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Research article

# The effectiveness of Jacobson's progressive muscle relaxation technique on maternal, fetal and neonatal outcomes in women with non-severe preeclampsia: a randomized clinical trial

Sara Ghorbannejad [a], Zahra MehdizadehTourzani [a], Kourosh Kabir [b], MansourehYazdkhasti [c,*]

[a] Department of Midwifery, School of Medicine, Alborz University of Medical Sciences, Karaj, Iran
[b] Department of Community Medicine, School of Medicine, Alborz University of Medical Sciences, Karaj, Iran
[c] Department of Midwifery, School of Medicine, Social Determinants of Health Research Center, Alborz University of Medical Sciences, Karaj, Iran

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ABSTRACT

*Background:* Preeclampsia (PE), as the most common major pregnancy disorder, has serious maternal, fetal and neonatal complications, and outcomes. The present study was designed to determine the effectiveness of Jacobson's progressive muscle relaxation technique on maternal, fetal, and neonatal outcomes in women with non-severe preeclampsia (PE).

*Methods:* This is a randomized clinical trial conducted from March 21, 2021 to July 22, 2021 in the Kamali referral center in Karaj, Iran. A total of 88 eligible participants were assigned to intervention and control groups (44 in each group) via blocked randomization. The intervention group (6 groups of 6 participants and one group of 8 participants) received Jacobson's progressive muscle relaxation technique in addition to receiving routine care, twice a week for 6 weeks (4 face-to-face sessions and 8 online sessions). The control group only received routine perinatal care. A checklist collected data before and after the intervention. Data were analyzed in SPSS software v.23. To analyze the obtained data, independent t-test, Paired t-test, Mann-Whitney, Chi-square, and Fisher test were used.

*Results:* The results showed a statistically significant difference between intervention and control groups in terms of Systolic Blood pressure (SBP) ($P < 0.001$), Diastolic Blood pressure (DBP) ($P < 0.001$), 24-hour urine protein level (proteinuria) ($P < 0.001$). and Fasting Blood Sugar (FBS) ($P < 0.001$), birth Weight (BW) ($P = 0.01$), baseline Fetal heart rate (BFHR) ($P < 0.001$) and Number fetal movements based on non-stress test (NFMsN), during 20 min ($P < 0.001$) after intervention ($P < 0.001$).

Also In the intervention group, the results showed a statistically significant difference in Amniotic Fluid Index (AFI) ($P = 0.01$), SBP($P < 0.001$), DBP($P < 0.001$), proteinuria ($P < 0.001$), FBS($P < 0.001$), BFHR based on non-stress test (NST) ($P < 0.001$), and NFMsN during 20 min ($P < 0.001$) in the intervention group before and after the intervention. There was no statistically significant difference in the control group.

*Conclusion:* This study's results showed the effectiveness of progressive muscle relaxation technique on the improvement of SBP, DBP, proteinuria, FBS, FHR and NFMsN during 20 min based on NST and BW in women with non-severe PE. Therefore, it is recommended to perform this technique in health centers.

## 1. Introduction

Preeclampsia (PE) is the most common major pregnancy disorder, accounting for 22% of maternal mortality in the world and the second most common cause of maternal mortality in the world [1, 2]. Spasms, increased peripheral vascular resistance, and reduced blood flow to key organs and the fetus are all symptoms of this illness. After the twenty week of pregnancy [3, 4, 5], it is characterized by hypertension and proteinuria, and it creates major difficulties and health concerns to the mother, fetus, and infant [6]. The global incidence rate of PE is 4–5%, and its incidence rate is higher in young and primiparous women than older women (3–10%) [3]. The incidence rate of PE in developing countries is higher than 18% [7], and according to the latest studies, this incidence rate in Iran has been reported about 14%, which has increased compared to previous years [2, 8]. Epidemiological studies have shown an increase in the incidence rate of PE in the world [6].

* Corresponding author.
*E-mail address:* Mansoyazd@yahoo.com (MansourehYazdkhasti).

