

Effects of a mindfulness learning program on blood pressure control in Thai patients with hypertension



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ABSTRACT

Hypertension is a significant public health challenge in Thailand, affecting approximately 60% of older adults and contributing substantially to cardiovascular morbidity and mortality. This study aimed to examine the effects of a 12-week mindfulness learning program on blood pressure control, hypertension awareness, self-care behaviors, and stress levels in patients with hypertension. A quasi-experimental one-group pretest-posttest design was used with 58 patients with blood pressure readings $\geq 140/90$ mmHg recruited from Sakhrat Hospital, Nong Khai Province, Thailand. The program included hypertension self-assessment and goal-setting, health education, mindfulness practice, hypertension-specific exercise, telemedicine follow-up via the LINE application, and final evaluation. Data were collected using validated instruments. Statistically significant improvements were observed across all measured parameters. Hypertension awareness increased from predominantly low levels (65.6%) to high levels (100%), while low stress increased from 62% to 96.6%. Systolic and diastolic blood pressure decreased significantly from 132.36 to 128.17 mmHg and from 72.83 to 68.86 mmHg, respectively ($p < 0.001$). Qualitative findings identified four themes: integration into daily routines, perceived physical benefits, social support, and implementation challenges. These findings suggest that mindfulness may provide a culturally appropriate complementary approach to hypertension management in rural Thai settings. However, the findings require confirmation through randomized controlled trials.

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1. Introduction

Hypertension affects approximately 60% of older adults in Thailand, representing a significant risk factor for disability primarily due to age-related vascular degeneration (Wongsin and Chen, 2022). As arterial pressure increases over time, blood vessels progressively lose elasticity and become more rigid. Several factors compound this condition, including genetic predisposition, diabetes mellitus, obesity, hyperlipidemia, tobacco use, alcohol consumption, highly seasoned food intake, psychological stress, and inadequate rest (Watanabe, 2025). According to

the World Health Organization's 2025 Global Report on Hypertension, an estimated 1.28 billion adults aged 30-79 years are affected worldwide, with two-thirds residing in low- and middle-income countries. Alarming, 46% of affected individuals remain undiagnosed, only 42% receive treatment, and merely 21% achieve adequate blood pressure control. This widespread inadequacy in hypertension management contributes significantly to premature mortality globally, prompting international health authorities to establish a target of reducing hypertension prevalence by 33% between 2010 and 2030. These statistics underscore the need for innovative approaches to hypertension management, including mindfulness-based interventions that address both physiological and psychological aspects of the condition (WHO, 2025). Recent randomized controlled trials have further demonstrated that mindfulness-based stress reduction programs are associated with meaningful improvements in blood pressure and stress-related

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outcomes among adults with hypertension (Chen et al., 2024).

Concerningly, a significant majority of adults with hypertension remain undiagnosed, and of those diagnosed, only a fraction receive appropriate treatment, with an even smaller proportion achieving effective blood pressure control (Jasuja et al., 2024). The WHO identifies hypertension as a "silent killer" that contributes significantly to cardiovascular disease and premature mortality worldwide (WHO, 2025). Without proper treatment, hypertension causes progressive damage to the vascular system, resulting in severe complications, including various types of cerebrovascular accidents (ischemic, thrombotic, or hemorrhagic), coronary artery disease with consequent ischemia (STEMI), and premature mortality (Denisova et al., 2022). Evidence demonstrates that maintaining blood pressure within normal ranges substantially reduces mortality from all complications, decreases overall mortality, and significantly reduces congestive heart failure incidence (Taler, 2023). Current hypertension management guidelines in Thailand emphasize behavioral modifications, focusing on knowledge acquisition and self-care skill development to control various risk factors (Buranakitjaroen et al., 2020). Patients with chronic physical conditions frequently experience concurrent psychological distress due to lifelong medication requirements, fear of complications, socioeconomic challenges, lack of support for medical appointments, sleep disturbances, and chronic fatigue. When inadequately addressed, these emotional stressors can distort patient perception and promote maladaptive behaviors such as increased tobacco and alcohol consumption, ultimately undermining effective blood pressure control (Marwaha, 2022). Appropriate emotional stress management is therefore essential for maintaining blood pressure below the clinical threshold of 140/90 mmHg, which significantly reduces severe complications, particularly cerebrovascular events, and decreases premature mortality (Fontes et al., 2023). Recent global health campaigns highlight that hypertension contributes to most of the cardiovascular disease mortality, with a substantial proportion of both adult women and men affected worldwide. Clinical evidence demonstrates that individuals with uncontrolled hypertension experience a significantly heightened risk of stroke, compared to those maintaining normal blood pressure parameters (Denisova et al., 2022). Multiple non-pharmacological approaches have demonstrated efficacy in blood pressure reduction. Recent research on SKT Mindfulness therapy as an adjunct to standard medical treatment showed that participants in the intervention group demonstrated significantly improved health promotion awareness and health behaviors compared to controls, with markedly lower systolic and diastolic blood pressure measurements (Babak et al., 2022).

