessels in the leg tissues attempt to drain the excess fluid, but the volume often exceeds their capacity, making this process ineffective. As the uterus enlarges during pregnancy, it also compresses the lymphatic vessels in the pelvic and abdominal regions, further hindering lymph drainage from the legs. This impaired flow leads to an accumulation of lymph, known as lymphoedema, which commonly contributes to swelling in the legs and ankles during pregnancy **(Knight,Johnson, Liu, 2023)**.

Significant pain is the most typical edema symptom, along with tingling, numbness, and cramping at night. Furthermore, legs could be unattractive and feel heavy and achy. After standing for extended periods of time and with each subsequent pregnancy, symptoms usually get worse. Physiological edema of the foot may be the cause of sleep disorders. Consequently, sleep durations of six hours or less per night can lead tolonger labor periods and a higher rate of instrumental births**(Saliba Júnior,de Lima & Fernandes,2020;Navaee&Rakhshkhorshid, 2020)**.

Evaluation of patients with lower-extremity edema during late pregnancy aims to exclude deep venous thrombosis (DVT), preeclampsia, peripartum cardiomyopathy, and other pathologic causes of edema. Physiological edema is a diagnosis of exclusion. The nurse midwife needs to rule out other causes through history taking, and specific measures including the pitting edema severity scale (graded from 0 to +4), and changes in circumferential measurements of the ankle, instep, and metatarsal–phalanges joint (the MP joint, where toe joins the foot) **(Raetz, Garzon & Dillingham, 2023;Araby, Hassan & Fawzy, 2025)**

Although physiological leg edema during pregnancy is normal, management is needed to reduce discomfort. In managing edema in healthy, pregnant women, treatment focuses on improving circulation, reducing fluid retention, and alleviating symptoms **(Mollaelahi&Shahali, 2022).**The use of complementary therapies alongside modern medical care has become increasingly accepted recently, particularly among midwives and nurses. A wide range of non-pharmacological techniques, including massage therapy, essential oils, herbal application, water soaking, and exercises(**Ahmed,Ismail & Hassan , 2021)**.

The nurse-midwife can recommend position, behavioral changes, elevating legs, lying on the left side, wearing compression stockings, avoiding prolonged standing or sitting, staying hydrated, support hose, appropriate clothing, as well as exercisessuch as the Buerger-Allen Exercises that are encouraged by the exercise board, The Buerger-Allen Exercises were originally developed for vascular patients to increase lower extremity perfusion **(Hassan,El-Naggar, Abdelrahman& Soliman, 2020; Zaki ,Ragheb, Taha & Omran, 2023; Saleh, El-Tantawy, & Ahmed, 2024).**Buerger-Allen exercises stimulate the interstitial fluids in the extravascular spaces, as well as improve venous blood circulation by combining two mechanisms, namely: 1. fluid migration from the extravascular space to the venous system and 2. fluid flow inside the extravascular space. It has no negative effects on health **(Navaee&Rakhshkhorshid, 2020; Mollaelahi&Shahali, 2023)**.

The Modified Buerger-Allen Exercises (MBAEs) have been adapted for pregnant women to stimulate peripheral circulation, drain engorged vessels, and alleviate leg edema. The MBAEs were designed to improve circulation and venous return, helping to reduce fluid retention in the lower extremities. They include a series of movements of leg elevation, flexion, and extension, which promote fluid movement toward the heart. The exercises utilize gravity to alternately empty and fill the blood vessels, stimulating collateral circulation.

The MBAEs also integrated a left lateral tilt (LLT) position to replace the supine posture to shift the fetal pressure away from the compressed inferior vena cava to enhance blood circulation**(Mollaelahi&Shahali, 2023; Vediappan,Lakshmi& Rajendran, 2024).**The nurses can educate pregnant women about the modified Buerger-Allen exercises and incorporate such exercises in their care to decrease discomfort of physiological leg edema during the third trimester of pregnancy and improve mobility and quality of life (**Radhika,Sangeetha & Menon, 2024)**

Significance of the study

Few studies have examined the use of alternative therapies among pregnant women in Egypt. Additionally, despite being a low-risk, affordable, and easy physical exercise, there has been no research investigating the effect of Buerger-Allen exercises on physiological foot edema caused by pregnancy **(Saleh, et al., 2024)**. The findings of this study could provide evidence to support the enhancement of nursing practices and contribute to the advancement and expansion of nursing knowledge, ultimately leading to better health outcomes for women.

Aim of the study:

The study aimed to assess the effectof Modified Buerger-Allen Exercises (MBAEs) on physiological leg edema during 3rd trimester of pregnancy.

Research hypothesis:

The pregnant women who will perform the Modified Buerger-Allen exerciseswillexhibit improvement in thephysiological leg edema than those who don’t.

Operational definition

Buerger-Allen exercises: In this study, the specific exercises involved elevating the leg between 35 and 90 degrees, then lowering it to a dependent position, and finally resting the leg in a horizontal position.