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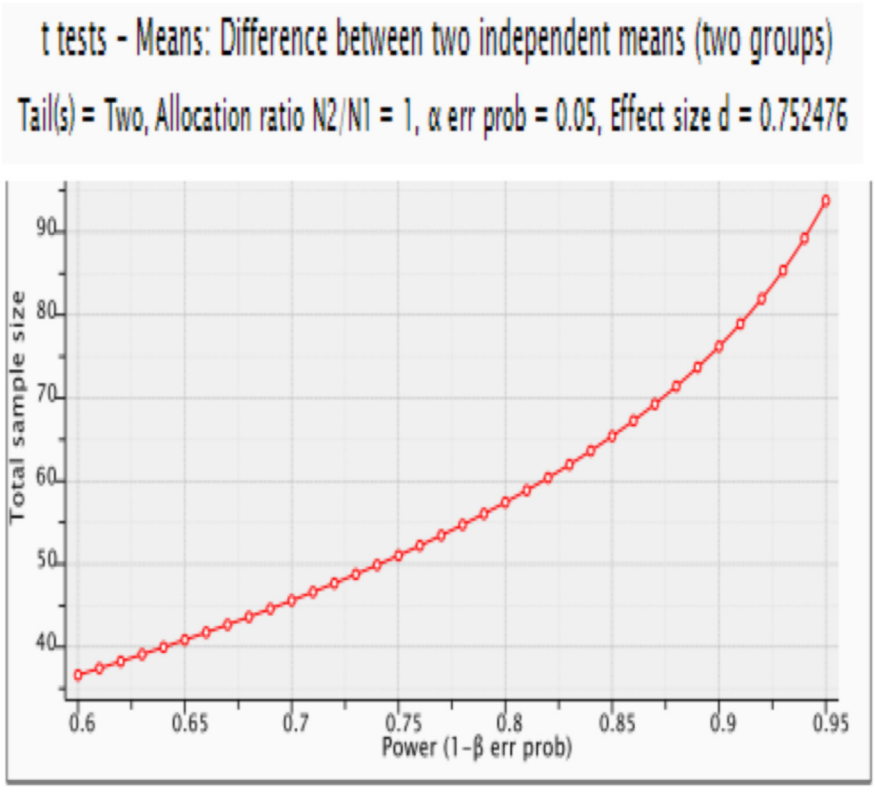


**Figure 1.** Sample size calculation in G-Power software.

Reduced blood supply to important organs such as the heart, brain, liver, and kidneys causes dangerous consequences, including cardiovascular diseases, diabetes, and even maternal mortality. Fetal and neonatal complications, including placental abruption, oligohydramnios, intrauterine growth restriction, low birth weight, unsatisfying Fetal heart rate (FHR), low Apgar score and need for neonatal cardiopulmonary resuscitation, fetal distress, the need for newborn intensive care unit (NICU) admission, and eventually intrauterine fetal demise [3].

Etiology of PE is still unknown, and there is no definitive cure for these severe disorders other than termination of pregnancy; however, strategies can be used to reduce complications of non-severe PE [5]. There are hypotheses suggesting the role of stress in this disorder [9, 10]. Psychosomatic disorders like hypertension and PE, according to the diathesis-stress hypothesis, are caused by two factors: heredity and stress [11, 12]. By increasing the activity of the autonomic nervous system and endocrine system, stress and anxiety increase heart rate, blood pressure, oxygen consumption, and the production of epinephrine and norepinephrine, and prolonged physiological arousal can cause disorders such as hypertension and PE through immune-suppression [9, 13]. Studies show higher levels of stress, anxiety [14, 15], and depression [16] in high-risk pregnancies (PE) than in the low-risk pregnancies. One of the non-pharmacological strategies to reduce stress and anxiety, which leads to a decrease in Systolic Blood pressure (SBP), Diastolic Blood pressure (DBP), and24-hour urine protein level (proteinuria) in pregnant women with PE, is using the muscle relaxation techniques. This technique reduces heart rate, blood pressure, the number of breaths and oxygen consumption, and carbon dioxide production, and improves oxygenation, and reduces arterial blood lactate [1, 17, 18, 19].

Among all anxiety reduction techniques, Jacobson's progressive muscle relaxation technique has received the most experimental support to reduce the perceived stress and improving pregnancy outcomes [20, 21]. Jacobson's progressive muscle relaxation technique is used in the clinical field, rehabilitation and is regarded as a tool to reduce stress, pain, and discomfort, chronic diseases such as hypertension, cardiovascular diseases, and other chronic diseases [22, 23]. Progressive muscle relaxation techniques can also be used to improve general health and restore the body's hemostatic balance in the face of stressful conditions [24, 25]. The resulting relaxation can reduce pain, stress, and depression in pregnant women [26].