This research examines the association between a mindfulness-based program and blood pressure

outcomes in hypertensive patients when combined with behavioral modification strategies. Based on current evidence, the study focuses particularly on mindfulness as a component of emotional regulation, implementing this intervention with patients who have not achieved adequate blood pressure control through conventional approaches. The program integrates structured mindfulness practice with educational components to enhance disease awareness, complementing standard medical treatment. Within current global approaches to hypertension management, mindfulness-based interventions are gaining recognition as valuable components of the "Healthy-lifestyle counselling" domain emphasized by leading health organizations (Wani et al., 2023). While comprehensive treatment protocols remain essential, mindfulness practices offer a distinctive pathway to address the psychological dimensions of hypertension management that are often overlooked in conventional care models. Recent implementation of person-centered care approaches across multiple countries has highlighted the importance of addressing patients' psychological well-being alongside physiological parameters (Millar and Salloum, 2018). This aligns with our understanding that mindfulness practices activate the parasympathetic nervous system, resulting in decreased heart and respiratory rates. Mindfulness promotes physical and psychological equilibrium, enhances endorphin secretion, and improves overall vitality. Individuals who develop greater concentration and mindfulness demonstrate improved emotional self-awareness, and when patients achieve psychological balance, they typically engage in behaviors that promote both personal and collective well-being (Ayoko, 2023). This facilitates enhanced emotional regulation, encouraging patients to adopt appropriate positive behavioral modifications aimed at maintaining normal blood pressure levels and preventing the serious complications associated with uncontrolled hypertension.

2. Conceptual framework

This research is grounded in Orem's conceptual framework and theories of patient care, which establish that humans possess an inherent Capability for Self-Care Operation (Orem, 1971). This theoretical foundation was developed with particular emphasis on individual-level self-care practices and demonstrates significant utility for practical nursing applications while serving as an appropriate framework for nursing research methodologies (Khademian et al., 2020). Orem (1971) articulated the self-care concept as the practice of activities that individuals initiate and perform independently for their benefit in maintaining life, health, and well-being. When individuals experience limitations in self-care capacity, they necessarily require assistance from external sources, highlighting the essential

capabilities required for effective self-management (Orem et al., 2003).

Effective health management necessitates that individuals gain an understanding of their condition's underlying mechanisms and current health status, participate actively in recommended therapeutic interventions, and develop flexible behavioral strategies to adapt to their changing health circumstances. A critical element in effective self-care involves establishing clear objectives, which may originate either from internal motivation or external influence. The intrinsic need for self-preservation serves as a catalyst for individuals to engage in self-care behaviors, ultimately fostering habitual practices. Effectively implemented self-care regimens can significantly prevent injury and disease manifestation, mainly complications associated with hypertension, while simultaneously supporting treatment protocols and enhancing physiological control mechanisms (Tipayatikumporn et al., 2024). Mindfulness-based approaches integrate impeccably with Orem's framework by

enhancing patients' self-awareness and emotional regulation capabilities (Sawyer, 2023). When patients demonstrate heightened awareness, implement effective self-care strategies, and establish well-defined goals, facilitated through collaborative learning exchanges with cohort patient groups sharing similar diagnoses, healthcare professionals, and mindfulness practitioners, they develop enhanced adaptive capabilities for program participation and goal achievement. This approach is associated with improved maintenance of blood pressure within normative parameters (Mahmoud et al., 2023). The mindfulness component may help address the psychological barriers to self-care that often impede successful hypertension management, including stress reactivity, emotional dysregulation, and attention deficits that can undermine adherence to therapeutic regimens (Mutmainna and La Isa, 2022). Based on these theoretical underpinnings, the researcher has constructed the following conceptual research framework as presented in Fig. 1.

