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ORIGINAL ARTICLE

The Effect of Modified Buerger–Allen Exercises on Lower Extremities Edema in Late Pregnancy: Randomized Clinical Trial

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Abstract

Background Lower limbs edema is one of the common problems in late pregnancy. This study aimed to determine the effect of modified Berger–Allen exercises on lower limb swelling in late pregnancy.

Materials and Methods This randomized clinical trial was conducted on 105 pregnant women suffering from lower limbs edema. Samples were randomly placed in three groups: modified Buerger–Allen exercises for five days, modified Buerger–Allen exercises for ten days, and the control group. Foot circumferences and volume and pain were measured before and after the study.

Results There was a significant difference between the average of right and left ankle circumference, right and left heel circumference, right and left foot circumference, left foot volume and pain score after the 5-day intervention group ($p < 0.05$). In the 10-day intervention group, there was a significant difference in all averages of ankles, heels, foot circumference and volume, and pain score 10 days after the intervention, compared to before the intervention ($p < 0.05$).

Conclusion Performing innovative modified Buerger–Allen exercises in pregnant women with lower limbs edema may reduce their pain and swelling. It can also reduce the leg areas in pregnant women with lower limb edema in late pregnancy.

Trial registration Approval number from Iranian Registry of Clinical Trials: IRCT20200713048096N1 (Registration date: 2020-11-12).

Keywords Edema · Lower limb · Pregnancy · Modified Buerger–Allen exercise

Background

Pregnancy is one of the most important stages in a woman's life. Although it is a blissful period for most women, it seems to be a stressful period attributed to physiological and psychological changes [1]. It can be the origin of many changes in the body system, changes that can take a few weeks to return to the original [2]. Some of these changes affect the lower body organs [3]. Affecting 80% of pregnant women, edema is not considered as a symptom of pregnancy-induced hypertension or preeclampsia [4]. Varney describes gestational edema as excessive fluid accumulation in tissues without hypertension or proteinuria [4, 5]. Lower limb edema occurs in 35–80% of all normal pregnancies in late pregnancy [6].

A study, conducted in India in 2015, reported that the prevalence of swelling is as such was 67%, in pregnant women, 49% in legs, 33% in the sacral area, and 14% [7] in both areas. According to a study conducted in Turkey, the prevalence of physiological leg edema was 80% [6]. In another study in Iran, the such prevalence was between 26 and 62.2% [8, 9]. Despite the fact that physiologic edema during pregnancy is not dangerous, the pain associated with it may be the most serious complication. Also, nocturnal cramps, numbness (weakness), paleness, discomfort, feeling of heaviness in the leg, painful paresthesia, and change in the shape of the leg are other symptoms associated with edema [10]. Physiological edema in the feet can be one of the causes of sleep problems and disorders. Insufficient sleep (6 h or less) reported to cause prolonged labor and increase

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the prevalence of instrumental delivery [11]. Thus, evaluating and treating such a problem seems necessary.

Buerger–Allen exercises may lead to the movement of interstitial fluids in the extravascular space as well as the venous system of blood circulation. It can be done by combining two mechanisms: 1. the movement of fluid in the extravascular space and 2. the movement of fluid from the extravascular space to the venous system. It does not have medical consequences [12].

Additionally, most pregnant women, who are in the third trimester, cannot sleep on their backs for a long time. It can lead to putting pressure on the great vein below, slowing down the return of blood to the heart, and restricting blood flow to the fetus [13]. Studies show that placing a pregnant mother in the position of sleeping on her back can increase the chance of still birth and IUGR [14, 15] at the end of pregnancy (third trimester). In the present study, we present the modified Buerger–Allen exercises that tilt the pregnant woman's body to the left (the left lateral tilt (LLT) position replaced the supine position), to remove the pressure of the fetus from the collapsed inferior vena cava to the left aorta, which is resistant to compression. Also, this can increase the speed of blood flow [13].