Jacobson's progressive muscle relaxation technique is performed in several ways:

1 Gradual contraction-relaxation method based on 21 muscle groups
2 Gradual contraction-relaxation method based on 16 muscle groups
3 Gradual contraction-relaxation method based on 7 muscle groups
4 Gradual contraction-relaxation method based on 4 muscle groups
5 Relaxation via the reminders
6 Relaxation via the reminders along with counting
7 Relaxation via only counting

Since the relaxation technique based on 16 muscle groups is used more frequently which has reduced stress, anxiety, and improved general health outcomes, the present study has taken into account this technique [27, 28]. Despite the ease and cost-effectiveness of progressive muscle relaxation techniques, they were used to improve maternal, fetal, and neonatal outcomes in women with non-severe PE less frequently and previous studies also yielded contradictory results in this regard [1, 28, 29, 30, 31, 32]. Therefore, this study aimed to determine the effectiveness of Jacobson's progressive muscle relaxation technique on maternal, fetal, and neonatal outcomes in women with non-severe PE.

## 2. Materials and methods

### 2.1. Setting

This was a parallel clinical trial with two control and experimental groups. The present study was performed in Kamali Educational Hospital, Karaj, Iran, from the March 21, 2021 to July 22, 2021. Data collection was performed before and after the intervention.

### 2.2. Participants

Inclusion criteria: Primiparous women, Gestational age of 26–34 weeks, Singleton pregnancy, Absence of non-severe PE criteria, and First and second stage screening were at low risk.

Exclusion criteria: underlying mental (depression with severe anxiety) or physical disorders (cardio-respiratory disease, seizures, gestational or overt diabetes, epilepsy) based on medical records, Symptoms of severe PE during the study period, History or presence of symptoms of preterm delivery, and use of alcohol, tobacco, and drugs.

The study protocol was approved by the Ethics Committee of Alborz University of Medical Sciences (Code: IR.ABZUMS.REC.1399.033), and was registered with the Clinical Trials Code of IRCT20180110038302N6. Written informed consent was obtained from all the participants.

### 2.3. Sampling and sample size

First, a list of pregnant women with non-severe PE was prepared in Excel software using their hospital records by referring to the Medical Records Department of the Kamali Hospital in Karaj. The study goal was then conveyed to participants over the phone, and they were directed to the appropriate educational facility according to the schedule. The participants were then informed about the prospect of being allocated to one of the intervention or control groups, and their written agreement was acquired.

According to Awad et al.'s article [1], the sample size was obtained 88 people using G-Power software considering a 10% loss to follow-up (Figure 1).

Blocked randomization was performed with 22 blocks of size 4 using a free software package (www.randomization.com). Accordingly, the participants were divided, in a one-to-one ratio, into the intervention and control groups each containing 44 participants.

### 2.4. Intervention definition

The intervention design was as follows: In addition to receiving routine counseling, the intervention group underwent Jacobson's progressive muscle relaxation exercises. According to the timetable, the exercises were performed in the intervention group twice a week for 6 weeks. There were 6 groups of 6 people and one group of 8 people who performed the exercises twice weeks (once a day). Each session lasted 45 min on average.

The participant in this group received the intervention during four face-to-face sessions and eight online sessions due to the Covid-19 pandemic. When it was confirmed that the participants did not have Covid-19 symptoms, face-to-face sessions were held in a quiet open-air place, while there was sitting on chairs arranged at a 2-m distance from each other. Face-to-face group counseling was performed in three stages: 1. Introduction and practice (first week), 2. Practice (second to fifth week), 3. Termination (Sixth week) based on Jacobson' method. The

**Table 1.** Contents of progressive muscle relaxation sessions according to the introduction and action, practice, and termination.