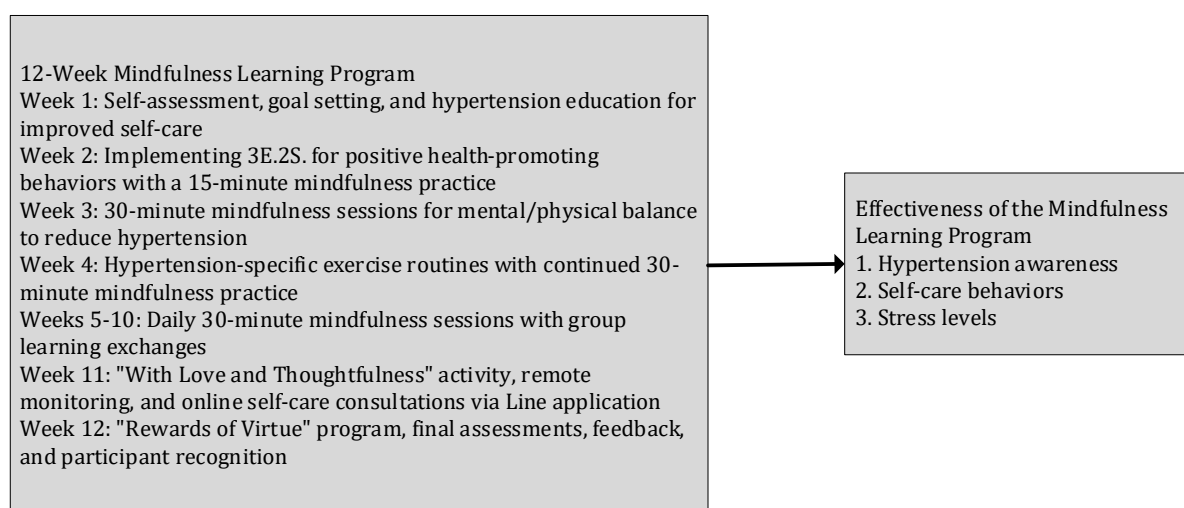


Fig. 1: Conceptual framework

3. Methods

3.1. Research design

This research employed a quasi-experimental one-group pretest-posttest design to evaluate the effectiveness of a 12-week mindfulness learning program on blood pressure control in hypertensive patients at Sakhray Hospital, Thailand. While primarily quantitative in approach, the study also collected written feedback from participants through open-ended questionnaire sections to provide supplementary insights into their experiences with the program.

3.2. Setting

The research was conducted at Sakhray Hospital in Nong Khai Province, Thailand. This district hospital serves the local population of Sakhray sub-district and surrounding communities with comprehensive primary and secondary care services,

including specialized hypertension management clinics. The hospital's hypertension registry and outpatient department provided the sampling frame for participant recruitment. The sample size was calculated using power analysis with parameters of 0.80 power, 0.50 effect size, and a statistical significance level of 0.05, yielding a total sample of 44 participants. The sample size was increased by 30% for potential data collection attrition, resulting in a final sample of 58 participants. Purposive sampling was employed to select participants diagnosed with hypertension, aged 15-65 years, who received treatment at Sakhray Hospital with the most recent blood pressure readings greater than or equal to 140/90 mmHg. The selection criteria included: physician-diagnosed hypertension, no comorbidities, chronic kidney disease not exceeding Stage 2, effective communication ability, literacy, cultural compatibility with the mindfulness practices employed in the study, voluntary consent, and residence within villages under the Primary Care Unit jurisdiction and Sakhray sub-district.

3.3. Intervention

The mindfulness learning program was implemented over 12 weeks and comprised 6 core components: hypertension self-assessment and goal-setting; health education delivered by nutritionists and psychiatric nurses; progressive mindfulness practice sessions led by local spiritual leaders, increasing from 15 to 60 minutes per session; hypertension-specific physical exercise guided by physical therapists; remote monitoring and online consultations via the Line application 'Sakhray Hos.Plus' telemedicine platform (conducted during Weeks 6, 9, and 11); and a final evaluation and recognition session in Week 12. Participants attended weekly group sessions every Friday afternoon from 13:30–15:00 at a designated community meditation space in Sakhray Sub-district throughout the 12-week period and were required to practice mindfulness independently at home for a minimum of 15 minutes daily.

3.4. Measurement and data collection

Data collection instruments included four tools. The hypertension awareness assessment questionnaire consisted of 22 items. Each correct response was assigned 1 point, while each incorrect response received 0 points, resulting in a maximum possible score of 22. Knowledge levels were classified according to Bloom (1972) criteria as high (80–100%), moderate (60–79%), or low (0–59%).

The self-care behavior assessment questionnaire consisted of 18 items. Responses were scored as 3 points for consistent practice, 2 points for occasional practice, and 1 point for no practice. Mean scores were interpreted as low-level practice (1.00–1.67), moderate-level practice (1.68–2.33), or high-level practice (2.34–3.00).

The stress assessment questionnaire, developed by the Department of Mental Health, Thailand, comprised five items, with total scores ranging from 0 to 15. Stress levels were classified as low (0–4), moderate (5–7), high (8–9), or severe (10–15). The fourth instrument was a mindfulness practice and blood pressure recording form, which was used to document participants' mindfulness practice and blood pressure measurements.

The development process of research instruments began with a comprehensive review of literature and relevant research studies to establish the scope and content domains of the research focus. Subsequently, the questionnaires were submitted to three experts for validation, determining content validity through the calculation of the Content Validity Index, with resulting values ranging from 0.67 to 1.00. Following expert review and necessary revisions, the instruments were pilot tested with elderly individuals in neighboring sub-districts, after which reliability analysis was conducted. This analysis revealed robust internal consistency with a Kuder-Richardson reliability coefficient of 0.84 for the hypertension awareness assessment and a

Cronbach's Alpha reliability coefficient of 0.87 for the self-care behavior assessment, thus confirming sufficient reliability for implementation in the main study.