Because limited studies have been conducted on the treatment of edema related to pregnancy, and according to the limitation of lying pregnant women in the supine position during Berger–Allen exercises, the present study aimed to determine the effect of modified Berger–Allen exercises on the physiological peripheral edema of pregnancy in the lower limbs.

Methods

Study Design

This randomized clinical trial was conducted on 105 pregnant women who went to the prenatal care at health centers covered by Zahedan University of Medical Sciences. It was performed from August 2020 to August 2021, after obtaining the code of ethics from the ethics committee of Tarbiat Modares University (IR. MODARES. REC. 1399.105) and registration in the Iranian Clinical Trial Registration Center (N120200713048096IRCT). The criteria for entering the research include: first pregnancy and singleton, age between 18 and 35, normal pregnancy between 30 and 40 weeks, presence of bilateral edema in the feet and legs of two plus or more, BMI in the normal range, normal state of amniotic fluid, not having the history of infertility, no symptom of systemic diseases such as heart and lung disorders, diabetes, thrombophlebitis, and high blood pressure, no skin disease such as severe eczema and absolute rest, no mental problems, no preeclampsia and eclampsia, no drug use except for the supplements during pregnancy, not having the history of drug addiction, no pain except to the area of the soles of the feet and ankles that spread from other organs. Evaluated in terms of compliance with the inclusion criteria, the samples of the research were randomly selected from the health centers covered by Zahedan University of Medical Sciences using a random number table. They were divided into test groups (5-day and 10-day exercises) and control (35 people in each group).

Sampling

The size of the sample was based on the pain scores before the intervention and five days after it in the control group and on the pilot intervention in ten people. The average of the two groups was 5 and 4, respectively, and the standard deviation difference was 1. First type of error α was 0.05, so $z1 = \alpha/2 = 1.96$. The second type of error ß was 0.2, and so $z1 = ß = 0.84$. The sample size for each group was 32 people. By taking into account the drop of 10%, it was 35 people (105 people in total).

Data Collection Tools

Data collection tools include demographic characteristics and obstetric history forms that was completed by the participants, pain ruler, inflexible tape measure, and volumeter of the lower limb.

Intervention

The participant of the study included 105 primiparous pregnant women who met the inclusion criteria and were referred to health centers covered by Zahedan University of Medical Sciences for prenatal care. Then, demographic characteristics and obstetric history forms were completed. Considering the privacy of the research samples, the researcher helped them sit on the examination bed. In order to maintain the health of the research samples and prevent the possibility of COVID-19, health protocols (social distance, use of two three-layer masks, and disposable latex gloves by the researcher and the research sample, as well as disinfection of the meter and equipment with alcohol spray) were met. In order to check the amount of edema, the examiner's thumb was pressed firmly and gently for 2 seconds on the area around the sole of the foot, behind the inner ankle or on the leg. Then, the depth of the indentation was estimated in centimeters. The size of the circumference around the wrist, around the heel, and between the fingers and metatarsal phalangeal joint (MPJ) metatarsal bones was measured using an inflexible tape measure.

Then, the volume of each leg was evaluated by a volumeter. Measuring the amount of water, the patient was asked

to slowly dip her foot into the volumeter until the horizontal rod which is placed at the end of the volumeter is between the second and third toes. The severity of the pain reported by the participants was evaluated using the VAS scale.

A training session on modified Buerger–Allen exercises along with the presentation of slides and a training booklet was performed in the intervention groups. Following the intervention, the researcher contacted the research units daily in the intervention groups to ensure that the exercises were carried out (by phone or social networks). The intervention groups included two groups: the group that performed modified Buerger–Allen exercises at home for five days and the group that performed modified Buerger–Allen exercises at home for ten days. All subjects of the intervention and control groups received routine pregnancy care.

The measurements were done once again on the fifth day. Furthermore, determining the consistency of the effect of the exercises in the third stage, the measurements were performed ten days after the beginning of the exercises. The measurement duration takes 15 minutes at each stage.