| Week | Session content |
|---|---|
| Introduction and practice (first week) | 1 Welcoming, introduction, maintaining the confidentiality of information to prevent information leakage to the control group l<br>2 Definition of preeclampsia and its symptoms and consequences<br>3 Explaining the mechanism of action, benefits, and purpose of relaxation<br>4 Teaching diaphragmatic breathing techniques<br>5 Basic training of muscle relaxation technique<br>6 Taking fasting blood sugar test with a glucometer and primary blood pressure, before exercising (from the right hand in a sitting position) and secondary blood pressure (after exercising)<br>7 Asking questions about fetal movements and risk symptoms (headache, epigastric pain, bleeding)<br>Items 6 and 7 were performed before relaxation exercises in each session. |
| Practice (second to fifth week) | 1 Reviewing the first session<br>2 Performing items 6 and 7 in the first session<br>3 The mother performs deep diaphragmatic breathing in a relaxed and comfortable position on the chair while her eyes are closed.<br>4 Conscious removal of tension from the muscles: Contractions start from the hands to the sole muscles (each muscle group was contracted for 5–7 s and then relaxed for 30–40 s). Each muscle group was relaxed twice. The sequence of muscle contraction and relaxation was performed as follows according to Jacobson' technique:<br>• Hand and the lower part of the dominant arm: Fist and tighten your hand, then relax.<br>• Hand and the lower part of non-dominant arm: Fist and tighten your hand, then relax.<br>• Dominant arm: Push the elbow down on the chair and then relax.<br>• Non-dominant arm: Push the elbow down on the chair and then relax.<br>• Forehead: Raise your eyebrows and wrinkle your forehead, then relax.<br>• Close your eyes tightly, then relax<br>• Muscles of the central part of the face: Cross your eyes and pull the nose upwards.<br>• The lower part of face, jaw and neck: Tie your teeth and tighten the corners of your mouth, then relax.<br>• Shoulders: Raise your shoulders as if you want to touch the ears, then relax.<br>• Chest and abdomen: Take a deep breath and hold it, then relax (Abdominal muscle contraction was avoided due to avoiding preterm labor contractions in this study).<br>• Dominant leg: Pull your toes down, away from your body, then relax.<br>• Dominant thigh: Contract the muscles above and below the thigh and then relax.<br>• Non-dominant leg: Pull your toes up and towards your body, then relax.<br>• Dominant thigh: Contract the muscles above and below the thigh and then relax.<br>• Check the whole body for the remaining tension: If you experience tension or pressure in certain muscles, repeat the muscle contraction and relaxation for that group of muscles.<br>5 The second to fifth sessions were held in person.<br>6 The sixth to eleventh sessions were held online.<br>7 Giving a CD of Jacobson' relaxation exercises for daily exercises at home<br>8 Giving checklist regarding relaxation exercises at home<br>9 Checking the checklists from the third to the eleventh session<br>10 Answering questions |
| Termination (sixth week) | 1 Reviewing the previous session<br>2 Performing Jacobson's relaxation exercises<br>3 Receiving the checklist of the previous session (by sending a checklist photo in online sessions)<br>4 Summarizing and answering questions (online before online sessions) |

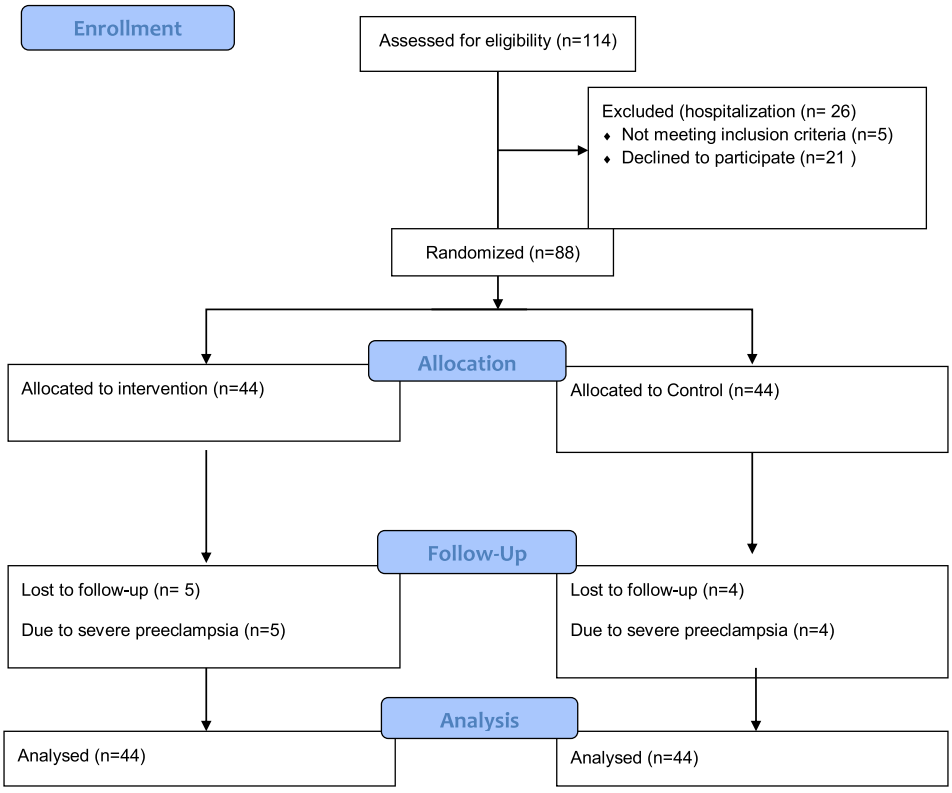


**Figure 2.** CONSORT 2010 flow diagram.

contents of the session are given in Table 1. The duration and method of exercises in online sessions were performed in accordance with face-to-face sessions. The control group received no intervention except for routine perinatal care.