The researcher initiated the process by conducting an informational meeting with the research team, including health promotion hospital network staff, the Non-Communicable Disease (NCD) committee, the Sakhray Hospital Director, the Patient Care Team (PCT) committee, and multidisciplinary healthcare professionals involved in the research such as nutritionists, physical therapists, and dental public health specialists.

Following this initial coordination, the researcher established connections with health promotion hospitals and village health volunteers within the network to schedule appointments for the 58 experimental group participants who had blood pressure levels equal to or greater than 140/90 mmHg from the Primary Care Unit (PCU) jurisdiction and Sakhray sub-district. These participants were then gathered at the kitchen conference room of Sakhray Hospital, Sakhray Sub-district, Sakhray District, Nong Khai Province.

During these preliminary meetings, the researcher thoroughly explained the objectives and benefits of program participation and provided aggregated blood pressure data without disclosing individual identities. Careful rapport was established with patients to facilitate relaxation, and normal blood pressure targets were communicated to prevent complications. Additionally, participants were informed about the 12-week program comprising 6 intervention components and the behavioral modification tools designed to promote health and reduce blood pressure. Mindfulness practice was specifically introduced as an alternative approach for behavioral modification. Strict confidentiality of collected data was assured, with access limited to academic advisors and researchers solely for research purposes. All results would be presented in aggregate form without identifying individual participants, thereby allowing patients to make informed decisions before signing consent documentation.

As part of the preparation phase, spiritual leaders from the local area were invited to inspire and teach Mindfulness techniques to hypertensive patients. Appropriate venues were secured for the designated dates and times throughout the 12-week program. Upon completion of the 12-week program, comprehensive data collection using questionnaires was conducted by the participants. Questionnaire completeness was thoroughly verified in preparation for subsequent data analysis.

The quantitative data analysis was conducted using SPSS software (version 26.0) following a systematic statistical approach. Descriptive statistics were calculated to characterize the sample and establish baseline measurements, including frequency distributions, percentages, means, and standard deviations for demographic variables and key outcome measures. For comparative analysis,

paired-sample t-tests were employed to evaluate differences between pre-program and post-program measurements of blood pressure, hypertension awareness, self-care behaviors, and stress levels. Statistical significance was determined at $p < 0.05$. Effect sizes were calculated using Cohen's d to assess the magnitude and clinical relevance of observed changes, and 95% confidence intervals were reported for all primary outcomes. This rigorous statistical framework enabled precise quantification of intervention outcomes while controlling for potential confounding variables.

Content analysis was applied to examine the qualitative data collected from open-ended feedback sections in the questionnaires. This analytical process involved systematically reviewing participants' written responses, identifying recurring concepts, and categorizing them into meaningful groups that reflected participants' experiences with the mindfulness program. The responses were coded and organized into distinct categories to identify common patterns and unique insights. This supplementary qualitative analysis provided additional context to enhance understanding of the quantitative findings, offering glimpses into participants' perspectives that numerical data alone could not capture.

4. Results

4.1. General characteristics of the sample

The majority of participants were female ($n = 38$, 65.5%), with males comprising 34.5% ($n = 20$) of the sample. Regarding marital status, most participants were married ($n = 46$, 79.3%), followed by single individuals ($n = 9$, 15.5%), with widowed participants representing the smallest proportion ($n = 3$, 5.2%). Educational attainment data indicated that most participants had completed primary education ($n = 41$, 70.7%), followed by secondary education ($n = 12$, 20.7%), with bachelor's degree holders and those without formal education representing the smallest category ($n = 1$, 1.7% each). Occupationally, the majority of participants were agricultural workers ($n = 34$, 58.6%), followed

by homemakers ($n = 14$, 24.1%), with unemployed individuals comprising the smallest group ($n = 1$, 1.7%).

4.2. Hypertension awareness

With a maximum possible score of 22 points on the hypertension awareness assessment, participants demonstrated significantly higher scores following completion of the Mindfulness program for blood pressure control. The post-intervention mean score reached a high level ($M = 19.79$, $SD = 1.005$), which was significantly higher than the pre-intervention score ($M = 11.48$, $SD = 3.47$) at the statistical significance level of 0.05 ($t = -20.986$, $df = 57$, $p < 0.001$, Cohen's $d = 2.75$, 95% CI [7.58, 9.04] points), as illustrated in [Table 1](#).

When analyzing individual dimensions of hypertension awareness among participants, the following results were observed. Dimension 1: Awareness of Risk for Disease Complications - Post-program scores demonstrated high-level awareness with a mean of 5.72 ($SD = 0.451$) out of a possible 6 points, which was significantly higher than pre-program scores ($M = 3.17$, $SD = 1.3$) at the statistical significance level of 0.05 ($t = -15.105$, $df = 57$). Dimension 2: Awareness of the Dangers of Complications - Participants achieved high-level scores ($M = 5.28$, $SD = 0.488$), which were significantly higher than pre-program scores ($M = 3.53$, $SD = 1.203$) at the statistical significance level of 0.05 ($t = -11.709$, $df = 57$). Dimension 3: Self-Care Awareness - Post-program scores reached high levels with a mean of 8.79 ($SD = 0.853$) out of a possible 10 points, which was significantly higher than pre-program scores ($M = 4.78$, $SD = 2.095$) at the statistical significance level of 0.05 ($t = -16.627$, $df = 57$). These results are presented in [Table 2](#).