The exercises performed by the pregnant woman were as follows: First, the sample was lain down on the left hand with an angle of 30° toward the supine (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). Then, sitting on a chair, she 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. Finally, straightening her legs, she lay on the bed on her left side for a few minutes. The duration of each position depends on the patient'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 min and lowered for 4–6 min. Then, the participant was straightened on the bed for 10 min (Fig. 1). The sample in the control group also completed the questionnaire of demographic and midwifery information. The measurements were done by the researcher in the same way as the test group. After that, they were asked to return to the research center in the next 5 and 10 days to re-measure the above-mentioned indicators.

Statistical Analysis

Finally, data were analyzed using SPSS software version 26. The normality of the data was checked with Kolmogorov–Smirnov test. Chi-square test was used to analyze the qualitative data, and the analysis of variance

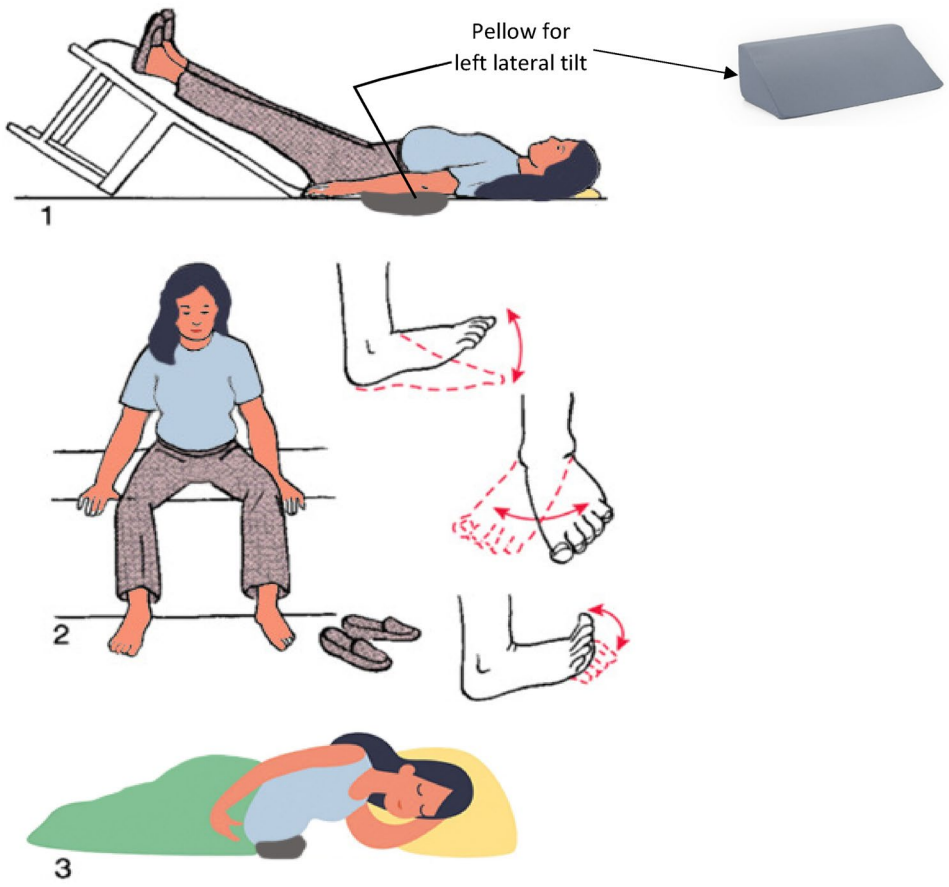

Fig. 1 Modified Buerger–Allen exercise steps

(Kruskal–Wallis) test was used to compare the quantitative variables. Additionally, the Kolmogorov–Smirnov statistical tests were used for the inferential analysis of the data, the paired t test (Wilcoxon) was used for checking the normality of the data, and the independent t test (Mann–Whitney) was used to compare two periods (before the intervention and after the intervention). Significant level was considered as $P < 0.05$.