Subjects and Method

Research design

A quasi-experimental (non-randomized control group) design was utilized.

Setting

The study was carried out at the antenatal clinic of Damanhour National Medical Institute, a hospital under the Ministry of Health in El-Beheira Governorate, Egypt. This facility was specifically selected because it is a primary healthcare center serving Damanhour city and its neighboring regions, with enough pregnant women to meet the study's requirements.

Subjects

A purposive sample of 90 antenatal women in their third trimester was selected from the previously mentioned study setting. They were randomly assigned into three groups: a control group (n=30) that received routine care for physiological leg edema; experimental group 1 (n=30), which performed Modified Buerger-Allen Exercises for lower limb edema over 10 days; and experimental group 2 (n=30), which performed the same exercises for 20 days.

Inclusion criteria

- Pregnant women in their third trimester (28 to 40 weeks of gestation).
- Diagnosed with physiological leg edema (non-pathological swelling).
- Age ranged between 20 and 40 years.
- Have normal blood pressure.
- Have a singleton pregnancy with no complications.
- Able to perform physical exercises without medical restrictions.
- Attending regular antenatal check-ups at the selected clinic.

Sample size

The sample size was calculated using the Epi Info program, considering a 5% margin of error, a 95% confidence level, a 10% expected frequency, and a population size of 180 over three months. The calculation indicated a minimum required sample size of 79, so a total of 90 participants were included in the study.

Tools

Four tools were utilized as follows:

Tool I: Structured interview schedule

This tool was developed by researchers after reviewing literature. It was used to assess basic data of the studied pregnant women. It is composed of two parts as follows:

Part (I):Socio-demographic characteristics such as the women's age, level of education,

occupation, marital status, current residence and family type.

Part (II):Obstetrics and reproductive history asgravidity, parity, number of abortions, still birth,livingchildren,and sex of living children.

Part (III):History of current pregnancy including weeks of gestation,antenatal visit, number of antenatalvisits,timing of edema, change of edema with position, and site of edema.

Tool II: Chartforpitting edema

This tool was adopted by researchers from **Brodovicz, McNaughton, Uemura, Mehta, Skare, & Perez (2009).** It was used to assess the degree of physiological foot edema. Edema is evaluated on its ability to pit. The researcher's thumb or forefinger is pressed into a dependent area of the mother's foot against a bony prominence for five seconds. If pitting edema is present the finger will sink into the tissue and leave a depression after removing the finger. **Brodovicz et al., (2009) estimated that** edemaisgraded on a scale of 1+ to 4 +. Edema of grade 1+: The indentation depth (less than 6 mm) quickly goes away. Edema of grade 2+: The indentation depth (6–12 mm) goes away in 10–15 seconds. Edema of grade 3+: The indentation depth (1 to 2.5 cm) goes away in 1 to 2 minutes. Edema of grade 4+: Pitting depth >2.5 cm subsides in 2–5 minutes.

Tool III: Non-elastic tape

The tape was constructed from non-stretched fiberglass material, ensuring measurement consistency by preventing elongation during use. It was 150 cm (60 inches) in length, with clear, high-contrast markings in both metric (centimeters and millimeters).It was used to have standardized measurements during the study. The participants' ankle, instep, and foot/toe junction circumferences were measured using this instrument.

Tool IV: Figure of eight measurements of the ankle swelling

The figure of eight measurement technique was originally developed by **Esterson in 1979** to assess ankle swelling. This method was later adapted to specifically evaluate swelling across several common sites of ankle sprains, including the anterior talofibular ligament, calcaneofibular ligament, and anterior tibiofibular ligament. The technique relies on the use of a non-elastic tape measure and a marking pen, with anatomical landmarks carefully identified around the ankle to ensure

consistency and reproducibility.During the procedure, the participant's ankle was positioned by the researchers in neutral dorsiflexion at 90 degrees. The tape measure was anchored midway between the tibialis anterior tendon and the lateral malleolus, passed medially across the navicular tuberosity, under the sole at the level of the fifth metatarsal base, then wrapped around the ankle crossing the medial and lateral malleoli to form a "figure-of-eight" pattern (**Figure 1)**. This approach allowed for a reliable and sensitive assessment of swelling over the talar and subtalar joints.

Figure-of-eight method. Flexible tape runs through from the tip of lateral malleolus, tuberosity of navicular, base of fifth metatarsal bone, tip of medial malleolus, and then returns to tip of lateral malleolus. (A) Medial side; (B) lateral side.

Figure (1): Figure of eight method(Petersen, W., Rembitzki, I. V., &Koppenburg, A. G. 2013).

Method

Administrative approval

An official letter clarifying the purpose of the study was obtained from the Faculty of Nursing, Damanhour University and was submitted to the responsible authorities of the selected study settings to obtain their approval and cooperation for carrying out the study. Additionally, an official permission to conduct the study was obtained from the medical director of Damanhour National Medical Institute after the study's purpose was clearly explained.

