

Prototype Box Breathing Innovation Overcoming the Risk of High Blood Pressure for Pregnant Women

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ABSTRACT

Introduction: Hypertension during pregnancy is a common complication that increases the risk of preeclampsia, leading to maternal and fetal morbidity and mortality. Box breathing techniques have shown promise in lowering blood pressure and stress, but their effectiveness in pregnant women at risk of hypertension and preeclampsia has not been widely studied. This study aims to evaluate the efficacy of a prototype box breathing intervention in reducing blood pressure and symptoms in pregnant women at risk of these conditions.

Methods: A quantitative, experimental study with a pretest-posttest design was conducted at four hospitals in Indonesia. A sample of 198 pregnant women in their 1st-3rd trimesters was selected using purposive sampling. The intervention involved using a prototype box breathing device, and data were collected on blood pressure and symptoms before and after the intervention. Data analysis was performed using the Wilcoxon test.

Results: After the prototype box breathing intervention, systolic blood pressure decreased significantly from 147.83 mmHg to 132.36 mmHg, and diastolic blood pressure decreased significantly from 94.76 mmHg to 86.16 mmHg (p-value 0.000). The average symptom score also decreased from 5.93 to 1.25 following the intervention.

Conclusion: The prototype box breathing device effectively lowers blood pressure and reduces symptoms associated with preeclampsia risk in pregnant women. This non-pharmacological intervention offers a promising approach for managing hypertension during pregnancy and preventing the progression of preeclampsia. Further research is needed to validate these findings and optimize the implementation of box breathing techniques in prenatal care.



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INTRODUCTION

Pregnancy is a time eagerly anticipated by many women, though it often brings both physical and psychological challenges. Among the risks associated with pregnancy, hypertension is particularly concerning, as it can lead to complications like preeclampsia. This condition is marked by elevated blood pressure and maternal endothelial dysfunction, with a lack of uterine-placental blood flow contributing to about 10% of pregnancies worldwide experiencing hypertensive complications. Clinically, hypertension during pregnancy manifests as an increase in arterial blood pressure (Bozoni et al., 2024)

Throughout the 1st to 3rd trimesters, pregnant women frequently experience symptoms that, if not properly managed, can adversely affect both maternal and fetal health. Hypertension affects not only the physical well-being of pregnant women but also their psychological state, contributing to increased anxiety and disrupted sleep quality, which can, in turn, exacerbate high blood pressure. This creates a cycle where uncontrolled hypertension can lead to severe

complications, including preeclampsia—a leading cause of maternal mortality worldwide. Despite its global impact, the exact etiology of preeclampsia remains uncertain, though nutrient deficiencies are believed to play a role in the disease's progression ([González-Fernández et al., 2023](#)).

Hypertension is one of the most common complications of pregnancy and significantly increases the risk of preeclampsia, a major contributor to maternal and fetal morbidity and mortality. Characterized by elevated blood pressure and organ damage, especially to the kidneys and liver, preeclampsia typically develops after 20 weeks of gestation and, if left unchecked, can progress to eclampsia—a life-threatening condition that can cause seizures, organ failure, and even death ([Gynecologists., 2020](#)).

The complex pathophysiology of preeclampsia is believed to involve oxidative stress and endothelial dysfunction, both of which contribute to hypertension and organ damage ([Katler et al., 2022](#)). Current management strategies focus on controlling blood pressure and preventing complications, though no definitive intervention has yet been identified ([Syed et al., 2021](#)). In recent years, breathing techniques like box breathing have shown promise as non-pharmacological methods for blood pressure management ([Phipps, E., Prasanna, D., Brima, W., & Jim, 2020](#)). Box breathing involves a structured sequence of inhaling, holding, exhaling, and pausing, each for equal durations. This technique helps reduce stress and improve autonomic balance, which may contribute to lower blood pressure ([Haddad et al., 2021](#)). Emerging research indicates that box breathing can significantly lower blood pressure in individuals with mild to moderate hypertension. However, studies focused on its effects specifically on pregnant women at risk for preeclampsia are still limited ([Kim, J. H., & Kim, 2021](#)).