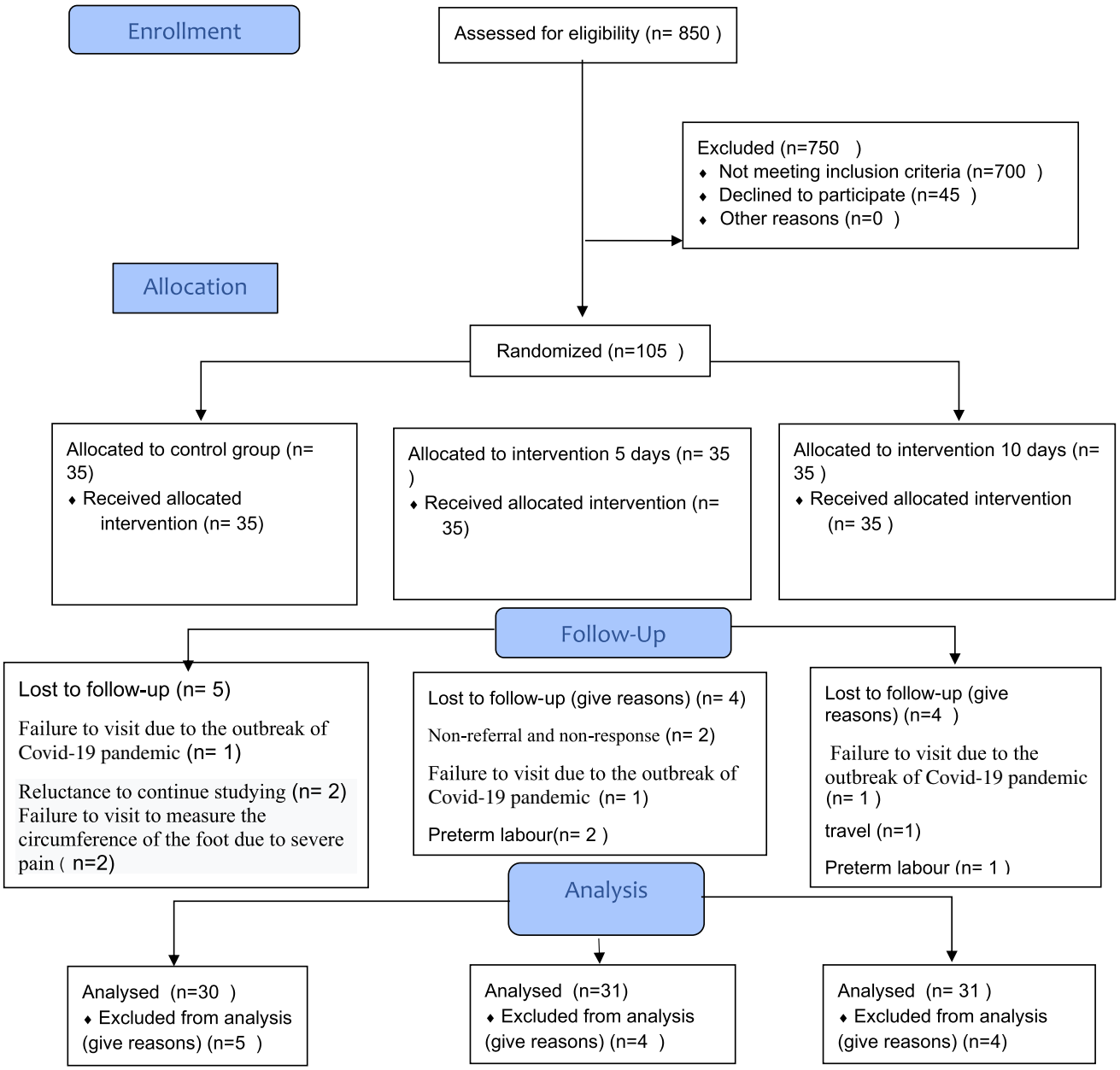

Fig. 2 Consort flow diagram

Results

In this study, 105 pregnant women were investigated. In each group, 35 people participated. Five people in the control group, four in the 5-day intervention group, and four people in the 10-day intervention group were excluded from the study (Fig. 2).

