Mobile-Based Box Breathing Application Blood Pressure in Pregnant Women at Risk of Preeclampsia

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ABSTRACT

Background: Preeclampsia is a pregnancy-related hypertensive disorder that remains a major contributor to maternal and perinatal morbidity and mortality. Non-pharmacological interventions, such as box breathing, have gained attention as complementary strategies for blood pressure control in pregnant women at risk of preeclampsia. This study aimed to examine the effect of a mobile-based box breathing intervention on blood pressure among pregnant women at risk of preeclampsia.

Methods: A pre-experimental study with a one-group pretest–posttest design was conducted among 197 pregnant women recruited using purposive sampling from four hospitals in Lampung Province, Indonesia. Blood pressure was measured before and after the intervention, and data were analyzed using a paired sample *t*-test.

Results: The mean systolic blood pressure decreased from 139.46 mmHg (SD = 14.28; range 105–195 mmHg) to 122.93 mmHg (SD = 10.91; range 96–167 mmHg), with a mean difference of 16.53 mmHg (SD = 13.43; $p < 0.001$). The mean diastolic blood pressure declined from 90.15 mmHg (SD = 11.90; range 56–156 mmHg) to 82.46 mmHg (SD = 8.21; range 66–106 mmHg), with a mean difference of 7.69 mmHg (SD = 10.74; $p < 0.001$).

Conclusion: Mobile-based box breathing was associated with a significant reduction in both systolic and diastolic blood pressure among pregnant women at risk of preeclampsia.

INTRODUCTION

Serious pregnancy conditions, preeclampsia, remain a serious global health issue. World Health Organization (WHO) reports preeclampsia and other hypertensive disorders during pregnancy account for about 14% of maternal deaths each year, making it a leading cause of death globally (WHO, 2023), Two major causes of maternal mortality, preeclampsia and hypertension during pregnancy, account for approximately 14% of all maternal deaths each year (Dini Kurniawati et al., 2023). Clinically, preeclampsia is defined as high blood pressure after the 20th day of pregnancy. Preeclampsia is a serious health problem for both mother and fetus, and is usually followed by kidney problems or signs of kidney failure (American College of Obstetricians and Gynecologists, 2022) Preeclampsia is also often associated with physiological stress, sleep disturbances, and emotional changes in pregnant women, which if left untreated can increase the risk of long-term complications.

Proteinuria or signs of organ failure are often found in preeclampsia, which is clinically defined as the development of hypertension after the 20th semana of pregnancy and poses a serious threat to maternal and infant wellbeing (Ministry of Health, 2023). National research shows that the incidence of preeclampsia ranges from 3%–10% of total pregnancies, with an

increased risk in pregnant women who have certain risk factors, such as extreme age (<20 years or >35 years), obesity with BMI >30, a history of hypertension or previous preeclampsia, gestational diabetes, twin pregnancies, as well as a family history of hypertension (Rinda Ica Ayuni et al., 2023). This condition indicates that most pregnant women need closer monitoring and early intervention to prevent further complications (Timiyatun & Oktavianto, 2021).

Locally, Lampung Province still faces challenges in reducing the number of maternal illnesses and deaths due to preeclampsia. Data from the Lampung Provincial Health Office shows that hypertension in pregnancy ranks second as the leading cause of maternal death in 2022. Several referral hospitals in Lampung, including Bob Bazar Kalianda Hospital, Ahmad Yani Metro Hospital, Sukadana Hospital, and Tjokrodipo Bandar Lampung Hospital, recorded a high number of pregnant women with a high risk of preeclampsia, so that it requires effective, practical, and sustainable interventions in health care facilities and at home (Provincial Health Office. Lampung, 2024). The latest study findings show a strong correlation ($p < 0.05$) between the incidence of preeclampsia and age, parity, body mass index (BMI), weight, chronic disease, physical exercise, nutrient intake, and lifestyle. A major risk factor is a history of chronic disease: p-value = 0.000 and OR = 70.636. This means that women who have a chronic disease are at a much greater chance of developing preeclampsia. Therefore, routine pregnancy control is very important for early detection so that quick and appropriate interventions can be carried out so that complications during pregnancy and childbirth can be prevented (Anita, Aprina, 2023).

Preeclampsia has a serious impact on both mother and fetus. In mothers, complications that can arise include eclampsia, stroke, kidney failure, and maternal death (Quzwain et al., 2025). Meanwhile, in fetuses, preeclampsia can cause intrauterine growth disorders, premature birth, low birth weight, and perinatal death (Hidayati et al., 2022).. In addition to physiological symptoms such as elevated blood pressure, proteinuria, edema, and headache, pregnant women with preeclampsia frequently experience psychological stress, sleep disturbances, and anxiety. These subjective symptoms may exacerbate hypertension and negatively affect pregnancy outcomes if not adequately managed (Kasmiati et al., 2023).

