

Original Article

Effectiveness of a Culturally Adapted Mindfulness-Based Intervention on Blood Pressure, Medication Adherence, and Self-Management: A Quasi-Experimental Study



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ABSTRACT

Background: Hypertension is a leading global health problem, with poor adherence to treatment remaining a major barrier to effective control. Mindfulness has emerged as a supportive strategy for improving adherence and self-care. However, the effectiveness in non-Western hypertensive populations remains unclear. This study aimed to evaluate the effectiveness of a culturally adapted mindfulness intervention on blood pressure, medication adherence, and self-care in patients with hypertension in Indonesia.

Methods: A nonrandomized quasi-experimental pretest-posttest control group design was employed. 40 adults aged 18-40 years with stage 1 hypertension were recruited through purposive sampling, and the minimum sample size was determined using power analysis (G*Power 3.1), resulting in a minimum of 15 participants per group. To account for attrition, 20 participants were recruited per group. We excluded adults with coronary heart disease, pregnancy, concurrent complementary therapies, or prior mindfulness experience. The study followed the TREND guideline for nonrandomized evaluations. Participants were allocated to an intervention group (n = 20) that received an eight-week culturally adapted mindfulness program delivered in group and individual sessions, or to a control group (n = 20) that received standard care. Data were collected at baseline, post-intervention, and one-month follow-up, using a validated digital sphygmomanometer (blood pressure), the Morisky Medication Adherence Scale-8 (medication adherence), and the Self-Care of Hypertension Inventory (self-care). Ethical clearance was obtained from the institutional review board (No. 109/VII/AUEC/2024), and data were analysed using repeated-measures ANOVA and independent t-tests.

Results: Participants in the intervention group experienced significant reductions in systolic and diastolic blood pressure and improved medication adherence compared with the control group, with effects sustained at follow-up (time x group interaction: SBP F = 8.33, p < 0.001, η^2 = 0.15; DBP F = 7.01, p = 0.002, η^2 = 0.13; MMAS-8 F = 15.27, p < 0.001, η^2 = 0.24). Self-care scores increased significantly post-intervention (p = 0.030) but declined at follow-up, with no significant group difference at T2 (p > 0.05). Baseline characteristics were comparable between groups, ensuring equivalence.

Conclusion: A culturally adapted mindfulness program effectively improved blood pressure control and medication adherence in Indonesian patients with hypertension, although self-care benefits diminished over time. These findings suggest that mindfulness-based interventions can be a feasible, low-cost complement to standard care, particularly in resource-limited settings.

Future studies with larger samples, longer follow-up, and reinforcement strategies are recommended to sustain self-care behaviours.

Keywords: Hypertension; Mindfulness; Medication adherence; Self-care; Nursing; Indonesia.

Implications for Practice:

- Culturally adapted mindfulness can be integrated into nursing programs to enhance medication adherence and blood pressure control in patients with hypertension.
- Mindfulness interventions are feasible and cost-effective in resource-limited community settings, making them a practical complement to standard care.
- Sustaining self-care benefits requires reinforcement strategies such as booster sessions, digital reminders, and involvement of family or peers.

Introduction

Hypertension remains a major global health problem and a leading risk factor for cardiovascular disease, stroke, and kidney failure ([Burnier & Damianaki, 2023](#)). Globally, the number of adults aged 30-79 years living with hypertension has risen to approximately 1.28 billion, and a substantial proportion remain undiagnosed or inadequately treated ([WHO, 2023](#)). In Indonesia, hypertension continues to pose a significant public health burden; Riskesdas 2018 reported a prevalence of 34.1% among adults, and national monitoring has continued through the Survei Kesehatan Indonesia (SKI) 2023 ([Kementerian Kesehatan RI, 2020, 2024](#)). Moreover, the adherence to treatment remains low, with only about 30% of patients consistently following therapy ([Direktorat Promosi Kesehatan dan Pemberdayaan Masyarakat Kementerian Kesehatan RI, 2022](#); [Irawan, Am et al., 2024](#)).

Poor adherence is often linked to the stigma of long-term medication use, limited access to health care, and low awareness of the importance of hypertension

management ([Benenson et al., 2021](#); [Nardi et al., 2021](#)). Many patients forget or feel reluctant to take medication, while others are not fully aware of their condition, which further complicates disease control ([Hamrahian et al., 2022](#); [Ojangba et al., 2023](#)). These barriers highlight the importance of nursing interventions that address not only physical health but also psychological and behavioral obstacles to adherence.

Mindfulness, a practice that emphasizes present-moment awareness and self-regulation, has gained attention as a supportive approach in chronic disease management. Previous research suggests that mindfulness may reduce stress, increase self-awareness, and improve treatment adherence in patients with chronic illness ([Chen et al., 2024](#); [Irawan AM et al., 2023](#); [Irawan AM et al., 2024](#)). However, the evidence remains mixed. Some studies report significant improvements in blood pressure control and adherence after mindfulness-based interventions ([Conversano et al., 2021](#); [Ponte Márquez et al., 2019](#)) while others show minimal or inconsistent effects ([Lee et al., 2020](#); [Sawyer, 2023](#)). This inconsistency may be related to variations in intervention design, cultural differences, or limited adaptation to patient contexts.