According to the research findings, the average age of women was as follows: 25.61 ± 4.1 years in the 5-day intervention group, 26 ± 4.16 years in the 10-day intervention group, and 25.84 ± 3.79 years in the control group. Also, the length of marriage was as follows: 2 ± 0.93 years in the 5-day intervention group, 1.82 ± 0.95 years in the 10-day intervention group, and 1.97 ± 0.76 years in the control group. The average body mass index was: 23.22 ± 1.43 in the 5-day intervention group, 23.66 ± 1.24 in the 10-day intervention group, and 23.88 ± 1.49 in the control group. 66.67% of women participated in this study, and 61.29% of their spouses had university degrees. The demographic data were not significantly different between groups. (Tables 1 and 2.)

Based on the Wilcoxon and Mann–Whitney U test, there was not a significant difference between the volume of the right foot, five days after the intervention, in comparison with before study ($P = 0.27$) and the control group ($p = 0.2$). However, Wilcoxon test showed that the average circumference of right ankle, left ankle, right heel, left heel, right foot, left foot, left foot volume, and pain score showed a significant difference in the 5-day intervention group compared to before the intervention ($p < 0.05$) (Table 3). The Mann–Whitney U test, however, showed no significant differences between two groups, five days after the intervention. In the 10-day intervention group, Wilcoxon test showed there was a significant difference in all averages of right ankle circumference, left ankle circumference, right heel circumference, left heel circumference, right foot circumference, right foot circumference, right foot volume, left foot volume, and pain score compared to before the intervention ($p < 0.05$) (Table 3). After 10 days, no significant differences were observed between the intervention and control groups in any of the above parameters.

Discussion

In the present study, an innovative modification of Buerger–Allen exercises was investigated to determine whether it had an effect on lower limb edema in late pregnancy. The results of the study showed that performing the modified Buerger–Allen exercise for 10 days can reduce the pain and swelling of the lower limbs in pregnant women. According to the results of the study, there was not a significant difference between the average circumference of the legs after the intervention in the 5-day test group and

Table 1 Demographic characteristics by groups

Characteristics	Control group	Intervention 5-day	Intervention 10-day	All		*p* value
Age	25.84(3.88)	25.61(4.1)	26(4.63)	25.82(4.16)	0.065	0.93
Age of spouse	28.84(3.84)	29.48(5.17)	28.67(4.06)	29(4.36)	0.295	0.74
Length of marriage	1.97(0.76)	2(0.93)	1.93(0.87)	1.93(0.87)	0.374	0.68
BMI	23.88(1.49)	23.22(1.43)	23.59(1.41)	23.59(1.14)	1.81	0.16
Standing time	5.41(1.93)	5.35(1.68)	5.47(1.78)	5.47(1.78)	0.29	0.76

Table 2 Qualitative variables' characteristics of participants

Variables	Level	Control group	Intervention 5-day	Intervention 10-day	All	*p* value
Level of education	Under diploma and diploma	8(25)	9(29.03)	9(29.03)	31(33.33)	G = 3.65
	Academic	24(75)	22(70.97)	22(70.97)	62(66.67)	P = 0.16
Spouse's level of education	Under diploma and diploma	11(34.38)	11(70.97)			G = 1.021
	Academic	21(65.63)	20(64.52)	16(53.33)	57(61.29)	P = 0. 60
Employment status	Housewife	21(65.63)	14(45.16)	19(63.33)	54(58.06)	G = 3.21
	Employee	11(34.38)	17(54.84)	11(34.38)	39(41.94)	P = 0.20
Spouse's employment status	Free	17(53.13)	14(45.16)	18(60)	49(52.69)	G = 1.35
	Employee	15(46.88)	17(54.84)	12(40)	44(47.31)	P = 0.50
The economic situation	Lower middle-income level	8(25)	4(12.9)	7(23.33)	19(20.43)	G = 1.87
	Middle-income level	19(59.38)	20(64.52)	17(56.67)	56(60.22)	P = 0.75
	Higher middle-income level	5(15.63)	7(22.58)	6(20)	18(19.35)	