Ethical and legal considerations were contemplated all over the study as follows

The study was approved by the Scientific Research Ethics Committee of the Faculty of Nursing, Damanhour University (Approval No. 96-b) before it began. Pregnant women's informed consent to participate in the study was obtained after explanation of the purpose of the study. The right to abstain or terminate participation at any time was respected. The nature of the study didn't cause any harm or pain for the entire sample. The women were assured about the privacy and confidentiality of the collected data, and that the data will be used only for the study purpose.

Tools development

Tool (I)was developed by researchersafter extensive review of literature.Tool (II) was adopted by the researchers from **Brodoviczetal., (2009).**Tool (III)was clearly examinedby the researchers for its fidelity and

numbers.Tool (IV)wasadapted by the researchersfromoriginally developed by **Esterson (1979)**

Validity of the tools

The content and facevalidity of the instruments were evaluated by fiveexperts from obstetrics and gynecology, and community nursing departmentstoensure that the instrumentsare relevant and appropriate for the study.

Pilot study

A pilot study was carried outon 10% (9) of the antenatal women who were excluded from the main study sample. Thisphase helped to evaluate the clarity andrelevance of the instruments. Following thefeedback, appropriate adjustments weremade to the instruments.

Reliability of the tools

Instruments II, III, and IVunderwent reliability testing utilizingCronbach's alpha. The results indicatedhigh reliability for all three Instruments, withscores of (**0.87)** for instrumentII (the Chart for pitting edema),(**0.86)** for instrument III (the non -Elastic tap measure), and (**0.85)** for instrument IV (the figure of eight measurements of ankle swelling).

Data collection

Tool (I) was used one time before the intervention, tools II, III, and IVwereused three times pre, after 10 days,andafter 20 days of the intervention. The study data were collected over a period of four months from the first ofNovember 2024 to the end of February 2025.

The study was implemented into three phases (assessment,implementation,an devaluation) as follows

Phase (1): Assessment

-The researchers explored both local and international literature pertinent to various aspects of the research problem through books, articles, internet sources, periodicals, and magazines. Then, they developed and determined the necessary data collection instruments and the studybookletusing clear and concise Arabic language.

-All participants were invited to participate after an explanation of the purpose of the study to obtain their informed consent. Then, theywerescreened by the researchers based on the inclusion criteria. The first 30 women who met these criteria were assigned to the control group. The next 30 eligible participants were allocated to experimental group (1).Consecutively, the next 30 eligible participants were allocated to experimental group (2).

-Recruitment started with the control group to ensure the target

sample size was achieved before enrolling participants into the experimental groups, thus reducing the possibility of sample contamination.

-All three groups underwent a pre-test assessment, during which participants were individually interviewed to collect the baseline data using tool(I).

- Next, the extent of foot edema was determined for all groups by pressing index and middle fingers on foot for 5 to 10 seconds and estimating the depth created using tool (II)the chart for pitting edema.

- Then, circumferences of three parts of each footincluding the ankle, instep, and foot/toe junction were measured by tool (III)the non-elastic tape for each group when the women were in sitting position. Ankle circumference was measured medially and laterally above the malleoli, where the diameter was the smallest. The instep circumference was measured over the cuneiform and cuboid bones distal to the heel, and the third circumference was measured on the distal end of the foot, at the metatarsal–phalanges joint (the MP joint, where toe joins the foot).

- Subsequently, instrument (IV) the Figureof-eight measurements for ankle swelling were conducted for each group. During this procedure, the studied pregnant women were positioned according to their ability to be in either in a supine position or seatedwith the ankle maintained at approximately 20° of plantarflexion position. The researchers began with placing the tape measure midway between the tibialis anterior tendon and the lateral malleolus. The tape was then guided medially and positioned just distal to the navicular tuberosity. Thetape is then pulled across the arch and just proximal to the fifth metatarsal. Then, the tape is pulled across the tibialis anterior tendon and around the ankle to a point just distal to the medial malleolus, before being finally pulled across the Achilles tendon and placed just distal to the lateral malleolus and across the start of the tape. Finally, the researchers pulled the tape snugly and read the circumference in centimeters, took three measurements and recorded the average.

Phase (2): Implementation

-The experimental groups (1 and 2) each consisted of 30 pregnant women performed the modified Buerger–Allen exercises at separate rooms of the prenatal clinic to ensure their privacy. During the initial interview, the

researchers taught the women how to perform the exercises using various visual aids such as videos, pictures, and a brochure.

-Additionally, the researcher demonstrated each step, encouraged the women to re-demonstrate the exercises, and emphasized the importance of regularly performing them.

-Participants in the experimental group (1) performed the modified Buerger–Allen exercises at home once daily for 30 minutes over 10 days, while those in the experimental group (2) followed the same routine once daily for 30 minutes over 20 days.

-All women, including those in the experimental and control groups, received the standard prenatal care, which included walking and massage.