Current management of preeclampsia primarily focuses on pharmacological therapy and routine clinical monitoring. However, these approaches may be limited by access barriers, adherence issues, and insufficient emphasis on stress management and self-care during pregnancy. As a result, non-pharmacological interventions are gaining attention as complementary strategies due to their safety, low cost, and ease of implementation. Structured breathing techniques, such as box breathing, have been proven to lower blood pressure by activating the parasympathetic nervous system, suppressing sympathetic activity, and promoting blood vessel relaxation (Ahmed et al., 2021).

So far, the treatment of preeclampsia has been more focused on pharmacological therapy and routine medical monitoring. However, non-pharmacological interventions are also starting to be studied a lot because they are considered effective, cheap, and easy to implement. One of them is structured breathing techniques, such as *box breathing*, which are able to lower blood pressure through the activation of the parasympathetic nervous system, suppress sympathetic responses, and improve vascular relaxation In addition, regular breathing exercises can reduce anxiety, improve sleep quality, and reduce the symptoms of headaches that are often experienced by pregnant women (Anis Afri Nurul Hudha & Sri Handayani, 2024). According to the most recent research, pregnant women at risk of preeclampsia may reduce their systolic blood pressure from 147.83 mmHg to 132.36 mmHg, their diastolic blood pressure from 94.76 mmHg to 86.16 mmHg, and their symptom ratings from 5.93 to 1.25 by using the prototype box breathing invention (Aprina, Titi, 2024).

Pregnant women may exercise freely, often, and continuously without the assistance of medical professionals thanks to the incorporation of box breathing methods into health-based mobile apps (m-health) (Andas et al., 2023). This mobile application also acts as a means of education and motivation, so that pregnant women are more actively involved in maintaining their health, including stress management and independent blood pressure monitoring (Rahmawati et al., 2025).

Therefore, this study was conducted in many hospitals in Lampung Province to examine the

impact of mobile-based box breathing interventions on blood pressure among expectant mothers at risk of gestation hypertension. The expected outcome of our research is to generate scientific data on the use of non-pharmacological technology-based interventions as a strategy for promoting and preventing adverse maternal and fetal health outcomes.

METHODS

This research examined the impact of mobile-based Box Breathing on the blood pressure of pregnant women at risk of preeclampsia using a pre-experimental design with a one-group pretest–posttest strategy. Bob Bazar Kalianda Hospital, Ahmad Yani Metro Hospital, Sukadana Hospital, and Tjokrodipo Hospital Bandar Lampung are the four referral hospitals in Lampung Province where the study was carried out between January and May 2025. With a sample of 197 respondents chosen via purposive selection procedures based on inclusion and exclusion criteria, the research population included all pregnant women at risk of preeclampsia who were under hospital management. Those who are willing to engage in box breathing therapies utilizing mobile apps, have a gestational age of at least 20 weeks, and are clinically evaluated as being at risk of preeclampsia are among the inclusion criteria. Exclusion criteria include pregnant women with severe complications other than preeclampsia or cognitive impairment that hinder the implementation of breathing exercises. Dependent factors included pregnant women's systolic and diastolic blood pressure, whereas independent variables included mobile-based Box Breathing therapies. Blood pressure is objectively measured using a standardized digital sphygmomanometer, with a measurement specification of ±2 mmHg accuracy and routine calibration before use. In addition, supporting data in the form of maternal age, urine protein test results, and the degree of hypertension were recorded according to medical records.

Data was gathered by utilizing a mobile application to measure blood pressure before and after the intervention, monitoring for preeclampsia symptoms, and documenting the respondents' demographic and clinical details. To determine how average blood pressure changed before and after the intervention, data analysis was performed with t-tests. Tables and narratives that showed variations in systolic and diastolic blood pressure as well as their correlation with respondent characteristics were used to describe the study's findings. Malahyati University Lampung's Health study Ethics Committee has granted ethical permission for all study methods, with approval number 5273/EC/KEP-UNMAL/VI/2025. The tools and materials used include a digital sphygmomanometer, a smartphone device with *the Box Breathing* application installed, and a digital-based breathing exercise guide to support pregnant women's independence during the intervention.

RESULTS

The results of this study are presented through univariate and bivariate analyses to describe the characteristics of the study participants and to examine changes in blood pressure before and after the mobile-based box breathing intervention. Univariate analysis was conducted to summarize the distribution of respondents based on the degree of hypertension as well as the mean values of systolic and diastolic blood pressure prior to and following the intervention. Subsequently, bivariate analysis was performed to assess the differences in blood pressure measurements before and after the intervention using paired statistical testing.