Evidence for mindfulness in hypertension management remains limited in non-Western populations. For example, trials in Thailand and India reported modest improvements in blood pressure and stress but lacked cultural adaptation to local tradition ([Pukdeesamai et al., 2023](#); [Konda et al., 2025](#)). Similarly, studies in China and Malaysia showed inconsistent effects on

adherence and self-care ([Suleiman et al., 2024](#); [Zhang et al., 2025](#)). Despite growing evidence supporting mindfulness-based approaches in chronic disease care, little is known about whether culturally adapted mindfulness interventions can effectively improve medication adherence and hypertension self-care in Indonesia. This gap is critical because Indonesia's sociocultural context -including communal norms, language nuances, and spiritual practices- may shape how patients interpret illness, adopt self-regulation skills, and sustain health behaviors.

Mindfulness-based interventions can be explained within behavioral frameworks such as the Health Belief Model and Self-care Theory. The proposed mechanism of mindfulness can be grounded in behavioral and self-care frameworks that emphasize self-regulation, perceived benefits, and self-efficacy. ([Miles et al., 2023](#); [Valley & Stallones, 2018](#)). Mindfulness training is theorized to strengthen attentional control and emotion regulation, thereby improving self-regulation and reducing psychological distress. These mechanisms have been shown to enhance adherence by helping patients overcome forgetfulness, denial, or reluctance to take medication ([Loucks et al., 2023](#)). Improved adherence, in turn, supports consistent self-care behaviors (e.g., dietary management, physical activity, stress control), which are essential to achieving and maintaining blood pressure control ([Hamrahan et al., 2022](#); [Irawan AM et al., 2023](#)). In this way, mindfulness offers a plausible pathway linking mindfulness, self-regulation, adherence and self-care, finally blood pressure outcomes.

Building on this rationale, the present study evaluated the effectiveness of a culturally adapted mindfulness intervention for adults with hypertension in Indonesia. In this context, cultural values, language, and spirituality strongly influence health behaviors, suggesting that culturally

tailored interventions may be more acceptable and effective ([Cipta et al., 2024](#)). The study aimed to determine whether the intervention improves medication adherence and hypertension self-care behaviors, with implications for scalable nursing strategies in community and primary care settings.

Methods

Study Design

This study used a quantitative quasi-experimental two-group pretest-posttest design. The intervention group received a culturally adapted mindfulness program, while the control group received standard care. The independent variable was the mindfulness intervention, and the dependent variables were blood pressure, medication adherence, and patient self-care. The study was reported in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement to ensure methodological rigor and completeness of reporting.

Because group allocation was nonrandom, this design is subject to limitations including selection bias and potential residual confounding. To mitigate these risks, we applied identical eligibility criteria for both groups, recruited participants from the same primary care context, used standardized intervention and measurement procedures, and assessed baseline comparability between groups.

Participants

The study was conducted in community health centers (Puskesmas) in Sukoharjo Regency, Indonesia, representing primary care facilities where hypertension screening, counseling, and long-term management are routinely delivered. This setting was selected to support feasibility and scalability of a community-based

nursing intervention for improving adherence and self-management.

Participants were recruited with support from local health workers using purposive sampling. Inclusion criteria were adults aged 18-60 years with stage 1 hypertension (systolic blood pressure 130-139 mmHg or diastolic blood pressure 80-89 mmHg). Exclusion criteria included coronary heart disease with high mortality risk, pregnancy, concurrent participation in other complementary therapies, and prior experience with mindfulness-related practices (e.g., yoga, tai chi, meditation). A total of 50 individuals were assessed for eligibility. Ten were excluded (six did not meet inclusion criteria and four declined participation). Forty participants were enrolled and allocated into two groups (n=20 intervention; n=20 control). All participants completed the study; no attrition occurred, which strengthens internal validity for the study period. A TREND-adapted flow diagram is provided (Figure 1).

was 12 participants per group. To account for potential attrition, the target was increased to ≥ 15 per group, and 20 participants per group were recruited.

Instruments

Digital sphygmomanometer

Blood pressure was measured using an automated digital sphygmomanometer (Omron HEM-7130, Japan). The device has been validated for clinical and field use, demonstrating good accuracy and sensitivity compared to mercury and aneroid sphygmomanometers (Shahbabu, 2016). A digital device is also recommended for field practice due to its efficiency and ease of use (Muniyandi et al., 2022). Prior to each data collection session, the sphygmomanometer was calibrated following the manufacturer's recommendation by cross-checking with a standard mercury sphygmomanometer in a certified clinical laboratory. Measurements were taken in a seated position after a minimum 5-minute rest, with two consecutive readings obtained at 2-minute intervals; the mean value was used for analysis. Blood pressure classification followed the American Heart Association 2017 guideline, namely: normal ($<120/<80$ mmHg), elevated ($120-129/<80$ mmHg), hypertension stage 1 ($130-139/80-89$ mmHg), hypertension stage 2 ($\geq 140/90$ mmHg), and hypertensive crisis ($>180/120$ mmHg) (American Heart Association, 2023).