-Measurements were repeated after 10 days for experimental group (1) and after 20 days for experimental group (2). During the intervention, the researchers maintained daily contact with the participants in the experimental groups through phone calls to encourage adherence to the exercise protocol.

The modified Buerger- Allen Exercises were performed by the pregnant woman as follows:

First, the pregnant woman was lain down on the left hand with an angle of 30° toward the supine left lateral tilt (LLT), and at the same time, the lower limb was raised up to an angle of 45°–90° and was kept until the skin turns white (appears dead white) (**Figure 2)**.

Figure (2): Lower Limb was raised up to an angle of 45º- 90º.

Then,she was sitting on a chair, lowered her legs below the surface of the rest of the body until redness appears (note that there is no pressure on the back of the knees) and the toes are bent and stretched (**Figure 3)**.

Figure (3): Legs lowered below the surface of the rest of the body.

Finally, the pregnant woman was straightening her legs; she lay on the bed on her left side for a few minutes (**Figure 4)**. The duration of each position depends on the woman’s tolerance and the

amount of skin color change. Typically, exercises were prescribed in such a way that the legs were raised for 2–3 minutes and lowered for 4–6 minutes. Then, the participant was straightened on the bed for 10 minutes.

Figure (4): Legs straighten and lay on the left side for a few minutes.

-The standard care of the health facility was provided for the control group in the presence of the researchers. This care included massage, walking, and health education about leg edema, along with history taking, physical examination, routine investigations, and measurement of limb circumferences.

Phase (3): Evaluation

-On the 10thand 20thdays after the intervention, foot circumferences, degrees of pitting edema, and figure-of-eight ankle swelling measurements were assessed for all three groups.

Statistical data analysis

Data were entered into the computer and analyzed using IBM SPSS software version 26.0. Qualitative data were presented as numbers and percentages, while quantitative data were summarized using means and standard deviations. Chi-square test was usedforthe categorical variables to compare between different groups, Monte Carlo correction was used to find correction for chi-square when more than 20% of the cells were less than 5 to analyze the significance between the different stages, the student t-test was used for the normally distributed quantitative variables to compare between two studied groups, and the analysis of variance (ANOVA) was used for the normally distributed quantitative variables to compare between more than two groups.

Results

Table (1): Shows socio-demographic characteristics of the studied pregnant women. It reveals that the study subjects were homogenous as there were no statistically significant differences in sociodemographic characteristics between the control group and the two experimental groups. Slightly more than two thirds of the (66.7%) of the control group their age ranged between 26–30 years, (50.0%) of the experimental group (1), and (63.3%) of the experimental group (2). Regarding education,

experimental group (2) had the highest percentage (60.0%) of illiteracy compared to (40.0%) among the control group and the experimental group (1). Most of the of the control group and the experimental group (1) (96.7%, and 93.3% respectively) were housewives, and almost as (100%) of the experimental group (2). Additionally, rural residence was more common among (66.7%) of the control group and (60.0%) of the experimental group (2), while (56.7%) of the experimental group (1)were urban participants. Regarding the family type, extended families were more frequent (70.0%) amongeach of the control group and experimental group (1), compared to (50.0%)of the experimental group (2).

Table (2): Demonstrates obstetric and reproductive history of the studied pregnant women. It proves that that the study subjects were homogenous as there were no statistically significant differences between the control and experimental groups (1 and 2). The control group had a slightly higher percentage of participants with more than five pregnancies (20.0%), compared to (13.3%)of the experimental group (1), while none of the experimental group (2) reported more than five pregnancies. Nulliparity was common across all groups, with (46.7%)of the control group and (50.0%)among each of the experimental groups. Most (73.3%, 80.0%, and 90.0% respectively) of the participants of all groups had no history of abortion. The participants in each group reported no history of stillbirth, ranging from (50.0% to 56.7%). The proportion of participants with living children was (36.7%, 30.0%, and 30.0% respectively) among the experimental group (2), the control group and experimental group (1).

Table (3): Displays current pregnancy history of the studied pregnant women. It establishes that there were no statistically significant differences in the history of current pregnancy between control and experimental groups (1 and 2).Gestational age ≥30 weeks was noted in (43.3%) of the control group, (53.3%) of the experimental group (1), and (56.7%) of the experimental group (2). Regular antenatal visits were reported by (36.7%) of the control group, (30.0%) of the experimental group (1), and (46.7%) of the experimental group (2).Most of the participants in all groups had four or more antenatal visits, (90.0%)of each of the

control group and experimental group (1), and (100.0%)of the experimental group (2). Regarding edema, its onset within less than two weeks was observed in (46.7%) of each of the control group and the experimental group (1), and in (40.0%) of the experimental group (2).Additionally, edema developing between (2–4) weeks was more common in (36.7%) of the experimental group (2), compared to (26.7%, and 16.7% respectively) of the control group and the experimental group (1). It is also noticed that nearly three quarters(73.3%, and 70.0% respectively) of the experimental group (2) and of the control group had no change of edema with position, as well as had bilateral edema; compared to nearly two thirds of the experimental group (1).