From the sample of 58 participants, when categorizing by score levels, pre-program overall awareness was high for 3 participants (5.2%), moderate for 17 participants (29.2%), and low for 38 participants (65.6%). Following program participation, all participants demonstrated high-level overall knowledge, as shown in [Table 3](#).

Table 1: Comparison of hypertension awareness among participants (N = 58)

Variables	Hypertension awareness (maximum score: 22)				
	M	SD	df	t	p
Pre-program participation	11.48	3.470	57	-20.986	0.000
Post-program participation	19.79	1.005			

Table 2: Comparison of dimensions of hypertension awareness among participants (N = 58)

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Variables	Awareness of hypertension				
	M	SD	df	t	p
1. Awareness of risk for disease complications (maximum score: 6 points)					
Pre-program participation	3.17	1.3	57	-15.105	0.000
Post-program participation	5.72	0.451			
2. Awareness of the dangers of complications (maximum score: 6 points)					
Pre-program participation	3.53	1.203	57	-11.709	0.000
Post-program participation	5.28	0.488			
3. Self-care awareness (maximum score: 10 points)					
Pre-program participation	4.78	2.095	57	-16.627	0.000
Post-program participation	8.79	0.853			

Table 3: Overall perception score levels regarding hypertension (N = 58)

Score levels	Pre-program participation		Post-program participation	
	Frequency	Percentage	Frequency	Percentage
High level	3	5.2	58	100
Moderate level	17	29.2	-	-
Low level	38	65.6	-	-
Total	58	100	58	100

4.3. Stress levels

The investigation revealed that prior to program participation, 36 individuals (62%) exhibited low stress levels, 17 individuals (29.3%) demonstrated moderate stress, and 5 individuals (8.7%) experienced high stress levels. Following program completion, the distribution shifted significantly, with 56 individuals (96.6%) reporting low stress and only 2 individuals (3.4%) exhibiting moderate stress, with no participants reporting high stress levels. Statistical analysis confirmed that mean stress scores were significantly lower following the intervention ($M = 1.84$, $SD = 1.309$) compared to baseline ($M = 3.62$, $SD = 3.178$) ($t = 5.62$, $df = 57$, $p < 0.001$, Cohen's $d = 0.74$, 95% CI [1.14, 2.42] points), as illustrated in [Tables 4 and 5](#).

4.4. Blood pressure levels

The study found that systolic blood pressure after program participation showed a statistically significant reduction, with a post-intervention mean of 128.17 mmHg ($SD = 17.325$) compared to a pre-intervention mean of 132.36 mmHg ($SD = 19.088$) ($t = 8.997$, $df = 57$, $p < 0.001$, Cohen's $d = 1.18$, 95% CI [3.27, 5.11] mmHg). Similarly, diastolic blood pressure decreased significantly, from a pre-intervention mean of 72.83 mmHg ($SD = 13.483$) to a post-intervention mean of 68.86 mmHg ($SD = 10.859$) ($t = 6.887$, $df = 57$, $p < 0.001$, Cohen's $d = 0.90$, 95% CI [2.83, 5.11] mmHg), as shown in [Table 6](#). While these reductions are statistically significant, the absolute magnitude of change, approximately 4 mmHg systolic and 4 mmHg diastolic, should be interpreted cautiously, as the clinical significance of

such modest reductions warrants confirmation through longer-term follow-up and controlled trials.

4.5. Qualitative findings

Content analysis of participants' written feedback yielded four distinct categories. To enhance transparency, the frequency of participant responses contributing to each category is reported alongside representative quotes in [Table 7](#).

The first category, 'Practice Integration' (reported by 41 of 58 participants, 70.7%), encompassed comments about incorporating mindfulness techniques into daily life. Representative statements included: 'I practice mindfulness while waiting for the bus' and 'Even five minutes of breathing awareness before bedtime has helped me sleep better.' 'Perceived Physical Benefits' (reported by 38 of 58 participants, 65.5%) emerged as the second category, with participants noting subjective improvements beyond blood pressure reduction, including reduced headaches, improved sleep quality, and greater energy levels.

The third category, 'Social Support Value' (reported by 35 of 58 participants, 60.3%), reflected the importance participants placed on the group learning environment, with comments emphasizing how shared experiences normalized challenges and reinforced motivation. 'Implementation Challenges' (reported by 29 of 58 participants, 50.0%) constituted the final category, with participants describing difficulties in maintaining consistent practice during busy agricultural seasons and occasional concentration difficulties during practice sessions.