To observe the research ethics, the exercise CD was also delivered to the control group at the end of the study. No side effects were found in the participants. Participants' feedback on this favorable method has been reported.

### 2.5. Outcome assessment

A data-gathering form was used for the demographic questionnaire includes questions on body mass index (BMI) (kg/cm$^2$), gestational age (GA) at the time of preeclampsia (w), Systolic Blood pressure (SBP), Diastolic Blood pressure (DBP), 24-hour urine protein level (proteinuria) and Fasting Blood Sugar (FBS), Amniotic Fluid Index (AFI), and baseline Fetal heart rate (BFHR) and Number fetal movements based on NST (NFMsN).

Additionally, checklist of maternal, fetal, and neonatal outcomes, including: birth height (BH) (cm), birth Weight (BW) (g) and birth head circumference (HC) (cm), first-minute Apgar score (out of 10) and gestational age at birth (GAD), SBP, and DBP (mmHg), 24-hour urine protein level (mg/L), FBS (mg/dL), AFI according to biophysical profile (BPP), baseline FHR (bpm) and FMs by NST.

### 2.6. Statistical analysis

Statistical analysis was conducted using the SPSS 23 software. Chi-square and Fisher's exact test were used for qualitative variables. Statistical results from the quantitative data were presented with Mean ± SD. Data normality was reviewed using the Skewness and Kurtosis. Mann-Whitney and Wilcoxon nonparametric tests were used for variables with the abnormal distribution. Independent parametric t-test and paired t-test were used for variables with the normal distribution.

### 2.7. Ethical considerations

Permission to conduct a study with a code of ethics IR.ABZUMS.-REC.1399.033 was obtained.

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or fal-sification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors. IRCT20180110038302N6.

## 3. Results

Statistical analysis was performed using the intention to treat (ITT) approach. In this approach, data analysis is performed on all data without considering the lost to follow-up [29]. The present study performed demographic characteristics and other analysis on 88 participants (44 in each group). Four women in the intervention group and Five women in the control group were lost to follow-up (Figure 2). The intervention and control groups were homogeneous in terms of maternal age, occupation, and socioeconomic status, level of education, maternal BMI, Methyl Dopa consumption, and history of abortion (Table 2).

Before the intervention or baseline, the results of the independent t-test showed that mean GA, SBP, DBP, 24-hour urine protein level, FBS, AFI, BFHR based on NST, and NFMsN during 20 min based on the Mann-Whitney test were not statistically significant in two groups (Table 3).

The results of paired t-test showed that mean SBP, DBP, 24-hour urine protein level, FBS, BFHR based on NSTwere significantly different in the intervention group before and after the intervention ($P < 0.001$). Also, AFI was significantly different in the intervention group before and after the intervention ($P < 0.01$).

The results of the Wilcoxon test showed a statistically significant difference in NFMsN during 20 min in the intervention group before and after the intervention ($P < 0.001$); but there was no statistically significant difference in the control group (Table 4).