Table (4): Explains grades of pitting edema of the studied pregnant women before, after 10 days and after 20 days of the intervention. It identifies that before the intervention, there were no statistically significant differences between the control group and experimental groups 1 and 2 in the severity of pitting edema (p= 0.409). Most of the participants across all groups had grade +4 edema, with (46.7%)among each of the control and experimental group (1), and (36.7%) in the experimental group (2). Ten days after the intervention, the experimental group (1) showed significant improvement compared to the control group (p= 0.002), with (26.7%) of the participants presenting with grade +1 edema versus none in the control group, and a decrease in grade +4 edema to (10.0%) compared to (36.7%) in the control group. After 20 days, the experimental group (2) demonstrated even greater progress, with (63.3%) of the participants showing grade +1 edema and no cases of grade +4 edema, while (46.7%) of the control group still had persistent grade +4 edema.

Table (5): Illustrates mean difference in the foot circumference of the studied pregnant women before, after 10 days and after 20 days of the intervention. It shows that before the intervention, there were no significant differences in ankle, instep, and MP joint circumferences among the control and experimental groups (1 and 2). After 10 days, the experimental group (1) showed a significant reduction in ankle and instep circumferences ($p < 0.05$ and $p < 0.002$, respectively), but no significant change in MP joint

circumference (p = 0.352). After 20 days, the experimental group (2) demonstrated highly significant reductions in all three measurements—ankle, instep, and MP joint (p < 0.001, p <0.001, and p = 0.001, respectively), compared to the control group.

Table (6): Describes mean difference in the ankle swelling among the studied pregnant women before, after 10 days and after 20 days of the intervention.It portrays that before the intervention, there were no statistically significant differences in the ankle circumference among the control and experimental groups (1) and (2)(p= 0.814). However, significant improvements were observed following the intervention. After 10 days of the intervention, the experimental group (1) showed a significant reduction in the mean of theankle circumference (56.92 ± 2.58 cm), compared to the control group (59.39 ± 2.04 cm), with a statistically significant difference (p < 0.001). This improvement was even more evident in the experimental group (2) after 20 days, where the mean ankle circumference further decreased to (56.81 ± 2.14 cm), compared to (59.39 ± 2.04) cm in the control group (p < 0.001).

Table (1): Socio-demographic characteristics of the studied pregnant women (n= 90).

Socio-demographic characteristics	Control group (n=30)		Experimental (1) after 10 days (n=30)		Experimental (2) after 20 days (n=30)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
Age (years)								
less of 25	7	23.3%	13	43.3%	8	26.7%		
26-30	20	66.7%	15	50.0%	19	63.3%	3.232	0.537
35 and more	3	10.0%	2	6.7%	3	10.0%		
Mean ± SD	27.3±5.8		26.5±4.2		27.8±4.4		F =0.611	0.545
Level of education								
Illiterate	12	40.0%	12	40.0%	18	60.0%		
Primary	7	23.3%	7	23.3%	3	10.0%	6.714	0.330
Secondary	10	33.3%	8	26.7%	9	30.0%		
University	1	3.3%	3	10.0%	0	0.0%		
Occupation								
House working	29	96.7%	28	93.3%	30	100.%	3.128	0.775
Employer	1	3.3%	1	3.3%	0	0.0%		
Other	0	0.0%	1	3.3%	0	0.0%		
Original residence								
Rural	20	66.7%	13	43.3%	18	60.0%	3.529	0.171
Urban	10	33.3%	17	56.7%	12	40.0%		
Type of family								
Nuclear	9	30.0%	9	30.0%	15	50.0%	3.445	0.179
Extended	21	70.0%	21	70.0%	15	50.0%		

χ^2: Chi square test
MC: Monte Carlo
F: F for ANOVA test

Table (2): Obstetrics and reproductive history of the studied pregnant women (n= 90).