This study aims to explore a prototype box breathing intervention tailored for pregnant women at risk of preeclampsia, with the goal of offering a new preventive tool for managing hypertensive symptoms. This research introduces an innovative approach by combining box breathing with a hypertension measurement scale, allowing pregnant women to independently monitor and manage their blood pressure by following guidelines provided in this box breathing prototype. This prototype leverages digital technology to offer interactive guidance, real-time monitoring through sensors, and personalized adjustments based on each woman's physiological condition. Equipped with sensors to track blood pressure and breathing patterns, the device provides immediate feedback to optimize each breathing session ([Patel, S., Murthy, P., & Desai, 2023](#)).

Additionally, the prototype incorporates visual and audio elements designed specifically to promote relaxation, which is essential for lowering preeclampsia risk. Unlike traditional breathing exercises, this innovation addresses the unique physiological needs of pregnant women, whose hormonal and physical changes require tailored interventions. This personalization aims to enhance the effectiveness of the prototype in preventing the progression of preeclampsia. In addition, this innovation will allow pregnant women to perform breathing exercises independently, improving accessibility and compliance in managing their blood pressure at home ([Lee, Y. J., & Kim, 2020](#)).

The prototype will also incorporate visual and audio elements specifically designed to calm and assist pregnant women in achieving optimal relaxation conditions, which are crucial in reducing the risk of preeclampsia ([Nguyen, P. L., Tran, H. T., & Li, 2023](#)). Unlike conventional breathing methods, this innovation will focus on adjusting the physiological needs of pregnant women who undergo significant hormonal and physical changes, thereby increasing the effectiveness of the intervention in preventing the development of preeclampsia. This study aims to determine the Use of Breathing Box Prototype to Lower Blood Pressure in Pregnant Women at Risk of Preeclampsia

METHODS

The study employs a quasi-experimental design with a pretest-posttest approach to evaluate a mobile-based application for the initial management of pre-eclampsia. The research will be conducted at four hospitals: Bob Bazar Kalianda Hospital, Sukadana Hospital, Muhammadiyah

Metro Hospital, and Dr. A. Dadi Tjokrodipo Hospital. The study spans two years, with the first phase scheduled from February to November 2024, and the second phase set for 2025.

The research population includes all pregnant women receiving care at these four hospitals. Using purposive sampling, 198 respondents across four districts are selected, focusing on pregnant women in their 1st to 3rd trimesters who are at risk of or experiencing eclampsia. This sampling technique is chosen to ensure that the study targets individuals who are most likely to benefit from and demonstrate the effects of the intervention.

The independent variable in this study is the Box Breathing Innovation Prototype, a tool applied as an intervention to support blood pressure management. The dependent variable is decreased blood pressure among pregnant women at risk of pre-eclampsia or experiencing eclampsia. Primary data is collected by implementing the Box Breathing Prototype and measuring both blood pressure and symptoms of high blood pressure, recorded through questionnaires administered before and after the intervention.

To assess the effectiveness of the Box Breathing Prototype, the Wilcoxon test will be used for data analysis, comparing pre- and post-intervention measurements. This study has received ethical approval under research ethics number 4387/EC/KEP-UNMAL/IV/2024, ensuring compliance with established ethical standards in human research.

RESULTS

1. Univariate Analysis

Table 1. Average Blood Pressure of Pregnant Women Before and After Being Given Prototype Box Breathing

Blood Pressure	Mean	SD	Min	Max
For systole	147.83	19.582	112	220
For diastol	94.76	9.136	80	150
Post-systole	132.36	15.798	100	195
Post-diastole	86.16	6.780	67	110

Based on Table 1, it is observed that before the administration of the Box Breathing Prototype, the average systolic blood pressure was 147.83 and diastolic was 94.76, with standard deviations of 19.582 for systolic and 9.136 for diastolic. The minimum systolic value was 112, the diastolic minimum was 80, the maximum systolic was 220, and the maximum was 150.

After applying the Box Breathing Prototype, the average systolic blood pressure decreased to 132.36 and the diastolic to 86.16. The standard deviation was 15.798 for systolic and 6.780 for diastolic, with a minimum systolic value of 100 and a diastolic minimum of 67, while the maximum systolic and diastolic values were 195 and 110, respectively.

Table 2. Average Blood Pressure Signs and Symptoms in Pregnant Women Before and After Being Given Prototype Box Breathing

Variable	Mean	SD	Min	Max
Pre-Intervention	5.93	1.611	3	9
Post Interventions	1.25	1.121	0	4

Based on table 2, it is known that before being given Prototype Box Breathing, the signs of symptoms in pregnant women through filling out a questionnaire with an average of 5.93, SD score of 1.611 with a minimum score of 3, and a maximum value of 9, while after being given Prototype Box Breathing, signs of symptoms in pregnant women through filling out a questionnaire with an average of 1.25, SD score of 1.121 with a minimum score of 0 and a maximum value of 4.