Table 4: Stress levels before and after participation in the mindfulness program for blood pressure control in hypertensive patients

Stress level during the 2–4 weeks period	Pre-program participation		Post-program participation	
	Frequency	Percentage	Frequency	Percentage
Low stress	36	62	56	96.6
Moderate stress	17	29.3	2	3.4
High stress	5	8.7	-	-
Total	58	100	58	100

Table 5: Comparison of stress level scores

Test	Stress scores					
	M	SD	Interpretation	df	t	p
Pre-program participation	3.62	3.178	No stress	57	5.62	0.000
Post-program participation	1.84	1.309	No stress			

Table 6: Blood pressure values before and after participation in the mindfulness program for blood pressure control in hypertensive patients

Test	Systolic blood pressure level					Diastolic blood pressure level				
	M	SD	df	t	p	M	SD	df	t	p
Pre-program participation	132.36	19.088	57	8.997	0.000	72.83	13.483	57	6.887	0.000
Post-program participation	128.17	17.325				68.86	10.859			

Table 7: Summary of qualitative categories, frequency, and representative quotes

Category	n (%)	Representative quote
Practice integration	41 (70.7%)	I practice mindfulness while waiting for the bus.
Perceived physical benefits	38 (65.5%)	I sleep better and have fewer headaches since starting the program.
Social support value	35 (60.3%)	Practicing together made it easier to keep going.
Implementation challenges	29 (50.0%)	It was hard to find quiet time during the harvest season.

This content analysis of participant feedback, while secondary to the quantitative outcomes, offers valuable insights into the lived experience of program participation and highlights factors that may have contributed to the intervention's effectiveness.

5. Discussion

The demographic characteristics of our participants, predominantly female, married, with primary education, and agricultural employment, reflect typical patterns seen in rural Thai primary care settings. The effectiveness of the program across this demographic profile suggests its potential applicability in similar rural communities throughout Thailand (Yarana et al., 2022). The predominance of female participants, consistent with other hypertension studies in Thailand, warrants consideration when developing future interventions, as it may reflect broader patterns of healthcare-seeking behavior that disadvantage male populations. Research has documented disparities in healthcare utilization patterns between different gender groups across various conditions and settings. This necessitates specialized approaches to engage underrepresented individuals who may encounter distinct barriers to participating in health promotion activities due to work responsibilities, health perceptions, or cultural expectations (Kaufman et al., 2023).

The findings of this study reveal significant improvements in hypertension awareness, stress reduction, and blood pressure control observed following the 12-week Mindfulness program at Sakhrui Hospital, though causal attribution cannot be established given the absence of a control group. These results warrant careful examination to understand their implications for clinical practice. The multifaceted approach combining mindfulness meditation with education and behavioral modification addresses several factors simultaneously, creating a comprehensive intervention for hypertension management. The improvements observed align with emerging evidence suggesting that mind-body interventions can effectively complement conventional pharmacological approaches to chronic disease management (Shaik and Fazeen, 2024). This integration of traditional meditative practices with modern medical understanding represents a promising direction for hypertension care that acknowledges both physiological and psychological dimensions of the condition.

The dramatic shift in hypertension awareness, from predominantly low awareness (65.6%) before intervention to universally high awareness (100%)

afterward, suggests a meaningful association between program participation and enhanced understanding of hypertension among participants. This transformation aligns with Orem's self-care theory, which emphasizes that individuals must comprehend their health challenges before engaging in effective self-care behaviors (Jamil Alkuwaisi et al., 2023). Integrating educational components with mindfulness practice appears to have created a synergistic effect, enabling participants to better absorb and apply health information. The improvements across all three dimensions of awareness, risk perception, complication recognition, and self-care knowledge suggest a comprehensive enhancement of health literacy that may sustain long-term behavioral change. Enhanced awareness likely improves patients' capacity to recognize symptoms, adhere to treatment recommendations, and implement lifestyle modifications, ultimately contributing to better blood pressure control through multiple pathways (Gömleksiz et al., 2025).

Equally noteworthy is the substantial reduction in stress levels, with nearly all participants reporting low stress after program completion. The complete elimination of high-stress cases particularly stands out. These changes may be associated with mindfulness practices that are known to activate parasympathetic responses while dampening sympathetic arousal (Wolfe et al., 2024), though the absence of a control group means alternative explanations cannot be excluded. Given that psychological stress is both a trigger for hypertension and a barrier to treatment adherence, this stress reduction may represent a critical mechanism through which the program achieved blood pressure improvements. Chronic stress activates the sympathetic nervous system and hypothalamic-pituitary-adrenal axis, increasing blood pressure through elevated catecholamine levels and vascular resistance, processes that mindfulness practice may counteract by promoting physiological relaxation and emotional regulation.

