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EFFECTIVENESS OF A HYBRID NURSE-LED SELF-MANAGEMENT MODEL ON MEDICATION ADHERENCE AND BLOOD PRESSURE REDUCTION IN PATIENTS WITH HYPERTENSION

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ABSTRACT

Hypertension is a chronic health condition that requires sustained medication adherence and effective disease self-management. Nurse-led interventions integrating face-to-face education and digital support may improve medication adherence and clinical outcomes among patients with hypertension. This study aimed to evaluate the effectiveness of a hybrid nurse-led self-management model in improving medication adherence and reducing blood pressure among patients with hypertension. A quasi-experimental study with a pretest–posttest control group design was conducted involving 60 patients with hypertension, comprising 30 participants in the intervention group and 30 in the control group. The intervention group received two structured nurse-led educational sessions, a digital self-management pocketbook, and weekly follow-up support over eight weeks, while the control group received standard care. Medication adherence was assessed using the eight-item Morisky Medication Adherence Scale (MMAS-8), and blood pressure was measured using a calibrated digital sphygmomanometer. The mean medication adherence score in the intervention group increased from 5.1 to 7.3, compared with an increase from 5.0 to 5.6 in the control group. Mean systolic blood pressure in the intervention group decreased from 152.4 to 138.1 mmHg, while diastolic blood pressure decreased from 94.3 to 86.2 mmHg. At post-intervention assessment, the intervention group demonstrated significantly higher medication adherence scores and lower systolic and diastolic blood pressure than the control group ($p < 0.01$). These findings suggest that the hybrid nurse-led self-management model may be an effective approach to improving medication adherence and reducing blood pressure among patients with hypertension in primary healthcare settings.

Keywords: Hypertension; Hybrid Self-Management; Nurse-Led Intervention; Medication Adherence; Blood Pressure Reduction.

INTRODUCTION

Hypertension remains one of the most significant global public health challenges, contributing substantially to cardiovascular morbidity and mortality worldwide (World Health Organization, 2021). Despite the availability of effective pharmacological therapies, blood pressure control remains suboptimal, particularly in primary healthcare settings. Recent evidence indicates that poor medication

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adherence is one of the main determinants of uncontrolled hypertension, leading to increased risk of complications such as stroke, coronary heart disease, and kidney failure (Bulto et al., 2024). In many low- and middle-income countries, including Indonesia, adherence rates among hypertensive patients are still below optimal levels, highlighting the need for more effective and sustainable intervention strategies.

Medication adherence is influenced by multiple factors, including limited knowledge, low motivation, forgetfulness, and inadequate access to continuous health education. Studies have shown that improving patient education and health literacy plays a crucial role in enhancing adherence behavior and clinical outcomes (Ruksakulpiwat et al., 2025). In addition, the use of digital health technologies, such as mobile health (mHealth), telemonitoring, and electronic educational tools, has demonstrated promising results in improving medication adherence and blood pressure control through better accessibility and continuous engagement (Boima et al., 2024a) . However, digital-only interventions often face challenges such as low engagement, limited digital literacy, and infrastructure barriers, especially in semi-rural settings.

Self-management is widely recognized as a key component in the management of chronic diseases, including hypertension. It emphasizes patients' active involvement in managing their condition through adherence to medication, lifestyle modification, and routine monitoring. Effective self-management has been associated with improved clinical outcomes and reduced complications (Oluwafunmilayo et al., 2021). Nevertheless, many patients still demonstrate inadequate self-management behaviors due to insufficient structured support in primary care.

Nurse-led interventions have emerged as an effective and practical approach to address these challenges. Nurses play a critical role in patient education, behavioral counseling, and continuous monitoring, making them well-positioned to facilitate long-term behavioral change. Evidence from recent systematic reviews and clinical studies shows that nurse-led interventions significantly improve medication adherence and contribute to better blood pressure control compared to usual care (Stephen et al., 2022). Furthermore, nurse-led programs incorporating follow-up support, either through direct interaction or telecommunication, have demonstrated effectiveness in reinforcing adherence behavior and improving patient outcomes (Zhao et al., 2025).