Table 1. Characteristics of Supporting Data in Pregnant Women at Risk of Preeclampsia

Characteristics	n	%
Degree of Hypertension		
1. Normal	8	4.1
2. Normal Hight	46	23.4
3. Hypertension Stadium 1	90	45.7
4. Hypertension Stadium 2	48	24.4
5. Hypertension Stadium 3	3	1.5
6. Malignant Hypertension	2	1.0

Table 1 indicates that the largest proportion of respondents were classified as having Stage 1 hypertension (45.7%), followed by Stage 2 hypertension (24.4%). Additionally, 23.4% of respondents were categorized as having high-normal blood pressure, reflecting a substantial proportion of participants who were already at increased risk of developing hypertension. Only 4.1% of respondents had normal blood pressure, while more severe hypertensive conditions were relatively uncommon, with Stage 3 hypertension accounting for 1.5% and malignant hypertension for 1.0% of the study population.

Table 2. Average Blood Pressure of Pregnant Women Risk of Preeclampsia Before and After Being Given Box Breathing Using a Mobile-Based Application

Blood Pressure	Mean	SD	Min	Maks
Pre Systole	139.46	14.276	105	195
Pre diastole	90.15	11.902	56	156
Post Systole	122.93	10.914	96	167
Post diastole	82.46	8,210	66	106

Prior to the intervention, the average systolic blood pressure of pregnant women was 139.46 mmHg (SD = 14.276), with a minimum of 105 mmHg and a high of 195 mmHg, according to Table 2. The mean systolic blood pressure dropped to 122.93 mmHg (SD = 10.914) after the intervention, with a minimum of 96 mmHg and a high of 167 mmHg. Pre-intervention diastolic blood pressure ranged from a minimum of 56 mmHg to a high of 156 mmHg, with a mean of 90.15 mmHg (SD = 11.902). The average diastolic blood pressure dropped to 82.46 mmHg (SD = 8.210) after the intervention, with a minimum of 66 mmHg and a high of 106 mmHg. This indicates that pregnant women's average systolic and diastolic blood pressure may be lowered by using a mobile-based Box Breathing app.

Table 3. Mobile-Based Box Breathing Application Lowers Blood Pressure in Pregnant Women at Risk of Preeclampsia

Blood Pressure	Mean	SD	p value
Pre systole- Post Systole	16.528	13.434	<0.001
Pre diastole- Post diastole	7.685	10.740	<0.001

After receiving a mobile-based Box Breathing intervention, systolic blood pressure decreased by an average of 16.53 mmHg (SD = 13.434), according to Table 3Statistical tests showed a p-value of <0.001 (p < 0.05), suggesting a strong link between the intervention and a drop in systolic blood pressure in pregnant ladies at threat of preeclampsia. Similarly, after the intervention, diastolic blood pressure decreased by an average of 7.69 mmHg (SD = 10.740). Statistical test results also show that the intervention significantly reduced diastolic blood pressure in pregnant ladies at risk of preeclampsia (p = <0.001; p < 0.05). Overall, our findings indicate that pregnant ladies at risk of preeclampsia can effectively lower their systolic and diastolic blood pressure using mobile-based box breathing techniques.

DISCUSSION

The results showed a reduction in blood pressure following the implementation of the mobile-based Box Breathing intervention among pregnant women at risk of preeclampsia. The mean systolic blood pressure decreased from 139.46 mmHg before the intervention to 122.93 mmHg after the intervention. Similarly, the mean diastolic blood pressure declined from 90.15 mmHg to 82.46 mmHg. Following the intervention, there was an average decrease of 16.53 mmHg systolic blood and 7.69 mmHg systolic blood, according to further research. Systolic and diastolic blood pressure showed meaningful differences prior to and following the procedure (p < 0.001), according to statistical analysis using a paired t-test. Overall, our results show that pregnant

women at risk of preeclampsia may successfully lower their systolic and diastolic blood pressure by using the mobile-based Box Breathing intervention.