Table 3. Results of normality tests before and after the Prototype Box Breathing intervention

Variable	Statistics	Df	Kolmogorov-Smirnov
For systole	0.864	198	<0.001
For diastole	0.832	198	<0.001
Post-systole	0.858	198	<0.001
Pasca diastole	0.970	198	<0.001
Pre-Intervention	0.235	198	<0.001
Post Interventions	0.241	198	<0.001

Based on Table 3, the results of the normality test using Kolmogorov-Smirnov were obtained with a Sig result of less than 0.05, which means that the data was not distributed normally, with a result of 0.001. Meanwhile, the results of the normality test were greater than 0.05. We then conducted a non-parametric test, namely the Wilcoxon test.

Table 4. Use of Breathing Box Prototype to Lower Blood Pressure in Pregnant Women Risk of Preeclampsia

Blood pressure	Average Rating	Number of Ranks	P value
Pre systole- Post systole	99.0	19503.0	<0.001
Pre diastole- Post diastole	100.79	19250.0	<0.001
Pre Intervention - Post Intervention	99.50	19701.0	<0.001

It is known that the P-Value is <0.001, < 0.05, it can be concluded that the "hypothesis is accepted" means that the use of Prototype Box Breathing can reduce the risk of blood pressure in pregnant women and reduce the symptomatic signs of risk of high blood pressure and pre-eclampsia in pregnant women.

DISCUSSION

The findings of this study demonstrate a significant impact of the Prototype Box Breathing intervention on reducing blood pressure and symptoms in pregnant women at risk of hypertension and preeclampsia. This discussion elaborates on the physiological changes observed before and after the intervention and contextualizes these results within the broader scope of maternal health.

Before applying the Prototype Box Breathing technique, the average systolic blood pressure among participants was recorded at 147.83 mmHg, indicating a hypertensive state for most respondents. The average diastolic blood pressure was 94.76 mmHg, which also falls within hypertensive levels. Variability was notable, with systolic pressures ranging from 112 to 220 mmHg and diastolic from 80 to 150 mmHg. This wide range suggests individual differences in hypertension severity are influenced by factors such as physical health, medical history, and levels of stress and anxiety during pregnancy ([Smith, R. D., Patel, L. M., & Chang, 2021](#)).

Following the intervention, there was a marked reduction in blood pressure, with average systolic values dropping to 132.36 mmHg and diastolic values to 86.16 mmHg, bringing many participants closer to normal blood pressure ranges. This reduction is clinically significant, as blood pressure above 140/90 mmHg in pregnant women is categorized as hypertension, a major risk factor for preeclampsia.

The observed reductions of 15.47 mmHg in systolic and 8.6 mmHg in diastolic pressure highlight the effectiveness of Prototype Box Breathing. These results may be attributable to the technique's deep breathing mechanism, which increases oxygenation and reduces sympathetic nervous system activation, often implicated in pregnancy-related blood pressure spikes ([Hofstede et al., 2022](#)). The reduction in blood pressure could thus be instrumental in lowering preeclampsia risk, as elevated blood pressure is an early preeclampsia indicator ([Garcia, L., Thompson, J., & McLeod, 2021](#)).

Alongside the decrease in blood pressure, there was also a significant reduction in symptoms. Initially, the average symptom score was 5.93, encompassing common hypertensive symptoms such as dizziness, headaches, shortness of breath, and tension. Post-intervention, the average score dropped to 1.25, with some participants reporting an absence of these symptoms. This symptom reduction is crucial, as severe headaches and visual disturbances are often preeclampsia precursors (Thompson, 2023). Lower symptom scores suggest better blood pressure management and the potential for this technique to serve as a preventive measure against more serious complications like preeclampsia.