The integration of digital health approaches with nurse-led interventions has gained increasing attention in recent years. Studies suggest that combining digital tools with healthcare provider support may yield better outcomes than standalone interventions, as it enhances patient engagement, reinforces knowledge retention, and supports sustained behavioral change (Charchar et al., 2024). This hybrid approach allows patients to receive structured face-to-face education while maintaining access to continuous digital support, thus addressing both cognitive and behavioral aspects of self-management (Wati;, 2021).

Previous studies have demonstrated the benefits of nurse-led and digital interventions for hypertension management. (Stephen et al., 2022), in a systematic review and meta-analysis, reported that nurse-led interventions in primary care could improve blood pressure outcomes and support medication adherence. Similarly, (Boima et al., 2024b) examined the effectiveness of digital health interventions for hypertension management in low- and middle-income countries, highlighting the relevance of digital approaches to blood pressure management.

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(Ferdinand et al., 2023) further demonstrated the potential of combining electronic messaging, social support, and blood pressure self-monitoring to improve medication adherence and systolic blood pressure. However, these studies employed heterogeneous intervention components and delivery mechanisms, leaving uncertainty regarding the feasibility and outcomes of a simplified hybrid intervention that integrates structured nurse-led education, an easily accessible digital educational resource, and regular follow-up within routine primary healthcare services (Rao et al., 2025).

To address this evidence gap, the present study evaluated a hybrid nurse-led self-management model in a primary healthcare clinic in Karanganyar, Central Java, Indonesia. The intervention combined two structured face-to-face educational sessions delivered by nurses, a QR-code-accessible digital self-management pocketbook, and weekly telephone or text-message follow-up over eight weeks. Unlike technology-intensive interventions requiring dedicated applications or connected monitoring devices, the proposed model utilized commonly accessible digital formats alongside direct nursing support. Its contribution lies in evaluating this specific combination of intervention components within the Indonesian primary healthcare context, with medication adherence and systolic and diastolic blood pressure changes assessed as the primary outcomes. This approach provides preliminary evidence regarding the potential applicability of a simplified hybrid self-management intervention in routine hypertension care.

Therefore, this study aims to evaluate the effectiveness of a hybrid nurse-led self-management model combining face-to-face education and a digital pocketbook in improving medication adherence and reducing blood pressure among patients with hypertension (Aji, Baidhowy, et al., 2026). The findings of this study are expected to provide evidence for a practical and sustainable intervention model that can strengthen primary healthcare services, enhance the role of nurses, and improve clinical outcomes in hypertension management.

METHODS

This study employed a quasi-experimental pretest–posttest control group design to evaluate the effectiveness of a hybrid nurse-led self-management model on medication adherence and blood pressure among patients with hypertension. A total of 60 eligible patients were recruited concurrently using consecutive sampling, with 30 participants included in the intervention group and 30 in the control group. Participants were assigned to the two groups through a non-randomized allocation procedure. Concurrent recruitment was used to ensure that both groups were observed under comparable healthcare service conditions during the same study period. The intervention group received the hybrid nurse-led self-management program, whereas the control group received routine care. The non-randomized allocation was considered a potential source of selection bias when interpreting the study findings (Politi et al., 2021).

The study was conducted at a primary healthcare clinic in Karanganyar, Central Java, Indonesia. The study population consisted of adult outpatients diagnosed with hypertension. Eligible participants were recruited concurrently using consecutive sampling during the study recruitment period. The sample size was determined based on the availability of eligible patients and the feasibility of recruitment within the clinical setting rather than a formal a priori statistical power calculation. A total of 60 patients were enrolled, comprising 30 participants in the intervention group and 30 participants in the control group. Consequently, the

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achieved sample size reflected the accessible study population and available recruitment resources. The absence of a formal a priori sample size calculation was acknowledged as a methodological limitation, particularly regarding the statistical power to detect smaller between-group differences.