Reproductive history	Control group (n=30)		Experimental (1) after 10 days (n=30)		Experimental (2) after 20 days (n=30)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
Gravidity								
Primigravida	11	36.7%	12	40.0%	15	50.0%		
2-4	13	43.3%	14	46.7%	15	50.0%	7.128	0.123
More than 5	6	20.0%	4	13.3%	0	0.0%		
Parity								
Nulipara	14	46.7%	15	50.0%	15	50.0%		
Primi	6	20.0%	6	20.0%	9	30.0%	1.943	0.746
Multi	10	33.3%	9	30.0%	6	20.0%		
Number of abortions								
No abortion	22	73.3%	24	80.0%	27	90.0%		
Once	6	20.0%	3	10.0%	3	10.0%	4.938	0.572
Twice	1	3.3%	2	6.7%	0	0.0%		
Three or more	1	3.3%	1	3.3%	0	0.0%		
Number of stillbirths								
No	17	56.7%	15	50.0%	15	50.0%		
One	2	6.7%	3	10.0%	0	0.0%	3.639	0.454
Not applicable	11	36.7%	12	40.0%	15	50.0%		
Number of living children								
Non	9	30.0%	9	30.0%	11	36.7%		
One	3	10.0%	5	16.7%	4	13.3%		
Two	3	10.0%	3	10.0%	0	0.0%	8.923	0.326
Three childrenor more	4	13.3%	1	3.3%	0	0.0%		
Not applicable	11	36.7%	12	40.0%	15	50.0%		
Sex of Living children								
Non	4	13.3%	3	10.0%	2	6.7%		
Only male	9	30.0%	7	23.3%	8	26.7%		
Only female	3	10.0%	7	23.3%	5	16.7%	6.116	0.653
Male and female	3	10.0%	1	3.3%	0	0.0%		
Not applicable	11	36.7%	12	40.0%	15	50.0%		

χ^2: Chi square test MC: Monte Carlo

Table (3): Current pregnancy history of the studied pregnant women (n= 90).

Current pregnancy history	Control group (n=30)		Experimental (1) after 10 days (n=30)		Experimental (2) after 20 days (n=30)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
Gestational age (weeks)								
<30	17	56.7%	14	46.7%	13	43.3%	1.156	0.561
≥30	13	43.3%	16	53.3%	17	56.7%		
Mean ± SD	29.4±1.5		29.8±1.5		29.8±1.4		F= 0.554	0.576
Antenatal visits								
Regular	11	36.7%	9	30.0%	14	46.7%	1.796	0.407
Irregular	19	63.3%	21	70.0%	16	53.3%		
Number of antenatal visits								
less than 4	2	6.7%	1	3.3%	0	0.0%		
4visits	1	3.3%	2	6.7%	0	0.0%	3.844	0.413
4 and more	27	90.0%	27	90.0%	30	100.0%		
Timing ofedema								
less than 2 weeks	14	46.7%	14	46.7%	12	40.0%		
from 2 to 4 weeks	8	26.7%	5	16.7%	11	36.7%	3.450	0.486
more than 4 weeks	8	26.7%	11	36.7%	7	23.3%		
Change of edema with position								
Yes	9	30.0%	11	36.7%	8	26.7%	0.726	0.696
No	21	70.0%	19	63.3%	22	73.3%		
Site of edema								
Unilateral	9	30.0%	11	36.7%	8	26.7%	0.726	0.696
Bilateral	21	70.0%	19	63.3%	22	73.3%		

χ^2: Chi square test
MC: Monte Carlo
F: F for ANOVA test

Table (4):Grades of pitting edema of the studied pregnant women before, after 10 days and after 20 days of the intervention (n=90).

Grades of pitting edema	Control group (n=30)		Experimental (1) after 10 days (n=30)		Experimental (2) after 20 days (n=30)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
Before intervention								
Grade 1+: Mild (1–2 mm)	0	0.0%	0	0.0%	0	0.0%		
Grade 2+: Moderate (2–4 mm)	7	23.3%	12	40.0%	12	40.0%		
Grade 3+: Moderately severe (4–6 mm)	9	30.0%	4	13.3%	7	23.3%	3.974	0.409
Grade 4+: Severe (6–8 mm)	14	46.7%	14	46.7%	11	36.7%		
10 days After intervention								
Grade 1+: Mild (1–2 mm)	0	0.0%	8	26.7%	-	-		
Grade 2+: Moderate (2–4 mm)	7	23.3%	10	33.3%	-	-		
Grade 3+: Moderately severe (4–6 mm)	12	40.0%	9	30.0%	-	-	14.039*	0.002*
Grade 4+: Severe (6–8 mm)	11	36.7%	3	10.0%	-	-		
20 days After intervention								
Grade 1+: Mild (1–2 mm)	0	0.0%	-	-	19	63.3%		
Grade 2+: Moderate (2–4 mm)	3	10.0%	-	-	11	36.7%		
Grade 3+: Moderately severe (4–6 mm)	13	43.3%	-	-	0	0.0%	58.781*	<0.001*
Grade 4+: Severe (6–8 mm)	14	46.7%	-	-	0	0.0%		

χ^2: Chi square test MC: Monte Carlo *: Statistically significant at $p \leq 0.05$

Table (5): Mean difference in the foot circumference of the studied pregnant women before, after 10 days and after 20 days of the intervention (n=90).