**Table 2.** Comparison of baseline demographics characteristics between intervention and control groups.

| Variable | | Intervention (n = 44) | | Control (n = 44) | | P-value |
|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | |
| M A (Y) | 20–30 | 10 | 22.7 | 18 | 40.9 | 0.54[a] $\chi^2 = 0.03$ |
| | 30–40 | 28 | 63.6 | 16 | 36.4 | |
| | 40–50 | 6 | 13.6 | 10 | 22.7 | |
| Job | House wife | 38 | 86.4 | 36 | 81.8 | 0.66[b] F = 1.286 |
| | Laborer | 3 | 6.8 | 6 | 13.6 | |
| | Employee | 3 | 6.8 | 2 | 4.5 | |
| SES | Poor | 21 | 47.7 | 19 | 43.2 | 0.78[b] F = 0.58 |
| | Moderate | 20 | 45.5 | 23 | 52.3 | |
| | Good | 3 | 6.8 | 2 | 4.5 | |
| Number of Abortion | 0 | 34 | 77.3 | 38 | 86.4 | 0.40[b] F = 2.00 |
| | 1 | 6 | 13.6 | 5 | 11.4 | |
| | 2–3 | 4 | 9.1 | 1 | 2.3 | |
| Level of Education | Middle school | 35 | 79.5 | 29 | 65.9 | 0.23[b] F = 2.56 |
| | High school Diploma | 9 | 20.5 | 14 | 31.8 | |
| | Academic | 0 | 0 | 1 | 2.3 | |
| CMD (Mg) | Not using | 28 | 63.6 | 21 | 47.7 | 0.133[a] $\chi^2 = 2.256$ |
| | 125mg | 16 | 36.4 | 23 | 52.3 | |
| BMI (kg/m2) | 19.8–26.9 | 14 | 31.8 | 12 | 27.3 | 0.812[a] $\chi^2 = 0.416$ |
| | 27–29.9 | 20 | 45.5 | 23 | 53.3 | |
| | 30–34.9 | 10 | 22.7 | 9 | 20.5 | |

MA = Maternal Age, Y = year, SES = Socio Economic Status, CMD = Consumption of Methyl Dopa, Mg = Milligram, Mg = Milligram, BMI = Body mass index.
[a] Chi-square.
[b] Fisher exact test.

The results of the independent t-test showed a statistically significant difference between the two groups in terms of mean SBP, DBP, 24-hour urine protein level, FBS, BFHR based on NST, and mean BW after the intervention ($P < 0.001$). However, there was no statistically significant difference between the two groups in terms of BH, AFI, and GAD.

The results of the Mann-Whitney test showed a statistically significant difference between the two groups in terms of NFMsN during 20 min after the intervention ($P < 0.001$), but there was no significant difference between two groups in terms of 1st min Apgar score and HC at birth (Table 5).

## 4. Discussion

This study aimed to determine the effectiveness of Jacobson's progressive muscle relaxation technique on maternal, fetal, and neonatal outcomes in women with non-severe PE. There was a significant difference between the two groups in terms of mean SBP, DBP, proteinuria, FBS, BFHR based on NST and NFMsN during 20 min before and after the intervention and BW after the intervention. Furthermore, mean SBP, DBP, proteinuria, FBS and baseline FHR based on NST and AFI were statistically significant in the intervention group before and after the

**Table 3.** Comparison of baseline gestational characteristics between intervention and control groups.

| Variable | control group n = 44 | intervention group n = 44 | Result |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | p- value |
| G A (W) | 28.25 ± 1.94 | 28.36 ± 1.95 | 0.78[a] t = 1.27 |
| SBP (mmHg) | 148.59 ± 4.68 | 150.02 ± 4.83 | 0.16[a] t = 1.45 |
| DBP(mmHg) | 99.65 ± 4.63 | 99.27 ± 4.91 | 0.70[a] t = -0.82 |
| 24-hour urine protein level (mg/L) | 204.61 ± 35.71 | 191.93 ± 32.08 | 0.08[a] t = 3.73 |
| FBS(mg/dL) | 107.68 ± 9.59 | 107.86 ± 10.13 | 0.93[a] t = 2.14 |
| AFI(mm) | 144.29 ± 28.76 | 139.09 ± 28.44 | 0.39[a] t = -0.60 |
| BFHR based on NST (bpm) | 146.38 ± 7.91 | 149.38 ± 5.59 | 0.40[a] t = 0.58 |
| NFMsN (during 20 min) | 4.93 ± 0.78 | 4.04 ± 0.88 | 0.61[b] Z = 0.50 |

W=Weeks, GA = Gestational age, SBP = Systolic Blood pressure, mmHg = millimeter of mercury, DBP = Diastolic Blood pressure, FBS = Fasting Blood Sugar, AFI = Amniotic Fluid Index, BFHR = baseline Fetal heart rate, bpm = beat per minute, NFMsN = Number fetal movements based on NST.
[a] Independent t-test.
[b] Mann-Whitney test.