Inclusion criteria included patients aged 30–70 years, diagnosed with hypertension, receiving antihypertensive therapy for at least three months, able to read and write, possessing a mobile phone capable of receiving messages, and willing to participate throughout the study. Exclusion criteria included patients with severe complications, cognitive impairment, or any condition that could interfere with participation in the intervention.

The intervention group received an eight-week hybrid nurse-led self-management program comprising three integrated components: structured face-to-face education, a digital self-management pocketbook, and weekly follow-up support. First, two structured face-to-face educational sessions were delivered by nurses during the first and second weeks. The educational content addressed hypertension management, medication adherence, dietary modifications with an emphasis on salt reduction, physical activity, stress management, and prevention of hypertension-related complications. The first session focused on understanding hypertension, prescribed medication regimens, and the importance of treatment adherence, while the second session reinforced practical self-management strategies and the maintenance of healthy lifestyle behaviors. Second, participants received a digital self-management pocketbook in PDF format, accessible through a QR code using their mobile phones. The pocketbook provided educational materials that participants could review independently throughout the intervention period. Third, participants received weekly follow-up support through telephone calls or text messages for eight consecutive weeks. These contacts were intended to reinforce medication adherence, review self-management progress, identify barriers to treatment, and provide motivational support. Intervention delivery was monitored using a checklist documenting attendance at educational sessions, follow-up contacts, and use of the digital pocketbook. The intervention combined direct nurse–patient interaction with accessible digital educational support, consistent with the broader approach of nurse-led hypertension management described in previous research (Ferdinand et al., 2023).

The control group received standard care routinely provided by the healthcare facility, including general health education and routine clinical consultation without structured nurse-led intervention or digital support.

The independent variable in this study was the hybrid nurse-led self-management program, while the dependent variables were medication adherence and blood pressure. Medication adherence was measured using the Indonesian version of the 8-item Morisky Medication Adherence Scale (MMAS-8), which has demonstrated good reliability with a Cronbach's alpha of 0.82 (Anh Hien et al., 2025). Blood pressure (systolic and diastolic) was measured using a calibrated digital sphygmomanometer following standardized measurement procedures.

Data collection was conducted in three phases: baseline assessment (pretest), intervention period, and post-intervention assessment (posttest). Baseline data included demographic and clinical characteristics such as age, gender, duration of hypertension, comorbidities, and current medication use. Medication adherence and blood pressure were measured before and after the intervention period in both groups. To minimize measurement bias, blood pressure

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measurements were performed by trained personnel using standardized procedures at the same time of day.

To ensure intervention fidelity, a monitoring checklist was used to document participants' attendance in education sessions, frequency of follow-up contacts, and utilization of the digital pocketbook. Content validity of the digital pocketbook was evaluated by experts prior to implementation.

Data analysis was performed using SPSS version 26. Descriptive statistics were used to summarize participant characteristics. Continuous variables were presented as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Shapiro–Wilk test. For normally distributed data, paired-sample t-tests were used to compare pretest and posttest outcomes within groups, and independent-sample t-tests were used to compare differences between groups. For non-normally distributed data, Wilcoxon signed-rank tests and Mann–Whitney U tests were applied. Statistical significance was set at $p < 0.05$ with a 95% confidence interval (Sawicka-Gutaj et al., 2022).

Ethical considerations were addressed throughout the study, with particular attention to voluntary participation, informed consent, confidentiality, and participant safety. Written informed consent was obtained from participants before data collection, and participation was voluntary. Participant information was coded to reduce the risk of identification, and research data were used exclusively for study purposes. The study involved digital communication through telephone calls or text messages; therefore, confidentiality of participants' contact information and communication records was an important consideration. Formal approval from a research ethics committee had not been obtained before the study commenced. This limitation is disclosed transparently and requires further clarification with the relevant institutional ethics committee and journal editorial office.

RESULTS

Characteristics of Participants

A total of 60 hypertensive patients participated in this study, consisting of 30 participants in the intervention group and 30 participants in the control group. The baseline characteristics of participants were comparable between the two groups, indicating homogeneity prior to the intervention.