Morisky Medication Adherence Scale (MMAS-8)

Medication adherence was assessed using the Indonesian version of the Morisky Medication Adherence Scale (MMAS-8), previously translated and psychometrically validated in Indonesia and used with permission from the copyright holder. The Indonesian version demonstrated good psychometric properties, including internal

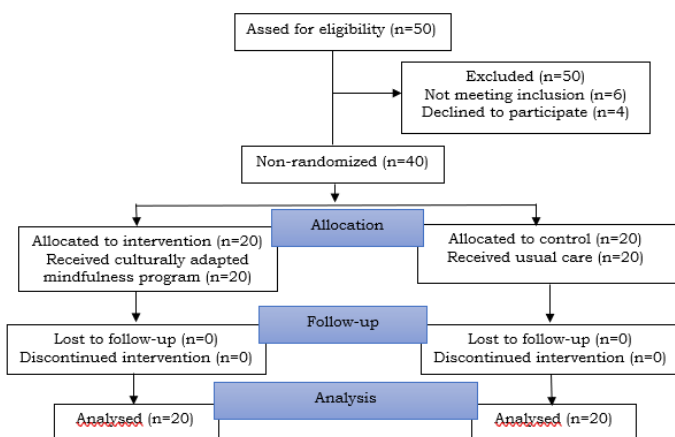


Figure 1. Participants recruitment flow diagram (adapted from CONSORT and reported according to TREND guidelines)

Sample size estimation was performed using G*Power 3.1. Based on a previous study (effect size=1.61), $\alpha=0.05$, and power $(1-\beta)=0.80$, the minimum required sample

consistency (Cronbach's alpha = 0.824), test-retest reliability (ICC = 0.881), and convergent validity ($r = 0.883$, $\chi^2 = 26.987$, $p < 0.05$) (Riani et al., 2017). The MMAS-8 comprises eight items (total score 0–8), categorized as high (8), medium (6–7), and low (<6) adherence. (Morisky et al., 2008).

To minimize missing data and accommodate varying literacy levels, the MMAS-8 was administered in a standardized interviewer-assisted format by trained enumerators using the same script and clarification rules across groups and time points. A brief feasibility check (pilot) with $n = 20$ eligible adults (excluded from the final sample) confirmed clarity and feasibility; completion time was approximately five minutes, and no item modifications were made.

The Self-Care of Hypertension Inventory (SCHI)

Hypertension self-care was measured using the Indonesian version of the Self-Care of Hypertension Inventory (SCHI), previously translated and psychometrically validated in Indonesia and used with permission from the developers. The SCHI-Indonesian version has good psychometric properties, with high validity (KMO = 0.941; $\chi^2 = 2136.32$, $p < 0.001$) and strong reliability (Cronbach's alpha = 0.937; ICC = 0.775–0.780). The SCHI includes 24 items across three subscales: self-care maintenance (1–12), self-care management (13–18), and self-care confidence (19–24); with subscale scores standardized to 0–100 (≥ 70 indicating adequate self-care) (Eldawati et al., 2022; Suwanno et al., 2022).

The SCHI was administered in the same standardized interviewer-assisted format by trained enumerators, applying identical scripts and clarification rules across groups and time points to ensure consistency and reduce item nonresponse. A feasibility check (pilot) with $n = 20$ eligible adults (excluded from the final sample) supported procedural feasibility and comprehension; completion time was approximately 10–12 minutes, and no item modifications were made.

Intervention

The intervention was a culturally adapted mindfulness program developed by the research team based on a standardized protocol used in prior work and refined through expert consensus (Irawan AM et al., 2023; Irawan AM et al., 2023). The program was delivered over eight weeks in a hybrid format (group and individual sessions) in the community setting under the supervision of community health centers (Puskesmas) in Sukoharjo Regency, Indonesia. The 8-week duration was selected because it is consistent with established mindfulness training structures (e.g., MBSR is commonly delivered over eight weeks) and with evidence from hypertension-related mindfulness trials using an 8-week format (Abdul Manan et al., 2024; Conversano et al., 2021; Tanjung, 2024). Table 1 summarizes the session plan, materials, and fidelity procedures

Table 1. Culturally adapted 8-week mindfulness program design for hypertension management