**Table 4.** Comparison of maternal, fetal and neonatal outcomes in two groups before and after intervention.

| Variable | Mean ± SD | | Result | Mean ± SD | | Result |
|---|---|---|---|---|---|---|
| | Intervention Group n = 44 | | | Control Group n = 44 | | |
| | Before intervention | After intervention | P-value | Before intervention | After intervention | P-value |
| SBP (mmHg) | 150.02 ± 4.83 | 137.59 ± 3.94 | 0.000[a] t = 13.23 | 148.59 ± 4.68 | 147.54 ± 4.99 | 0.23[a] t = 1.19 |
| DBP (mmHg) | 99.27 ± 4.91 | 88.72 ± 3.768 | p = 0.000[a] t = 11.10 | 99.65 ± 4.63 | 99.22 ± 4.54 | 0.68[a] t = 0.41 |
| 24-hour urine protein level (mg/L) | 191.93 ± 32.08 | 169.56 ± 27.45 | 0.000[a] t = 4.40 | 204.61 ± 35.71 | 201.00 ± 28.15 | 0.50[a] t = 0.66 |
| FBS(mg/dL) | 107.86 ± 10.13 | 101.79 ± 6.78 | 0.000[a] t = 4.13 | 107.68 ± 9.59 | 111.00 ± 9.54 | 0.09[a] t = -2.72 |
| AFI (mm) | 139.09 ± 28.44 | 155.27 ± 27.44 | 0.01[a] t = -2.68 | 144.29 ± 28.76 | 153.54 ± 30.31 | 0.16[a] t = -1.39 |
| BFHR based on NST (bpm) | 149.38 ± 5.59 | 139.81 ± 6.20 | 0.000[a] t = 7.49 | 150.38 ± 7.91 | 150.11 ± 6.54 | 0.14[a] t = -1.56 |
| NFMsN (during 20 min) | 4.04 ± .88 | 7.05 ± 0.23 | 0.000[b] z = -3.63 | 4.93 ± .78 | 4.63 ± 0.86 | 0.1[b] z = 0.63 |

[a] Paired t-test.
[b] Wilcoxon W.

intervention; however, there was no statistically significant difference in the control group in terms of the above variables before and after the intervention.

Anxiety and stress are possible causes of preeclampsia, and stress, and anxiety scores were reported to be higher in women with PE (severe or non-severe). Therefore, relaxation methods can improve hypertension symptoms and other maternal, fetal, and neonatal outcomes by reducing the anxiety or stress of pregnant mothers. Jacobson's technique is based on psycho-neurological-immunological theory [30]. In this method, by activating the sympathetic and parasympathetic systems, muscle tension is controlled. Reducing muscle tension is accomplished by performing active contraction and then relaxing a group of specific muscles in a progressive state. Therefore, it makes the heart work better and regulates blood pressure, and also helps decrease in SBP and DBP [31, 32, 33, 34]. In our study, Jacobson's progressive muscle relaxation technique reduced mean SBP, DBP, 24-hour urine protein level, which is consistent with the results of a study by Awad et al. [1]. In their quasi-experimental study, SBP, DBP and 24-hour urine protein level variables were investigated. They found a significant reduction in SBP, DBP and 24-hour urine protein level in the progressive muscle relaxation group. However, in the present study, in addition to SBP, DBP, and 24-hour urine protein level, other preeclampsia-related variables, including FBS, AFI, FHR and FMs movements, birth anthropometric indices, and first-minute Apgar score were investigated. In one study, simultaneous Jacobson's progressive muscle relaxation exercises and breathing techniques improved SBP and DBP in pregnant women with gestational hypertension in the intervention group [35].

Another research found that the benefits of progressive muscle relaxation combined with mental imagery on SBP and DBP in women with pregnant hypertension are beneficial from the first week of treatment. After the intervention, there was also a statistically significant drop in the intervention group compared to the control group [36]. Jafarnejad et al. (2011) investigated the effect of muscle relaxation exercises on gestational hypertension. The findings of these researchers showed a reduction in SBP even after one session, but DBP decreased at least two weeks after the intervention in the intervention group. The present study also showed a decrease in SBP and DBP after the intervention [37].

In a study of women with pulmonary asthma, the results showed that Jacobson's technique significantly reduced SBP, but not DBP [38].