As shown in Table 1, there were no meaningful differences in age, gender distribution, duration of hypertension, or comorbidities between the two groups.

Table 1. Characteristics of Participants

Variable	Intervention (n=30)	Control (n=30)
Age (years), mean ± SD	56.2 ± 8.1	55.7 ± 7.9
Female, n (%)	18 (60.0%)	17 (56.7%)
Duration of hypertension (years), mean ± SD	6.3 ± 3.2	6.1 ± 3.0
Comorbidity (yes), n (%)	12 (40.0%)	11 (36.7%)

Medication Adherence

At baseline, medication adherence scores were similar between the intervention and control groups. After eight weeks of intervention, the mean adherence score in the intervention group increased significantly from 5.1 ± 1.2 to 7.3 ± 0.9 ($p < 0.01$). The mean difference was +2.2 points (95% CI: 1.6 to

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2.8), indicating a substantial improvement. The effect size analysis demonstrated a large effect (Cohen's d = 2.05).
In contrast, the control group showed a slight increase from 5.0 ± 1.1 to 5.6 ± 1.0, which was not statistically significant (mean difference = 0.6; 95% CI: -0.1 to 1.2; p = 0.072), with a moderate effect size (Cohen's d = 0.55).
As presented in Table 2, the intervention group experienced a markedly greater improvement in medication adherence compared to the control group.

Table 2. Medication Adherence Scores (MMAS-8)

Group	Pretest Mean ± SD	Posttest Mean ± SD	Mean Difference	95% CI	p-value	Cohen's d
Intervention	5.1 ± 1.2	7.3 ± 0.9	+2.2	1.6 – 2.8	p < 0.01	2.05
Control	5.0 ± 1.1	5.6 ± 1.0	+0.6	-0.1 – 1.2	p = 0.072	0.55

Blood Pressure Outcomes

The intervention group demonstrated a significant reduction in blood pressure following the intervention. The mean systolic blood pressure decreased from 152.4 ± 10.2 mmHg to 138.1 ± 9.5 mmHg (p < 0.01), with a mean reduction of 14.3 mmHg (95% CI: 10.2 to 18.4) and a large effect size (Cohen's d = 1.45). Similarly, diastolic blood pressure decreased from 94.3 ± 6.5 mmHg to 86.2 ± 5.9 mmHg (p < 0.01), with a mean reduction of 8.1 mmHg (95% CI: 5.2 to 11.0) and a large effect size (Cohen's d = 1.30).

In contrast, the control group showed only minimal and non-significant changes. Systolic blood pressure decreased from 151.7 ± 9.8 mmHg to 147.3 ± 9.1 mmHg (p = 0.058), while diastolic blood pressure decreased from 93.9 ± 6.2 mmHg to 91.5 ± 6.0 mmHg (p = 0.081).

Table 3 demonstrates that the reduction in blood pressure was substantially greater in the intervention group compared to the control group.

Table 3. Blood Pressure Changes

Variable	Group	Pretest Mean ± SD	Posttest Mean ± SD	Mean Difference	95% CI	p-value	Cohen's d
Systolic BP (mmHg)	Intervention	152.4 ± 10.2	138.1 ± 9.5	-14.3	10.2 – 18.4	p < 0.01	1.45
	Control	151.7 ± 9.8	147.3 ± 9.1	-4.4	-0.2 – 9.0	p = 0.058	0.45
Diastolic BP (mmHg)	Intervention	94.3 ± 6.5	86.2 ± 5.9	-8.1	5.2 – 11.0	p < 0.01	1.30
	Control	93.9 ± 6.2	91.5 ± 6.0	-2.4	-0.8 – 5.6	p = 0.081	0.38

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Comparison Between Groups

Post-intervention comparison showed that the intervention group had significantly higher medication adherence scores than the control group (7.3 ± 0.9 vs 5.6 ± 1.0; $p < 0.01$), with a mean difference of 1.7 (95% CI: 1.1 to 2.3) and a large effect size (Cohen's d = 1.85).