The statistically significant reductions in both systolic and diastolic blood pressure represent a notable finding of this intervention. However, the absolute magnitude of change, approximately 4 mmHg in systolic and 4 mmHg in diastolic blood pressure, should be interpreted with caution, as such modest reductions, while statistically significant, may not independently constitute clinically meaningful changes for all patients. Their potential cumulative impact on cardiovascular risk, particularly when sustained over longer periods, warrants further investigation through randomized controlled trials with extended follow-up. According to the Thai Hypertension Association, even small

improvements in blood pressure control can significantly reduce mortality rates and complication incidence (Sakboonyarat and Rangsin, 2024). The fact that these improvements were achieved through a non-pharmacological approach is particularly valuable, as it potentially reduces medication dependency and associated adverse effects. Research from population studies indicates that modest blood pressure reductions can lead to significant reductions in stroke and coronary heart disease rates, emphasizing why these interventions are important for public health (Manta et al., 2022).

Several aspects of the program design likely contributed to its effectiveness. The progressive extension of mindfulness practice duration allowed participants to develop their meditation skills incrementally, potentially enhancing both competence and adherence (Cho, 2024). The balance between structured group sessions and flexible home practice accommodated varying participant schedules while ensuring consistent engagement. Additionally, the involvement of spiritual leaders as instructors provided cultural resonance that may have enhanced program acceptability and engagement among participants. This cultural congruence may have increased participants' receptivity to intervention messages and facilitated integration of mindfulness practices into their daily lives, factors known to influence the success of behavioral interventions across diverse cultural contexts (Listiyandini et al., 2023).

The program's interdisciplinary approach represents another strength. The intervention addressed multiple dimensions of hypertension management beyond meditation alone by involving nutritionists, psychiatric nurses, physical therapists, and spiritual leaders (Espinell et al., 2023). This comprehensive strategy aligns with contemporary understanding of hypertension as a complex condition influenced by physiological, psychological, and behavioral factors (Raj et al., 2024). The integration of telemedicine follow-up through the Line application "Sakhrail Hos.Plus" telemedicine platform further demonstrates how traditional mindfulness practices can be effectively combined with modern technology to enhance healthcare delivery. Digital health technologies are increasingly recognized as valuable adjuncts to behavioral interventions, providing opportunities for remote monitoring, tailored feedback, and continued engagement between formal sessions, all elements that may enhance intervention effectiveness and sustainability (Liu et al., 2025).

The qualitative findings from content analysis provide additional context for understanding the program's effectiveness. The identification of four distinct categories, Practice Integration, Perceived Physical Benefits, Social Support Value, and Implementation Challenges, offers insight into participants' experiences that complement the quantitative outcomes. The Practice Integration category aligns with the significant improvements in self-care behavior observed in the quantitative

analysis. The lasting benefits of the intervention were possibly due to how well participants were able to integrate mindfulness practices into their daily lives (Walls et al., 2022). This practical integration represents a key factor in behavioral interventions for chronic disease management, particularly in rural communities where demanding agricultural schedules may limit time for separate health activities (Schuman-Olivier et al., 2020). The flexibility of mindfulness practices appears to have enhanced the accessibility and regular implementation, potentially supporting the consistent blood pressure improvements documented in the quantitative results. Participants' descriptions of Perceived Physical Benefits beyond blood pressure reduction suggest the intervention may have broader health implications than captured in our primary measurements. These subjective improvements in symptoms like headaches and sleep quality align with research documenting mindfulness effects on multiple physiological systems through autonomic regulation (Yuniarsih et al., 2024). Future studies might benefit from including additional outcome measures to capture these extended benefits.

The social support value category provides insight into the role of group dynamics in intervention effectiveness. While the quantitative analysis focused on individual-level outcomes, participant feedback suggests that the collective learning environment functioned as a therapeutic community that enhanced motivation and normalized challenges (Sari et al., 2022). This social dimension of the program may have contributed to the high completion rate and consistent participation observed throughout the 12-week intervention. Finally, the Implementation Challenges identified through content analysis highlight important considerations for program refinement. The difficulties some participants reported in maintaining consistent practice during busy agricultural seasons point to the need for seasonally adaptive approaches in rural settings. These qualitative insights, while supplementary to the quantitative findings, enhance our understanding of the program's mechanisms and contextual factors that influenced its effectiveness. They also provide valuable direction for future program development and implementation in similar settings.

Despite these promising results, several important limitations must be acknowledged and should be carefully considered when interpreting the findings. First, the absence of a control group is a fundamental methodological limitation of this study. Without a randomized comparison group receiving usual care or a waitlist condition, it is not possible to attribute the observed improvements solely to the mindfulness program. Observed changes may reflect regression to the mean, the Hawthorne effect, seasonal variation, or other concurrent factors unrelated to the intervention. Future research should employ randomized controlled trial designs to establish causal evidence. The authors