Foot circumference	Control group (n=30)	Experimental (1) after 10 days (n=30)	Experimental (2) after 20 days (n=30)	F	p
Ankle					
Before intervention	25.26±0.38	25.29±0.57	25.23±0.60	0.121	0.886
10 days After intervention	25.40±0.39	24.33±0.88	-	t=5.098*	<0.050
20 days After intervention	25.45±0.41	-	22.91±0.81	t=15.306*	<0.001*
Instep					
Before intervention	25.26±0.38	25.31±0.37	25.22±0.49	0.380	0.685
10 days After intervention	25.45±0.42	24.88±0.55	-	t=4.490*	<0.002*
20 days After intervention	25.53±0.42	-	23.17±1.16	t=10.498*	<0.001*
MP joint					
Before intervention	23.16±0.83	23.22±0.76	23.18±0.75	0.042	0.959
10 days After intervention	23.28±0.79	23.10±0.69	-	t=0.938	0.352
20 days After intervention	23.28±0.70	-	22.68±0.68	t=3.351*	0.001*

F: F for ANOVA test t: Student t-test

*: Statistically significant at $p \leq 0.05$

Table (6): Mean difference in the ankle swelling among the studied pregnant women before, after 10 days and after 20 days of the intervention (n=90).

Measurements of ankle swelling	Control group (n=30)	Experimental (1) after 10 days (n=30)	Experimental (2) after 20 days (n=30)	F	P
Measure ankle circumference					
Before intervention	58.75±2.45	58.74±2.30	59.09±2.36	0.206	0.814
10 days After intervention	59.39±2.04	56.92±2.58	-	t=4.099*	<0.001*
20 days After intervention	59.39±2.04	-	56.81±2.14	t=4.770*	<0.001*

F: F for ANOVA test t: Student t-test *: Statistically significant at $p \leq 0.05$

Discussion

Physiological leg edema during the third trimester of pregnancy is a frequent issue often resulting in discomfort and decreased mobility. This condition arises mainly due to the increased pressure exerted by the growing uterus on the pelvic veins and the inferior vena cava, which hinders the return of blood from the lower extremities. Hormonal changes and fluid retention also play a role in causing swelling, particularly in the feet, ankles, and legs. Proper management of the physiological leg edema (lower limb edema) is important to enhance maternal comfort, support healthy circulation, and prevent potential complications **Shrestha ,Adhikari ,Tamrakar , Shrestha & Shrestha (2020)** So, this study aimed to investigate the effect of modified Buerger-Allen exercises (MBAEs) on physiological leg edema during the third trimester of pregnancy.

The results of the current study revealed to no statistically significant differences in socio-demographic characteristicssuch as age, education, occupation, residence, and family typeacross control and experimental groups. These results agree with **Mollaelahi and Shahali (2023)**, who stated that Modified Buerger-Allen Exercises effectively reduced lower limb edema and related pain in late pregnancy, regardless of

participants' socio-demographic profiles. This evidence reinforces the effectiveness of the intervention across diverse populations .On the other hand, **Jahan**, **et al., (2023)** contradicts with this study results they revealed that the factors like age, education level, and prior exercise significantly influence pregnant women's engagement in antenatal exercises. Their findings indicate that younger, more educated women with previous exercise experience are more likely to participate in such interventions. Similarly, a study conducted in **Alnaeem, Almalik, Alghamdi & Alotaibi (2024),** found that socio-demographic factors, including age and occupation, affected pregnant women's knowledge, attitudes, and practices regarding antenatal exercise. These contrasting findings attributed to variations in sample characteristics, differences in the timing and frequency of implementing the intervention.

Regarding obstetrics and reproductive history of the studied pregnant women, this study revealed that **no statistically significant differences** between the control and experimental groups regarding various reproductive history variables, including gravidity, parity, number of abortions, stillbirths, living children, and sex of living children. These results agree with **Ali, Zafar & Khan (2023)** .They demonstrated that the venous return enhancement due to lower limb elevation and graded movement in Buerger-Allen Exercises is a mechanical effect, not significantly modulated by a woman's obstetric history. On the other hand, **Elgzar**, **Ibrahim, Salem &Elhassaneen (2023)** disagree with this study results. They revealed that **multiparity** might increase the likelihood of developing leg edema due to chronic vascular changes and reduced venous tone in repeated pregnancies. They suggested that interventions may require longer durations or more intensive sessions in multiparous women for optimal results.

Concerning the current pregnancy historyof the studied pregnant women, this study discovered that **no statistically significant differences** in gestational age, antenatal visit frequency, edema duration, positional changes, or site of edema. These results corresponded to **Saliba-Júnior, Rollo, Saliba & Sobreira (2022).**. They showed no baseline group differences in gestational age or edema characteristics; participants wearing stockings experienced significantly less swelling and reported positive perceptions On the other hand, **Mahmoud, El-Nemer & El Sayed (2022)** opposes this study results.

They revealed that interventions requiring postural accuracy and daily repetition (like Buerger-Allen) may be less effective in populations with poor antenatal follow-up, where reinforcement and supervision are limited. This discrepancy may be attributed to variations in sample characteristics, differences in the timing and frequency of implementing the Modified Buerger-Allen Exercises, as well as inconsistencies in participants' compliance.