In addition, systolic blood pressure was significantly lower in the intervention group compared to the control group (138.1 ± 9.5 mmHg vs 147.3 ± 9.1 mmHg; $p < 0.01$), with a mean difference of -9.2 mmHg (95% CI: -13.5 to -4.9). Diastolic blood pressure also showed a significant reduction (86.2 ± 5.9 mmHg vs 91.5 ± 6.0 mmHg; $p = 0.002$), with a mean difference of -5.3 mmHg (95% CI: -8.1 to -2.5).

As summarized in Table 4, the intervention group consistently demonstrated superior outcomes compared to the control group across all measured variables.

Table 4. Posttest Comparison Between Groups

Variable	Intervention Mean ± SD	Control Mean ± SD	Mean Difference	95% CI	p-value	Cohen's d
Adherence Score	7.3 ± 0.9	5.6 ± 1.0	+1.7	1.1 – 2.3	p < 0.01	1.85
Systolic BP (mmHg)	138.1 ± 9.5	147.3 ± 9.1	-9.2	-13.5 – -4.9	p < 0.01	0.98
Diastolic BP (mmHg)	86.2 ± 5.9	91.5 ± 6.0	-5.3	-8.1 – -2.5	p = 0.002	0.88

DISCUSION

The findings of this study demonstrate that the hybrid nurse-led self-management model significantly improved medication adherence and reduced blood pressure among patients with hypertension. The magnitude of improvement observed in the intervention group indicates that combining structured face-to-face education with digital support provides a more comprehensive and effective approach compared to conventional care.

Quantitatively, the intervention group demonstrated a mean improvement of 2.2 points in medication adherence, accompanied by reductions of 14.3 mmHg in systolic blood pressure and 8.1 mmHg in diastolic blood pressure over the eight-week intervention period. In comparison, the control group showed a smaller improvement in medication adherence (0.6 points) and smaller reductions in systolic (4.4 mmHg) and diastolic blood pressure (2.4 mmHg). The descriptive between-group differences in mean changes were therefore 1.6 points for medication adherence, −9.9 mmHg for systolic blood pressure, and −5.7 mmHg for diastolic blood pressure, favoring the intervention group. These findings suggest that the hybrid nurse-led self-management program was associated with greater improvements in medication adherence and blood pressure outcomes than routine care. The observed blood pressure reductions may be clinically relevant, given the established importance of sustained blood pressure lowering in hypertension management. However, the study assessed blood pressure changes over eight weeks and did not directly measure cardiovascular events, long-term cardiovascular risk, or the persistence of treatment effects. Therefore, the findings

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should not be interpreted as direct evidence of reduced cardiovascular morbidity or mortality. Furthermore, the non-randomized design limits causal inference, and the magnitude of the intervention effect should be interpreted cautiously.

The improvement in medication adherence can be explained by the integration of educational and behavioral reinforcement strategies. Direct interaction with nurses during face-to-face sessions enhances patients' understanding of hypertension and its management, while continuous follow-up through digital communication reinforces adherence behavior (Rizkasari, 2025). This finding is consistent with previous studies showing that nurse-led interventions significantly improve adherence through personalized education, counseling, and ongoing support (Dai et al., 2024).

Furthermore, the use of a digital pocketbook contributed to sustained behavioral change by providing accessible and repeatable educational content (Poddar;, 2023). Unlike conventional one-time education, digital materials allow patients to revisit information as needed, thereby strengthening knowledge retention and supporting long-term self-management. Previous studies have emphasized that digital health interventions are more effective when combined with healthcare provider support, rather than used as standalone tools (Yardley;, 2020).

From a theoretical perspective, the effectiveness of this intervention can be explained using behavior change theory. Repeated exposure to structured information, combined with continuous reinforcement through follow-up, facilitates the transition from knowledge acquisition to sustained behavioral change (Reshetnik;, 2025). According to the Behaviour Change Wheel framework, consistent cues, reinforcement, and support are essential to transform intention into long-term adherence behavior (Aji, Bhadowy, et al., 2026). In this study, weekly follow-up served as a reinforcement mechanism that strengthened patients' adherence and lifestyle modification practices.