Week	Format and duration	Core activities	Support materials	Monitoring/ fidelity	Theory target (Self-Care Theory)
1	Group, 90 minutes	Introduction to mindfulness, orientation, mindful breathing practice, psychoeducation on hypertension	Handbook, audio guide	Session, checklist, observation	Maintenance + Confidence
2	Group, 90 minutes	Body scan, discussion of home practice, self-care awareness (noticing cues and routine barriers)	Handbook, audio guide	Practice logs collected	Management + Confidence
3	Group, 90 minutes	Mindful movement (gentle stretching), group sharing, lifestyle education (diet/physical activity)	Handbook, audio guide	Checklist + weekly debrief	Maintenance
4	Individual, 45-60 min	Identify personal barriers, tailored mindfulness plan, medication adherence review and goal setting	Personalized guidance sheet	Facilitator notes reviewed	Confidence + Maintenance
5	Group, 90 minutes	Integrating mindful breathing + body scan, peer support discussion, relaxation for BP control	Handbook, audio guide	Session observation	Management + Maintenance
6	Group, 90 minutes	Deepening mindful movement; stress management strategies; self-care planning	Handbook, audio guide	Practice log monitoring	Management + Maintenance
7	Group, 90 minutes	Mindfulness in daily routines (medication-taking and diet), coping with lapses, problem-solving and help-seeking strategies	Handbook, audio guide	Checklist + weekly debrief, practice log review	Maintenance + Management + Confidence
8	Group, 90 minutes	Integration of practices, reflection, relapse-prevention strategies, closing session	Handbook (final module), audio guide	Fidelity checklist completed	Confidence + Maintenance
1-8	Digital support: Weekly WhatsApp messages with reminders and motivational content. Participants submitted practice logs via WhatsApp for adherence monitoring. Theory target were for maintenance and confidence.				

Theoretical mapping to Self-Care Theory

The intervention was explicitly designed using the Self-Care Theory framework (self-care maintenance, self-care management, and self-care confidence), with mindfulness mechanisms positioned as self-regulation skills that support sustained health behaviors (Fan & Cui, 2024; Sawyer, 2023). Self-care maintenance (routine behaviors): Group sessions emphasizing mindful breathing, mindful movement, and lifestyle education supported routine behaviors such as consistent medication taking, healthy diet, physical activity, and appointment keeping (Weeks 1-3, 5-6). Mindfulness practices were used to strengthen attention and habit formation, supporting daily adherence routines.

Self-care management (response to BP elevation/stress): Body scan and stress-management modules were used to improve interoceptive awareness (noticing bodily cues), recognize escalation (e.g., stress-related BP rise), and apply coping strategies (Weeks 2, 6), including problem-solving and seeking guidance when needed (reinforced during individualized sessions).

Self-care confidence (self-efficacy): Individual sessions focused on identifying personal barriers, tailoring a home-practice plan, and setting realistic self-care goals, thereby strengthening confidence to sustain adherence and self-care actions (Week 4 and reinforced in later sessions).

Dose-response rationale

A dose-response rationale was incorporated because mindfulness-related behavior change typically requires repeated practice and reinforcement over time. The program combined (1) weekly structured contact (group sessions and one individualized session) with (2) guided home practice supported by handbooks/audio materials and (3) weekly WhatsApp reminders to encourage engagement and reduce drop-off. This

structure was selected to promote skill acquisition (attention/emotion regulation) and habit consolidation, consistent with evidence that greater mindfulness “dose” (program intensity/length and practice engagement) can be associated with stronger outcomes in mindfulness-based programs (Abdul Manan et al., 2024; Chen et al., 2024). Participant engagement was monitored using weekly practice logs submitted via WhatsApp and reviewed by the team to support adherence to the practice schedule.

Delivery, facilitators, fidelity, and safety

The program consisted of eight weekly sessions. Group sessions (approximately 90 minutes) introduced and progressively deepened core practices (mindful breathing, body scan, mindful movement), combined with peer discussion and hypertension self-care education. The individualized session (45-60 minutes) targeted barriers, personalized practice planning, and self-care goal setting. Two instructors with international mindfulness teaching certification (MBSR/MBCT) and >5 years of experience delivered the program, supported by trained nurse/midwife facilitators who completed preparatory training in hypertension self-care and mindfulness guidance.

Fidelity was supported through a structured session manual and checklists, random session observations, weekly facilitator debriefings, and review of practice logs. Participants were informed about potential transient discomfort (e.g., restlessness or emotional release during meditation) and were offered individual support and referral if needed; no adverse events were reported. The control group received usual care as provided by local health services without additional intervention.

Data Collection

Data were collected in Sukoharjo, Central Java, at community health centers (Puskesmas) and village health posts where the intervention sessions were conducted. Measurements were performed at three time points: baseline before the intervention (T0), immediately after the 8-week mindfulness program (T1), and one month post-intervention (T2). Data collection was conducted by four trained enumerators who were not involved in intervention delivery.

Prior to data collection, the principal investigator delivered a structured training program (12 hours over two days) covering: (1) standardized blood pressure measurement procedures using the validated digital sphygmomanometer (resting conditions and repeated-measures protocol), (2) standardized interviewer-assisted administration of MMAS-8 and SCHI using uniform instructions and predefined clarification rules, (3) ethical procedures (confidentiality and informed consent verification), and (4) data recording and entry procedures, including completeness checks.

To enhance inter-enumerator consistency, enumerators used a unified measurement manual and checklist, completed supervised practice sessions, and were required to demonstrate protocol adherence prior to baseline assessment. Throughout the study period, supervisory spot-checks and brief debriefings were conducted to identify and correct any procedural drift. Given the use of an automated digital device and a standardized protocol with two consecutive readings averaged at each time point, variability attributable to enumerator technique was further minimized.