Table 3 The mean and standard deviation of the environments measured in the legs, in centimeters and the volume of the legs in millimeters, separately for the 5-day, 10-day test groups and the study control, before, and after the intervention

	Variables	Control group			Intervention 5-day group			Intervention 10-day group		
		Pre	Post	*p* value	Pre	Post	*p* value	Pre	Post	*p* value
		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Right	Ankle	23.68 ± 2.94	23.68 ± 2.949	0.04	23.61 ±2.84	23.69 ± 2.99	0.04	23.74 ± 2.12	23.71 ± 2.12	0.003
	Instep	25.05 ± 2.62	25.05 ± 2.62	0.59	26.28 ± 3.56	26.14 ± 3. 54	0.59	25.47 ± 1.87	25.36± 1.89	P < 0.001
	MPJ	21.58 ± 1.38	21.58 ±1.38	0.001	22.23 ± 1.09	22.28 ± 2. 91	0.011	21.85 ± 1.36	21.75 ± 1.38	0.035
	Volume	278.59 ±24.24	278.59 ± 24.24	0.19	264.55 ±5.97	269.32 ±34.98	0.19	274.83 ± 27.62	269.83 ± 28.69	0.001
Left	Ankle	23.67 ± 2. 48	23.67 ± 2.48	0.19	23.64 ± 2.91	23.71 ± 2.91	0.001	23.67 ± 2.48	23.64 ± 21.91	*P* < 0.001
	Instep	25.12 ± 2.48	25.12 ± 2.48	0.002	26.38 ± 3.44	26.35 ± 3.48	0.002	25.43 ± 1.83	25.43 ± 1.83	*P* < 0.001
	MPJ	21.60 ± 1.33	21.60 ± 1.33	0.001	22.18 ± 1.92	22.26 ± 1.94	0.001	21.85 ± 1.33	21.85 ± 1.33	*P* < 0.001
	Volume	278.75 ± 25.11	278.75 ± 25.11	*P* < 0.001	263.35 ± 56.18	272.45 ± 34.80	<0.001	275.50 ± 28.66	275.50 ± 28.66	*P* < 0.001

MPJ: Metatarsal–phalanges joint

the average volume of the right leg compared to before the study. In the 10-day intervention group, there was a significant difference in all averages of right ankle circumference, left ankle circumference, right heel circumference, left heel circumference, right foot circumference, right foot circumference, right foot volume, left foot volume, and pain score compared to before the intervention.

Coban and Sirin studied the effect of massage on the reduction of physiological edema of the lower limbs in pregnancy. They found that after 5 days of daily massage, the average of all the leg circumferences except around the left ankle was significantly reduced in the test group compared to the control group. It confirms the effect of massage on reducing the amount of physiological edema in pregnancy [16]. Nevertheless, according to the results of this study, there was a reduction in the average of dimensions of the leg circumferences on the left side, which seems to be due to the modified LLT position.

In a study done by Ahmed et al. with the aim of comparing effleurage massage and water immersion exercise in reducing physiological leg swelling among primiparous women for 5 days, it was shown that effleurage massage was more effective than water immersion in reducing the symptoms of edema in the lower limbs of women. This reduction was reported in all circumferences of foot and degree of edema. The results may be due to the fact that aphrodisiac massage can stimulate blood flow, fluid movement, and the function of the lymphatic system. It can also move excess fluid in the vessels without disturbing the intravascular fluid [17].

The results of Rahimikian et al.'s study showed that foot massage is effective in reducing the physiological edema of pregnancy. Moreover, the results showed that there is a significant statistical difference between the average amount of the measured circumference in the legs (around the wrist, heel, and joint between the fingers and metatarsal bones) in the two tests and control groups after five days of massage for 20 min a day($P < 0.001$) [18]. The different mechanisms of massage in relation to modified Buerger–Allen exercises can be one of the reasons for the inconsistency of this study with the current study, despite the similarity in the duration of the intervention.