Statistical analysis yielded a p-value of 0.000, indicating that the changes in blood pressure and symptoms before and after the intervention are statistically significant. These results align with previous studies showing that deep breathing techniques, including Box Breathing, have therapeutic effects on hypertensive conditions (Smith, R. D., Patel, L. M., & Chang, 2021). By modulating the autonomic nervous system, the technique enhances parasympathetic activity, promoting relaxation and blood pressure reduction (Hofstede et al., 2022). Given that preeclampsia affects approximately 5–8% of pregnancies and hypertension is a significant risk factor (WHO, 2019). The Box Breathing Prototype's effectiveness underscores its potential as a preventive intervention for preeclampsia. The associated reduction in hypertensive symptoms further reinforces this technique's viability as a non-pharmacological approach to preeclampsia risk management (Garcia, L., Thompson, J., & McLeod, 2021).

Lowering blood pressure may also reduce the risk of organ damage—such as to the kidneys and liver—that is often associated with preeclampsia. This is particularly valuable for pregnant women with limited access to healthcare, as the Prototype Box Breathing technique offers a practical, self-administered solution (Nguyen, P. L., Tran, H. T., & Li, 2023).

The side effects of pharmacological treatments drive the growing interest in non-pharmacological approaches for managing preeclampsia. Breathing techniques, especially Box Breathing, are increasingly being researched as effective and accessible alternatives. The four-step method—inhale, hold, exhale, hold—has shown benefits not only for blood pressure but also for stress reduction and mental focus (Georgakis et al., 2020). The physiological impact of breathing techniques on the autonomic nervous system, which plays a key role in blood pressure regulation, is well-documented. Box Breathing in particular enhances parasympathetic activity, resulting in vasodilation, or blood vessel dilation, which helps to lower blood pressure (Mafuika & Naicker, 2021). In studies with pregnant women at risk of preeclampsia, regular Box Breathing practice over four weeks has been associated with significant reductions in systolic blood pressure, supporting its use as a safe and practical intervention for pregnant women (Liu et al., 2021).

Factors such as exercise duration and frequency significantly affect the technique's effectiveness. For example, 10-minute sessions over four weeks have demonstrated meaningful blood pressure reductions in pregnant women, though further research is needed to determine optimal practice duration and frequency. Besides lowering blood pressure, Box Breathing is known to reduce stress, a contributing factor to elevated blood pressure and increased preeclampsia risk. Stress reduction through Box Breathing has been linked to improved outcomes and fewer pregnancy complications stress reduction through breathing techniques such as box breathing can help in lowering blood pressure and reducing the risk of pregnancy complications (Chen et al., 2022).

While numerous studies underscore Box Breathing's efficacy, certain limitations must be acknowledged. Many studies, including the current one, have limited sample sizes or shorter durations, restricting the generalizability of results. Larger-scale studies and rigorous methodologies are essential for validating these findings (Smith, J., Davis, M., & Thompson, 2023). With further empirical support, Box Breathing could become a clinically recommended part of preeclampsia management (Greenberg et al., 2022).

This study supports Prototype Box Breathing as an effective intervention for lowering blood pressure and reducing symptoms in pregnant women at risk of hypertension and preeclampsia. The technique's simplicity and structure make it a powerful tool for lowering blood pressure and

alleviating hypertensive symptoms. With statistically significant evidence, this study concludes that Box Breathing holds promise as a health management approach for pregnant women, especially for preventing preeclampsia and its associated complications.

CONCLUSION

The results of this study reveal a statistically significant impact of the Prototype Box Breathing technique in lowering blood pressure among pregnant women at risk of preeclampsia, as indicated by a p-value of 0.000, well below the 0.05 threshold. This finding supports the hypothesis that Box Breathing is an effective intervention for reducing hypertensive symptoms in this population. Clinically, the observed reduction in blood pressure is not only statistically significant but also meaningful, as it moves many participants closer to safer, near-normal blood pressure levels. Such a decrease is critical in preventing the progression to severe hypertensive conditions, which are known risk factors for preeclampsia and other complications.

This study contributes to the growing body of evidence supporting non-pharmacological interventions for managing hypertension in pregnant women. Through its ease of use and structured approach, Prototype Box Breathing offers a valuable alternative for blood pressure management, especially for those seeking or requiring options beyond medication.

In terms of healthcare practice, these findings suggest that Box Breathing could be recommended as a routine intervention for pregnant women at risk of preeclampsia, particularly in prenatal care programs. For resource-limited settings, this technique presents a low-cost, accessible solution that can be self-administered, thereby offering substantial public health benefits. Integrating Prototype Box Breathing as a preventive practice could significantly reduce the burden of hypertensive disorders in pregnancy, ultimately improving maternal health outcomes and easing the demand on healthcare systems.

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