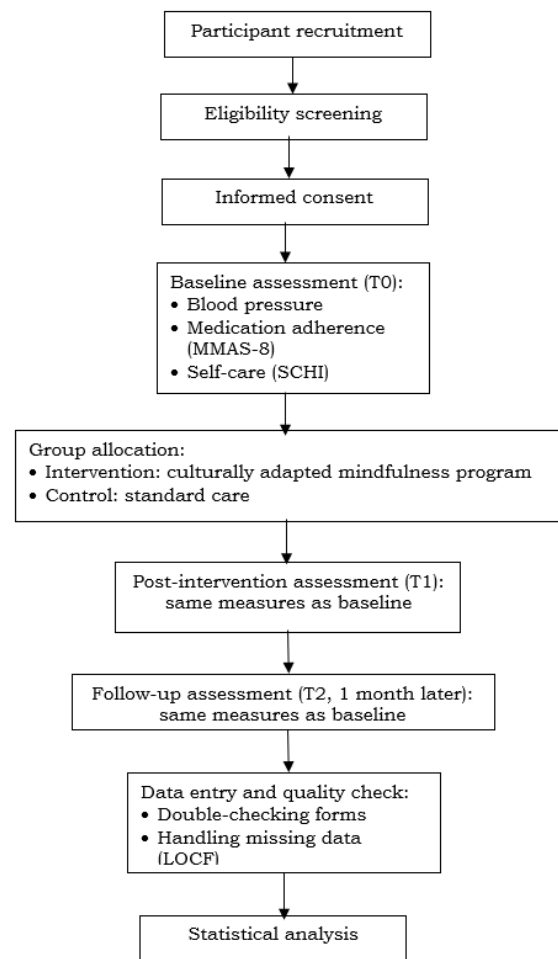


Figure 2. Workflow of data collection

Community health workers supported logistics and coordinated participant attendance but were not involved in measurement or data entry. A workflow diagram (Figure 2) summarizes the data collection process from recruitment to follow-up assessment. All enrolled participants completed outcome assessments at T0, T1, and T2, resulting in no missing outcome data.

Data Analysis

Data were analyzed using SPSS (version 22.0). Descriptive statistics were used to summarize participant characteristics.

Prior to hypothesis testing, assumptions were evaluated: normality was assessed using the Shapiro–Wilk test and homogeneity of variance using Levene’s test. All variables met normality and homogeneity assumptions ($p > 0.05$).

To evaluate changes in outcomes (blood pressure, MMAS-8 score, and SCHI subscale scores) across three time points (T0, T1, T2), repeated measures ANOVA was conducted. When significant effects were identified, post-hoc pairwise comparisons were performed (T0 vs. T1, T1 vs. T2, and T0 vs. T2) with appropriate adjustment for multiple comparisons. Between-group differences at each time point were examined using independent-samples t-tests. Effect sizes were reported using partial eta squared (η^2) for repeated measures ANOVA and Cohen’s d for between-group comparisons. Statistical significance was set at $p < 0.05$.

Analyses were planned under an intention-to-treat (ITT) framework. We pre-specified last observation carried forward (LOCF) as a conservative approach in the event of missing follow-up outcome data, while acknowledging its limitations (it may bias estimates when outcomes change over time and can underestimate variability). We also pre-specified a complete-case sensitivity analysis to examine robustness under alternative assumptions. In the final dataset, no outcome data were missing across time points; therefore, imputation was not required and the ITT and complete-case analyses were identical.

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee with approval number 109/VII/AUEC/2025. All participants were informed about the purpose, procedures, potential benefits, and risks of the study before enrollment. Written informed

consent was obtained from each participant prior to data collection.

Participation was voluntary, and participants were free to withdraw at any time without any consequences for their access to health care. Confidentiality and anonymity were maintained by using codes instead of personal identifiers, and all data were stored securely with restricted access to the research team only.

Results

Table 2 presents the demographic and baseline characteristics of the participants.

Table 2. Characteristics of the participants

Variable	Intervention (n=20)	Control (n=20)
Age, mean±SD (years)	33.7±2.0	33.9±1.7
Sex		
Male, n (%)	11 (55.0%)	9 (45.0%)
Female, n (%)	9 (45.0%)	11 (55.0%)
Highest education completed		
High school, n (%)	10 (50%)	10 (50%)
College and above, n (%)	10 (50%)	10 (50%)
Occupation		
Employed	13 (65%)	11 (55.0%)
Unemployed	7 (35%)	9 (45.0%)
Duration of hypertension (mean, years)	1.15	1.20

A total of 40 participants were enrolled, with 20 assigned to the intervention group and 20 to the control group. The mean age was comparable between groups (33.7 ± 2.0 vs. 33.9 ± 1.7 years). The sex distribution was balanced, with 55% males in the intervention group and 45% in the control group. Educational attainment was evenly distributed, with 50% of participants in each group having completed high school and 50% having attained college or higher education. Employment status was similar between groups, with 65% employed in the intervention group and 55% in the control group. The mean duration of hypertension was also comparable (1.15 vs. 1.20 years).