Regarding grades of pitting edema of the studied pregnant women before, after 10 days and after 20 days of the intervention, the results of the current study specified that after performing the modified Buerger–Allen exercises for 10 days, the experimental group (1) showed significant improvement of the physiological leg edema, compared to the control group, with a higher number of participants exhibiting mild edema and fewer experiencing severe edema. After 20 days, the experimental group (2) demonstrated even greater improvement, with most participants showing mild edema and none having severe edema. In contrast, a considerable number of participants in the control group continued to experience persistent severe edema.

This finding aligns with the results of **Mollaelahi&Shahali (2023)**. They reported significant improvements in all foot measurements, foot volume, and the severity of pitting edema compared to pre-intervention values. Thus, the hypothesis was confirmed, demonstrating that modified Buerger–Allen exercises can effectively reduce the physiological leg edema during the third trimester of pregnancy. Following the 10-day intervention and subsequent evaluation. There was a marked and clinically meaningful reduction in the average foot circumference, foot volume. These improvements are likely due to enhanced blood circulation in the lower limbs resulting from consistent performance of the modified Buerger–Allen exercises over the 10-day period.

As regardto foot circumference of the studied pregnant women before, after 10 days and after 20 days of the intervention, the results of the recent study showed that after 10 days, the experimental group (1) experienced a notable reduction in ankle and instep circumferences, while the MP joint remained unchanged. By 20 days, experimental group (2) showed significant reductions in all measured areas ankle, instep, and MP joint when compared to the control group. This suggests that performing modified Buerger–Allen exercises for ten days effectively

improve peripheral blood flow in the lower limbs.

These results are consistent with those reported by **Hassan, et al. (2020).** who found a significant increase in the average ankle–brachial index (ABI) after 15 days of practicing the same exercises. However, no significant change in ABI was noted after just five days of intervention, which is also consistent with their results.

This improvement may be attributed to enhanced collateral circulation, better peripheral blood flow, and increased blood perfusion in the lower limbs. As with many exercise routines, extending the duration of the intervention may contribute to more pronounced and beneficial outcomes. The reduction in the leg's circumference may be related to the modified left lateral tilt (LLT) position, which is believed to improve venous return by easing pressure on the inferior vena cava, thereby enhancing fluid drainage from the lower extremities.

Regarding ankle swelling of the studied pregnant women before, after 10 days and after 20 days of the intervention using figure of eight measurements, the present study showed that the intervention led to significant improvements in reducing ankle swelling. Ten days after the intervention, the first experimental group showed a noticeable decrease in ankle circumference compared to the control group. This reduction became even more pronounced in the second experimental group after 20 days, with both comparisons showing statistically significant differences.

These results align with **Mollaelahi&Shahali (2023**.) who showed that performing the modified Buerger–Allen exercises for 10 days can effectively reduce swelling in the lower limbs of pregnant women. These improvements were observed in the circumferences of both ankles, both heels, both feet compared to the pre-intervention measurements.

The findings of this study highlight the potential of modified Buerger–Allen exercises as an effective method for reducing or preventing physiological leg edema during pregnancy. This is likely attributed to these exercises promoting enhanced blood circulation and improved peripheral blood flow. Therefore, prolonging the duration of the modified Buerger–Allen exercise can optimize effectiveness in alleviating physiological leg edema during the third trimester of pregnancy **(El Sayed, Abd El-Fattah, & Abdelrahman , 2021).**

Considering that pregnant women have unique physiological characteristics, it can be useful to examine findings from similar

populations, such as individuals with diabetes. In this regard, a systematic review by **Chang Lai, Chen & Hsu (2015)** investigated the effectiveness of Buerger–Allen exercises in improving peripheral blood circulation. The review indicated that these exercises may have beneficial effects, low cost and convenience of performing them safely at home. Furthermore, Buerger–Allen exercises can enhance local blood flow. Converselya study by **Brodovicz et al. (2009)** reported no significant changes in peripheral edema measurements following similar exercise interventions. The inconsistency may be due to differences in study design, intervention duration, or measurement techniques.

Conclusion

The modified Buerger-Allen exercises method is an effective, non-invasive complementary approach for the managing the physiological leg edema during the third trimester of pregnancy.

Recommendations

Based on the findings of this study, it is recommended that nurses, midwives, and other prenatal care providers should be trained for the proper technique and benefits of MBAEs. Considering the prevalence of physiological challenges during pregnancy and their effect on quality of life, it is advisable for healthcare providers to familiarize themselves with these exercises and include them in standard prenatal care routines to ensure consistent and accurate instructions to pregnant women. Additionally, educational materials and sessions should be developed to each pregnant women on how to safely perform MBAEs at home, empowering them to take an active role in managing edema. Healthcare institutions and policymakers should consider including MBAEs as part of the standard antenatal care protocols, especially in settings where access to advanced medical treatments is limited. Additionally, further research studies with larger sample sizes and diverse populations are recommended to explore long-term benefits of the MBAEs on maternal comfort, mobility, and quality of life.

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