acknowledge, however, that the absence of a control group also reflected certain contextual constraints inherent to this research setting. As Sakhrui is a small sub-district, the available hypertensive patient population was limited, making it difficult to recruit enough to support a two-group design with adequate statistical power. Additionally, the research team hoped to offer potentially beneficial intervention to all eligible community members, as withholding it from some participants raised ethical concerns in this context. While the authors recognize that these considerations do not fully offset the methodological limitations of a single-group design, they are offered as contextual factors that future reviewers and readers may wish to consider when interpreting the findings. Second, the use of purposive sampling rather than random selection introduces sampling bias, meaning the findings may not be generalizable to all hypertensive patients in Thailand or similar settings. Participants who voluntarily enrolled and completed the program may differ systematically from those who declined or dropped out. Third, the 12-week follow-up period is insufficient to determine whether the observed improvements in blood pressure, stress, and awareness are sustained over time. Hypertension is a chronic condition requiring long-term management, and the durability of mindfulness-based interventions beyond the active program period remains unknown in this context. Fourth, the reliance on self-reported measures for stress levels and self-care behaviors introduces potential social desirability bias, whereby participants may have over-reported adherence to healthy behaviors and mindfulness practice. Although blood pressure provides an objective primary outcome, the subjective measures should be interpreted cautiously (Teh et al., 2023). Fifth, the exclusion of patients with significant comorbidities such as diabetes and advanced chronic kidney disease limits the generalizability of findings to more complex patient populations frequently encountered in clinical practice (Garg, 2023). Finally, no adverse events were reported during the program; however, the small sample size and short duration may be insufficient to detect rare or delayed harms.

For clinical practice, these results suggest that healthcare providers should consider incorporating structured mindfulness training into comprehensive hypertension management strategies, particularly for patients experiencing stress or struggling with treatment adherence. The relatively low resource requirements and absence of adverse effects associated with mindfulness practices further enhance their potential utility as complementary approaches in diverse healthcare settings, including resource-limited environments where access to pharmaceutical options may be constrained.

In the Thai context, this study demonstrates how indigenous cultural and spiritual resources can be effectively mobilized to address contemporary health challenges. As Thailand continues to face a growing burden of hypertension and other non-communicable diseases, culturally echoing

interventions may prove increasingly valuable. The integration of traditional wisdom with evidence-based medicine reflects a pragmatic approach that leverages existing cultural assets while maintaining scientific rigor, a balance that may enhance intervention acceptability and effectiveness in diverse cultural contexts beyond Thailand (Patwardhan et al., 2023).

These findings contribute to the growing evidence supporting mindfulness-based interventions for chronic disease management. The integration of traditional mindfulness practices with conventional hypertension care represents a promising approach that acknowledges both biomedical and psychosocial aspects of this condition (Am et al., 2023). The study also highlights the value of adapting evidence-based interventions to local cultural contexts, suggesting that mindfulness-based approaches might be similarly customized for different populations while maintaining their core therapeutic elements. These findings should be regarded as preliminary and hypothesis-generating, providing a foundation for more rigorous investigation through randomized controlled trials with longer follow-up periods and larger, more diverse samples.

6. Conclusion

This study suggests that a 12-week mindfulness program was associated with reductions in blood pressure levels and stress, and improvements in hypertension awareness, among hypertensive patients at Sakhrui Hospital in Thailand. These findings are promising but should be interpreted with caution given the quasi-experimental design and absence of a control group. The research advances knowledge by providing evidence for mindfulness efficacy in rural Thai settings and integrating traditional practices with contemporary health education. A plausible scientific rationale for these associations includes mindfulness-induced parasympathetic activation, which aligns with Orem's self-care theory, though causal mechanisms cannot be confirmed without more rigorous experimental designs. Future research should prioritize randomized controlled trial designs with waitlist or usual care control groups, extended longitudinal follow-up periods beyond 12 weeks to assess sustainability of outcomes, larger and more diverse samples including patients with comorbidities, and cost-effectiveness analyses to evaluate feasibility of broader implementation in resource-limited settings. For nursing practice, this research provides preliminary support for mind-body interventions, highlights the potential value of psychological approaches to hypertension management, and suggests that culturally congruent interventions may enhance program acceptability and engagement in similar rural settings. Nurses and healthcare providers should consider these findings as encouraging but preliminary, pending confirmation through more rigorous research

designs. The findings suggest that mindfulness-based approaches hold promise as a complementary strategy within standard hypertension management, addressing both physiological and psychological dimensions of this condition. However, broader integration into clinical practice should await confirmation from randomized controlled trials with robust methodology and longer follow-up periods.

List of abbreviations

CI	Confidence interval
df	Degrees of freedom
M	Mean
mmHg	Millimeters of mercury
N	Total sample size
n	Number of participants in a subgroup
NCD	Non-communicable disease
p	p-value
PCT	Patient care team
PCU	Primary care unit
SD	Standard deviation
SKT	Meditation healing exercise
SPSS	Statistical package for the social sciences
STEMI	ST-elevation myocardial infarction
t	t-statistic
WHO	World Health Organization

Compliance with ethical standards

Ethical considerations

The research protocol and questionnaire received ethical approval for human subject research from the Nong Khai Provincial Public Health Office (Certificate of Approval No. NONKPH 183.1, dated January 30, 2024).

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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