Preliminary analyses confirmed that all study variables met the assumptions of

normality and homogeneity. The Shapiro-Wilk test indicated no significant deviation from normality (all $p > 0.05$), and Levene's test showed homogeneity of variances across groups (all $p > 0.05$). These results supported the use of independent t-tests and repeated measures ANOVA for subsequent analyses.

Blood pressure, medication adherence, and self-care between intervention and control groups

Table 3 presents the comparison of systolic and diastolic blood pressure, medication adherence, and self-care between intervention and control groups.

Table 3. Comparison of systolic and diastolic blood pressure, medication adherence, and self-care between intervention and control groups at baseline, post-intervention, and follow-up

Variable	Intervention (n=20)	Control (n=20)	Mean Difference (95% CI)	t (df)	p-value	Cohen's d (95% CI)	partial η^2
SBP (mmHg)							
T0	131.5±4.9	130.4±3.8	1.10 (-1.57,3.77)	0.84 (38)	0.408	0.27 (-0.36,0.91)	0.02
T1	123.5±4.4	128.7±3.8	-5.20 (7.83,-2.57)	-4.00 (38)	<0.001	1.26 (0.58,1.95)	0.30
T2	123.8±5.0	128.1±4.5	-4.30 (7.35,-1.25)	-2.86 (38)	0.007	0.90 (0.25,1.56)	0.18
DBP (mmHg)							
T0	86.1±4.3	86.1±4.3	0.00 (-2.43,2.43)	0.00 (38)	1.00	0.00 (-0.63,0.63)	0.00
T1	81.3±3.7	85.2±4.4	-3.90 (6.50,-1.30)	-3.03 (38)	0.004	0.96 (0.30,1.62)	0.19
T2	81.6±3.8	85.2±4.1	-3.60 (6.13,-1.07)	-2.88 (38)	0.007	0.91 (0.26,1.56)	0.18
MMAS-8							
T0	4.45±0.69	4.45±0.69	0.00 (-0.40,0.40)	0.00 (38)	1.000	0.000 (-0.63,0.63)	0.00
T1	2.10±0.79	4.40±0.60	-2.30 (2.75,-1.85)	-10.37 (38)	<0.001	3.28 (2.32,4.24)	0.74
T2	1.85±0.67	4.40±0.60	-2.55 (2.96,-2.14)	-12.68 (38)	<0.001	4.01 (2.92,5.10)	0.81
SCHI							
T0	63.5±16.0	63.5±16.0	0.00 (-9.72,9.72)	0.00 (38)	1.000	0.000 (-0.63,0.63)	0.00
T1	74.1±14.0	63.4±16.0	10.70 (1.08,20.32)	2.25 (38)	0.030	0.71 (0.07,1.35)	0.12
T2	73.9±14.0	72.5±14.0	1.40 (-7.56,10.36)	0.32 (38)	0.754	0.10 (-0.52,0.72)	0.00

*Notes. Values are presented as mean±SD. SBP= Systolic blood pressure; DBP: Diastolic blood pressure; MMAS-8: Morinsky Medication Adherence Scale (lower score=better adherence), SCHI: Self-care of Hypertension Inventory (higher score=better self-care). p-values from independent t-test. Cohen's d with 95% CI and partial η^2 are reported as measures of effect size. T0= baseline, T1: post-intervention, T2: follow up

At baseline (T0), there were no significant differences between the intervention and control groups in systolic or diastolic blood pressure, medication adherence, or self-care (all $p > 0.40$; $d = 0.00$ –

0.27). At post-intervention (T1), participants in the intervention group showed significantly lower systolic blood pressure (123.5 ± 4.4 vs 128.7 ± 3.8 mmHg, $t(38) = -4.00$, $p < 0.001$, Cohen's $d = 1.26$,



95% CI \backslash [0.58, 1.95]) and diastolic blood pressure (81.3 ± 3.7 vs 85.2 ± 4.4 mmHg, $t(38) = -3.03$, $p = 0.004$, $d = 0.96$, 95% CI \backslash [0.30, 1.62]) compared with the control group. These improvements were sustained at follow-up (T2), with large effect sizes for both systolic ($p = 0.007$, $d = 0.90$) and diastolic pressure ($p = 0.007$, $d = 0.91$).

Medication adherence (MMAS-8, lower = better) improved markedly in the intervention group, with significant differences observed at T1 (2.10 ± 0.79 vs 4.40 ± 0.60 , $t(38) = -10.37$, $p < 0.001$, $d = 3.28$, 95% CI \backslash [2.32, 4.24]) and maintained at T2 (1.85 ± 0.67 vs 4.40 ± 0.60 , $t(38) = -12.68$, $p < 0.001$, $d = 4.01$, 95% CI \backslash [2.92, 5.10]). For self-care (SCHI, higher = better), the intervention group had higher scores than the control group at T1 (74.1 ± 14.0 vs 63.4 ± 16.0 , $t(38) = 2.25$, $p = 0.030$, $d = 0.71$, 95% CI \backslash [0.07, 1.35]), indicating a moderate-to-large effect. However, this difference was no longer significant at T2

($p = 0.754$, $d = 0.10$). The SCHI outcome was analyzed and reported as an overall standardized score in accordance with the predefined study outcomes. Domain-level (maintenance, management, confidence) and item-level analyses were not performed because subscale/item-level outputs were not specified a priori and were not available in the aggregated dataset used for analysis. Item-level data can be made available to the journal upon request.