Results of a study of maternal, fetal and neonatal outcomes showed that Jacobson's technique increased the accelerations and decreased the number of heartbeats in the NST and decreased FMs based on the NST [39, 40, 41]. The current research also found that in the intervention group, the number of baseline FHR and FMs improved, as measured by the NST. This rise may be linked to enhanced perfusion and an increase in the oxygen supply to the fetus since Jacobson's approach is an aerobic technique [39, 42]. Other investigations found that six weeks of Jacobson's progressive muscle relaxation increased BW, improved blood pressure symptoms, and decreased FBS in the intervention group compared to the control group [30, 43], which matched the findings of

**Table 5.** Comparison of maternal, fetal and neonatal outcomes between intervention and control groups after intervention.

| Variable | Mean ± SD | Mean ± SD | Result |
|---|---|---|---|
| | Intervention Group n = 44 | Control Group n = 44 | P- value |
| SBP (mmHg) | 137.59 ± 3.94 | 147.54 ± 4.99 | 0.000[a] t = -10.54 |
| DBP (mmHg) | 88.72 ± 3.768 | 99.22 ± 4.54 | 0.000[a] t = -11.80 |
| 24-hour urine protein level (mg/L) | 169.56 ± 27.45 | 201.00 ± 28.15 | 0.000[a] t = -4.89 |
| FBS(mg/dL) | 101.79 ± 6.78 | 111.00 ± 9.54 | 0.000[a] t = -5.34 |
| AFI(mm) | 155.27 ± 27.44 | 153.54 ± 30.31 | 0.82[a] t = 0.22 |
| BFHR based on NST (bpm) | 139.81 ± 6.20 | 150.11 ± 6.54 | 0.000[a] t = -7.48 |
| NFMsN (during 20 min) | 7.05 ± 0.23 | 4.63 ± 0.86 | 0.000[b] z = -3.63 |
| 1st min Apgar | 9.01 ± 0.36 | 8.82 ± 0.32 | 0.71[b] z = -0.37 |
| BH (Cm) | 47.83 ± 2.12 | 47.53 ± 2.15 | 0.51[a] t = 0.65 |
| BW (gr) | 2863.48 ± 176.01 | 2762.72 ± 202.10 | 0.01[a] t = 2.47 |
| GAD (w) | 36.31 ± 0.70 | 36.18 ± 0.78 | 0.39[a] t = 0.85 |
| HC (Cm) | 34.69 ± 0.23 | 34.45 ± 0.12 | 0.24[b] Z = -1.15 |

1st min Apgar = first-minute Apgar, BH = Birth High, BW = Birth Weight, GAD = gestational age at delivery, HC = head circumference.
[a] Independent t-test.
[b] Mann-Whitney test.

the current research. It seems that lowering SBP, DBP and improving placental-uterine perfusion can increase BW [30]. However, using Benson's muscle relaxation technique led to no statistically significant difference between the intervention and control groups in terms of head circumference, Apgar score and BW [32].

The present study showed no significant difference between the two groups in terms of head circumference and Apgar score, but BW was higher in the intervention group. While another study showed that using Jacobson's technique improved the birth height and head circumference, there was no difference between the two groups in terms of Apgar score. Therefore, using this technique probably depends on the duration of use and the method used [31].

## 5. Limitations

Because of the Covid-19 epidemic, the current research was limited. In-person sessions were handled via proper grouping, and efforts were made to overcome this constraint by observing 2-meter social distance, wearing masks, doing activities in an open-air location, and evaluating body temperature and any symptoms suggesting Covid-19. Another restriction that was alleviated with a brief serving after exercise was fatigue in pregnant mothers.

## 6. Conclusion

Considering that hypertension is one of the high-risk pregnancies and in line with the results of the Sixth National Development Plan (2030) [44] aiming at reducing pregnancy complications and outcomes, this progressive muscle relaxation technique probably can be used as an alternative in this regard. This method relieves muscle tension in pregnant women and leads to a feeling of relaxation. It is suggested that according to the results of our study, this method be taught to midwifery students in the management of non-severe PE. The findings of the present study indicate the positive effect of Jacobson's progressive muscle relaxation in improving outcomes such as SBP, DBP, 24-hour urine protein level, FBS, FMs movements and fetal heart rate, and BW. Therefore, this technique can be a suitable solution for women with non-severe PE in healthcare centers.

## Declarations

### *Author contribution statement*

Sara Ghorbannejad: Conceived and designed the experiments.
Mehdizadeh Tourzani: Performed the experiments.
Kourosh Kabir: Analyzed and interpreted the data.
Mansoureh Yazdkhasti: Contributed reagents, materials, analysis tools or data; Conceived and designed the experiments; Wrote the paper.

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### *Data availability statement*

The authors do not have permission to share data.

### *Declaration of interests statement*

The authors declare no conflict of interest.

### *Additional information*

The clinical trial described in this paper was registered at the Iranian Registry of Clinical Trials under the registration number IRCT201801 10038302N6.

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