Hartmann and Huch investigated the response of leg edema in pregnancy to a session of immersion in water, it was shown that the average size of the leg and the volume of the right foot decreased ($P = 0.007$) and it was consistent with the present study. It seems that the reason for this correspondence is the use of the same tool in measuring the volume of the legs and estimating the amount of edema [19].

The results of the recent study showed that the average pain score before doing the Modified Buerger–Allen exercises was 5.23, while the average pain score after doing the

exercises for ten days was 3.8. Thus, there was a significant difference in all dimensions of the feet, the volume of the feet, and the amount of pitting with before the study. Therefore, the hypothesis was supported, because doing modified Buerger–Allen exercises in pregnant women can reduce pain and lower limb edema. According to the results of the 10-day intervention study and the evaluation after ten days, there was a significant difference and an acceptable level in the improvement of the average foot circumferences, foot volume, and pain, which can be attributed to the improvement of blood supply in the lower limbs during the ten days of performing modified Buerger–Allen exercises.

This means that performing modified Buerger–Allen exercises for ten days is effective in improving the peripheral blood flow of the lower limbs, which is in line with the results of Hassan et al. [20] who reported a significant difference in the average ankle–brachial index (ABI) score after performing these exercises for 15 days. However, after five days of intervention, no significant difference was observed in the ABI score, which is consistent [20]. The resulting change may be due to the improvement of the lateral blood circulation of the lower limbs, the peripheral blood circulation, and blood perfusion. Also, like other exercise programs, increasing the time may help increase the production of desired results.

Considering that the conditions in pregnant women are different, the studies in people who suffer from diabetes were like this. In this regard, the systematic study done by Chyong-Fang Chang et al. (2015) and with the aim of investigating the effectiveness of Buerger–Allen exercise on improving peripheral blood circulation showed that there might be some evidence for the beneficial effects of Buerger exercises, the low cost, and the safety of performing these exercises at home in diabetic patients [12, 21]. This review has shown that Buerger -Allen exercises can be beneficial for peripheral artery disease patients, postoperative patients with orthopedic, and gynecological problems by improving local blood circulation.

Hafid et al. [22] and Kumari et al. [23] showed that the Buerger–Allen exercise is effective in improving the peripheral blood circulation of the lower limbs in diabetic patients, and it was in line with the results of the present study which indicated that there was a reduction in edema.

This study showed that the modified Buerger–Allen exercise can reduce edema in the 10-day intervention group and to some extent the 5-day intervention group in comparison with before the intervention. It can be due to the positions used to improve blood circulation and improve peripheral blood flow. This way leads to the reduction of edema in the lower limbs. Therefore, it is better to use modified Buerger–Allen training for a longer period of time to increase the effect of the exercise in reducing edema.

The findings of this research supported the possibility of a greater effect of the modified Buerger–Allen exercises as an intervention to reduce the physiological edema of pregnancy or to prevent the development of leg edema. Therefore, modified Buerger–Allen exercises can be performed as a useful, low-risk, and low-cost method by trained midwives either in centers that provide prenatal care or in women's homes. Modified Buerger–Allen exercises with correct positions can be used for healthy pregnant women as a useful technique by trained midwives without obstetric complications in prenatal care centers or in the homes. Also, because of the prevalence of pregnancy physiological problems in courtship and its impact on the quality of life, it is recommended that the medical and health staff become familiar with such exercises and use them.

Conclusion

Thus, it is suggested that wider studies be carried out on the effect of the modified Berger–Allen exercise on the swelling of the lower limbs in pregnant women. If it is effective, we can benefit from the low-cost and low-complication complementary treatment in reducing the severity of the symptoms of such physiological problems in pregnancy. Generally, according to the findings of the present study, the modified Buerger–Allen exercise can be effective in reducing the severity of symptoms of lower limb edema in pregnant women.

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Declarations

Conflict of interest The author declares that there is no conflict of interest in this article.

Ethics approval and consent to participate The ethics code of this study has been approved by the Ethics Committee of Tarbiat Modares University (IR. MODARES. REC. 1399.105), and written informed consent has been obtained from all participants in the study.

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