Comparisons of blood pressure, medication adherence, and self-care between intervention and control groups

The independent t-test was used to compare outcomes between the intervention and control groups at baseline (T0), post-intervention (T1), and follow-up (T2). The results are summarized in **Table 4**.

Table 4. Repeated measures ANOVA results for blood pressure, medication adherence, and self-care between intervention and control groups

Variable	Effect tested	F(df)	p-value	η^2
SBP	Time	12.45 (2.96)	<0.001	0.21
	Group	10.18 (1.48)	0.002	0.18
	Time x Group	8.33 (2.96)	<0.001	0.15
DBP	Time	9.72 (2.96)	<0.001	0.17
	Group	6.14 (1.48)	0.017	0.11
	Time x Group	7.01 (2.96)	0.002	0.13
MMAS-8	Time	20.61 (2.96)	<0.001	0.30
	Group	18.44 (1.48)	<0.001	0.28
	Time x Group	15.27 (2.96)	<0.001	0.24
SCHI	Time	4.26 (2.96)	0.017	0.08
	Group	1.02 (1.48)	0.318	0.02
	Time x Group	2.14 (2.96)	0.123	0.04

*Notes: η^2 =eta squared effect size (0.01= small, 0.06= moderate, 0.14= large)

Results of repeated measures ANOVA are presented in Table 4. Significant main effects of time were observed for SBP, DBP, MMAS-8, and SCHI (all $p < 0.05$). Significant group effects were found for SBP ($F = 10.18$,

$p = 0.002$, $\eta^2 = 0.18$), DBP ($F = 6.14$, $p = 0.017$, $\eta^2 = 0.11$), and MMAS-8 ($F = 18.44$, $p < 0.001$, $\eta^2 = 0.28$). Significant time x group interaction effects were detected for SBP ($F = 8.33$, $p < 0.001$, $\eta^2 = 0.15$), DBP ($F = 7.01$,

$p = 0.002$, $\eta^2 = 0.13$), and MMAS-8 ($F = 15.27$, $p < 0.001$, $\eta^2 = 0.24$), whereas no significant interaction was found for SCHI ($p > 0.05$).

Discussion

This study showed that a culturally adapted mindfulness intervention produced significant improvements in systolic and diastolic blood pressure and medication adherence, with effects sustained at one-month follow-up. Self-care (SCHI total) improved immediately post-intervention but was not sustained at follow-up. This pattern suggests that mindfulness training may generate relatively durable gains in physiological regulation and adherence routines, while broader self-care behaviors may require longer reinforcement to consolidate into stable habits (Albarracín et al., 2024).

Our findings are consistent with recent evidence indicating that mindfulness-based interventions can reduce blood pressure among adults with elevated blood pressure or hypertension (Chen et al., 2024; Conversano et al., 2021; Ponte Márquez et al., 2019). A 2024 systematic review and meta-analysis of randomized controlled trials reported that mindfulness-based interventions were associated with reductions in blood pressure, supporting the role of mindfulness as a complementary strategy in hypertension management (Lee et al., 2020; Sawyer, 2023). Mechanistically, mindfulness training can strengthen self-regulation through attentional control and emotion regulation, which may reduce stress reactivity and support better day-to-day decision making. In hypertension, such self-regulatory capacity is clinically relevant because stress-related arousal and behavioral lapses (missed medication, poor dietary choices) are common pathways to poor control (Albarracín et al., 2024). Importantly, the very large improvements observed in medication adherence suggest

that the intervention may have influenced both behavioral execution (remembering and following the regimen) and motivational barriers (reluctance toward long-term medication). This is conceptually aligned with hypertension-tailored mindfulness models developed in high-income settings (e.g., mindfulness-based blood pressure reduction programs) that explicitly apply mindfulness skills to the behavioral drivers of blood pressure such as diet, physical activity, and self-management routines (Albarracín et al., 2024; Lee et al., 2020; Sawyer, 2023).

The added value of cultural adaptation is not merely “translation,” but the enhancement of intervention fit; how well intervention content, delivery, and meaning align with participants’ beliefs, norms, and daily contexts. Recent syntheses of culturally adapted mindfulness-based interventions show that adaptations most commonly involve language and content, aiming to increase accessibility and resonance with cultural values, customs, and beliefs; factors linked to engagement and acceptability (Cipta et al., 2024). In the present study, integrating Indonesian language, locally meaningful examples, collectivist group processes, and spiritually congruent practices (e.g., gratitude/contemplation) likely strengthened three interrelated mechanisms: (1) Comprehension and perceived relevance (cognitive fit): Language-congruent instructions and culturally familiar examples reduce misunderstanding and cognitive load, facilitating correct practice and adherence to home assignments, (2) Motivation and identity alignment (affective fit): When mindfulness is framed in a way that aligns with participants’ spiritual and communal values, it can reduce resistance and increase intrinsic motivation to practice and adhere, and (3) Social reinforcement (ecological fit): Group sharing, peer normalization, and

WhatsApp-based reminders can leverage collectivist norms, making adherence and practice more socially supported and less individually burdensome ([Irawan AM et al., 2023](#); [Irawan AM et al., 2023](#)). These mechanisms are consistent with broader cultural adaptation literature, which emphasizes that systematic modifications can improve engagement and effectiveness when interventions are transferred from Western contexts to culturally distinct settings ([Li et al., 2024](#)).