These findings are in line with the research of Kılıçlı and Zeyneloğlu (Kılıçlı & Zeyneloğlu, 2025) The study found that in pregnant ladies suffering from preeclampsia, awareness-based exercises significantly lowered their systolic and diastolic blood stress by almost 7% and 6.4% of their baseline values, respectively. The study explained that structured breathing techniques are able to increase parasympathetic nerve activation and reduce stress, thereby having an impact on blood pressure regulation. The same thing was also revealed by El-Bandrawy & Ghareeb (El-Bandrawy & Ghareeb, 2022) showed in order to lower gestational hypertension, device-guided breathing is superior than aerobic activity (Mishra et al., 2023). Therefore, the statement was deleted. According to research, systematic breathing exercises may lower the stress response and improve parasympathetic nervous system activation, which may have an impact on blood pressure management (Querejeta Roca et al., 2020). According to other studies, breathing exercises like breathing-based yoga may improve psychological well-being and some pregnancy outcomes (Abadibavil et al., 2021), but there is no strong consensus on the specific effectiveness of certain techniques in the context of gestational hypertension. Furthermore, research (Herniyatun et al., 2022) demonstrates that the use of guided breathing is more successful than aerobic activity in lowering gestational hypertension. With evidence that respiratory treatments are effective, (Pan et al., 2023) finds that for pregnant women who are at risk of developing hypertension, rhythmic breathing exercises may be a safe and effective non-pharmacological option.

Theoretically, breathing exercises like box breathing may regulate autonomic nervous system activity by enhancing parasympathetic activity and inhibiting the sympathetic response. This contributes to decreased heart rate, relaxation of vascular muscles, as well as improved tissue perfusion which ultimately lowers blood pressure (Verywell Health, 2024). Furthermore, it has been shown that using mobile apps as a health intervention is beneficial in increasing the frequency of breathing exercises and has a substantial short-term and long-term influence on lowering systolic blood pressure (Motta-Yanac et al., 2025).

The classification of gestational hypertension according to StatPearls (StatPearls, 2021) divides blood pressure conditions into the categories of normal, normal high, stage 1–3 hypertension, and malignant hypertension. Understanding this classification is important to determine the appropriate intervention according to the severity. In theory, breathing exercises such as box breathing serve to increase parasympathetic nervous system activity and reduce sympathetic nervous system response in order to balance the autonomic nervous system. This can contribute to a decrease in pulse rate and relaxation of blood vessel muscles, which ultimately has a positive effect on tissue perfusion and an overall reduction in blood pressure (Querejeta Roca et al., 2020). In addition, the use of mobile apps as a health intervention tool also showed positive effects, although research supporting this statement was not found in the references provided.

The researchers argue that the success of this intervention is due to a combination of the physiological mechanisms of structured breathing exercises that decrease sympathetic activation, increase parasympathetic activity, and improve vascular relaxation, with the ease of use of mobile applications that facilitate pregnant women to perform routine, monitored, and independent exercises. The existence of this digital technology can also be a means of education and motivation, so that pregnant women are more actively involved in maintaining their health. Most pregnant women were classified as stage 1 (45.7%) and stage 2 (24.4%) hypertension, indicating that they still had mild to moderate hypertension, based on the characteristics of participants according to their degree of hypertension. This condition is relatively more responsive to non-pharmacological interventions such as *box breathing*, as changes in autonomic tone and vascular relaxation can have a noticeable impact on lowering blood pressure (Babar et al., 2023). Meanwhile, the number of respondents with severe hypertension (stage 3 and malignant) was very small (2.5%), so this intervention may be less than optimal when applied as a single therapy, but still useful as a supportive therapy. The implication is that the use of *Box Breathing* is not only relevant for individuals at risk of preeclampsia, but can also be adapted more broadly to the community, for

example for promotive and preventive programs for pregnant women's health in primary services, posyandu, and pregnant women's companion groups. In addition to lowering the strain on healthcare systems and raising public awareness of the significance of stress management and mental-physical health during pregnancy, this intervention may be a low-cost substitute for avoiding hypertension issues during pregnancy. Thus, the integration of mobile technology in maternal health practices has the potential to expand the range of interventions, improve adherence, and provide long-term benefits for maternal and infant health.

CONCLUSIONS

Pregnant women at risk of preeclampsia showed a substantial decrease in systolic and diastolic blood pressure after using the mobile-based Box Breathing intervention, according to the study's findings. These findings suggest that structured breathing exercises delivered through a mobile application may have potential benefits as a complementary, non-pharmacological approach for blood pressure management during pregnancy. However, due to the quasi-experimental design and the absence of a control group, causal conclusions should be interpreted with caution.

Given these limitations, the findings should be considered preliminary. The current evidence does not yet support broad implementation of the intervention in community maternal health programs. Rather, this study offers a starting point for further research on the function of breathing therapies based on mobile devices in prenatal care.

It is advised that future studies use longer follow-up periods, bigger and more varied populations, and randomized controlled trial designs to evaluate the durability of blood pressure improvements. In addition, future studies should evaluate user adherence, usability, and engagement with the mobile application, as well as compare box breathing with other non-pharmacological interventions to determine relative effectiveness.

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