Compared with many mindfulness trials conducted in high-income countries that often delivered in specialized clinical or academic settings with relatively stable access to care, this intervention was implemented in community-based primary care (Puskesmas) and supported by local health system structures. High-income country mindfulness programs for blood pressure commonly report modest but meaningful reductions in blood pressure and behavioral improvements, often mediated by diet, physical activity, and stress outcomes ([Chen et al., 2024](#); [J. Li et al., 2023](#); [Sulosaari et al., 2022](#)). In contrast, our study observed particularly strong changes in medication adherence. One plausible explanation is that in lower-resource community settings, culturally adapted and socially reinforced interventions may yield larger gains where baseline adherence barriers (forgetfulness, stigma about lifelong medication, low health awareness) are more prominent and modifiable through structured support. This contrast underscores the importance of context: the same mindfulness “core” may produce different behavioral pathways and effect sizes depending on healthcare infrastructure, cultural meaning systems, and social support structures.

The non-sustained SCHI improvement at one-month follow-up may reflect that self-care behaviors are multidimensional and require ongoing reinforcement to

persist. While mindfulness skills can be learned within 8 weeks, maintenance of broader lifestyle behaviors may depend on continued prompts, environmental restructuring, and social/family reinforcement. The end of structured sessions and monitoring may have reduced accountability and practice frequency, especially given competing social and occupational demands. To enhance durability, future programs should consider booster sessions, continued digital reinforcement, and structured peer/family involvement; approaches that align with evidence on sustaining behavior change and culturally responsive delivery ([Albarracín et al., 2024](#); [Sawyer, 2023](#)).

Overall, these findings suggest that cultural adaptation may function as an active ingredient that strengthens engagement and self-regulation pathways in mindfulness-based care, translating into clinically meaningful improvements in blood pressure and medication adherence in community settings. The attenuation of self-care at follow-up further indicates that sustaining broader behavioral change likely requires structured reinforcement beyond the initial training period.

Implications and limitations

This study contributes conceptually by demonstrating that a culturally tailored behavioral intervention, specifically a mindfulness program adapted to Indonesian language, values, and spirituality, can enhance adherence and blood pressure control in a younger, non-Western hypertensive population. These findings expand the predominantly Western evidence base and suggest that cultural adaptation may act as an important mechanism for improving the effectiveness of psychosocial interventions. This adds to self-care theory by highlighting the role of contextual and cultural factors in sustaining health behaviors, and provides a foundation

for future research examining culturally sensitive behavioral models in chronic disease management. The study's limitations include a modest sample size and single-site recruitment, which restrict statistical power and representativeness. The nonrandomized design also limits causal inference. In addition, reliance on self-reported measures of medication adherence and self-care introduces potential bias, and the short follow-up period prevents conclusions regarding long-term sustainability. These limitations should be considered when interpreting the results, and future studies with larger, randomized, and multicenter designs are needed to confirm and extend these findings.

Relevance to Practice

This study demonstrates that mindfulness can be incorporated into community and clinical nursing programs as a complementary approach to improve adherence and support hypertension management. By showing that a culturally adapted mindfulness program is both feasible and low-cost in resource-limited settings, the findings highlight its potential as a practical strategy to complement standard care. However, the observed decline in self-care at follow-up underscores the importance of integrating reinforcement mechanisms, such as booster sessions, digital reminders, or peer support, into future programs to ensure lasting impact. At the policy and educational level, these results emphasize the need to train nurses in delivering culturally tailored mindfulness interventions, which could strengthen chronic disease management and inform the development of future community-based health programs.

Conclusion

A culturally adapted mindfulness program improved blood pressure and

medication adherence among Indonesian adults with hypertension, with sustained effects at follow-up, while self-care gains attenuated over time. Future studies should test this intervention in adequately powered multisite randomized trials with longer follow-up, incorporate and compare maintenance strategies (e.g., booster sessions and mHealth reinforcement), and examine mechanisms/moderators (e.g., practice dose and self-efficacy) to identify the components that drive durable behavior change.

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CrediT Authorship Contributions Statement

Ady Irawan, A.Md.: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft.

Kusumaningtyas Siwi Artini: Software, Validation, Formal Analysis, Visualization, Writing – Review & Editing.

Anggie Pradana Putri: Resources, Project Administration, Funding Acquisition, Writing – Review & Editing.

Conflicts of Interest

There is no conflict of interest.

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Supplementary Materials

Supplementary File S1: Research Instrument contains the full questionnaire used for data collection.

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