The novelty of this study lies in the implementation of a hybrid nurse-led self-management model that integrates structured face-to-face education with a simple, low-cost digital pocketbook in a semi-rural primary healthcare setting (Alev Yildirim Keskin; Nurhan Özpancar Şolpan; Hasan Değirmenci3, 2024). Unlike previous studies that predominantly rely on either digital interventions or face-to-face education alone, this study combines both approaches to address the limitations of each modality. This integrated approach provides a context-appropriate and scalable solution, particularly for healthcare systems with limited digital infrastructure (Aji & Lazuardi, 2025).

Importantly, this study contributes to the growing body of evidence supporting nurse-led interventions as a key strategy in chronic disease management. Nurses play a central role in delivering patient-centered care, providing continuous support, and facilitating behavioral change. The findings suggest that empowering nurses to lead hybrid interventions can significantly improve patient outcomes in primary care settings (Kementerian Kesehatan, 2024).

This study matters because it provides a practical, low-cost, and scalable intervention model that can be readily implemented in primary healthcare, particularly in resource-limited and semi-rural settings (Hinneh et al., 2024). By integrating human interaction with simple digital tools, this approach addresses both behavioral and structural barriers to medication adherence. The model has

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strong potential for wider implementation to improve hypertension control and reduce the burden of cardiovascular diseases (Stephen et al., 2022).

Despite these findings, several methodological limitations should be acknowledged. First, the quasi-experimental design with non-randomized group allocation may have introduced selection bias and residual confounding, limiting causal inference regarding the effectiveness of the intervention. Although participants were recruited during the same study period, potential differences in antihypertensive medication regimens, medication adjustments, dietary habits, physical activity, and other lifestyle-related factors may have influenced the observed outcomes. Second, the intervention group received additional educational sessions and regular follow-up contacts, whereas the control group received routine care. Consequently, differences in healthcare provider attention and participant engagement may have contributed to the observed effects independently of the specific intervention components. Third, conducting the study within a single healthcare facility introduced a potential risk of contamination through information exchange between participants in the intervention and control groups. In addition, the possibility of measurement bias associated with assessor awareness of group allocation cannot be excluded because assessor blinding was not documented. Fourth, medication adherence was assessed using a self-reported instrument, which may have introduced recall and social desirability biases. The inclusion of participants who were able to read and write and possessed mobile phones may also have introduced selection bias and limited the applicability of the findings to patients with lower literacy or limited access to digital technology. Fifth, the eight-week intervention period did not allow assessment of the long-term sustainability of medication adherence or blood pressure reduction. Furthermore, because the intervention integrated face-to-face education, a digital pocketbook, and weekly follow-up support, the independent contribution of each component could not be determined. The study also did not conduct a formal mediation analysis; therefore, it cannot establish whether improvements in medication adherence mediated the observed reductions in blood pressure. Finally, the sample size was determined by recruitment feasibility rather than a formal a priori power calculation, potentially limiting the precision of the estimated intervention effects. Future studies should employ adequately powered multicenter randomized controlled designs, longer follow-up periods, objective medication adherence measures, standardized attention-control conditions, and component-specific or mediation analyses to clarify the mechanisms and sustainability of the intervention effects.

Overall, the findings confirm that a hybrid nurse-led self-management model is an effective and clinically meaningful strategy for improving medication adherence and blood pressure control among hypertensive patients. The integration of structured education, digital support, and continuous follow-up provides a comprehensive framework for enhancing patient engagement and promoting sustainable self-management behaviors in primary healthcare.

CONCLUSION AND RECOMENDATION

This study demonstrates that the hybrid nurse-led self-management model, which integrates face-to-face education with a digital pocketbook, is effective in improving medication adherence and reducing blood pressure among patients with hypertension in primary healthcare settings. The significant improvement in adherence observed in the intervention group contributed directly to better blood

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pressure control, as reflected by the statistically and clinically meaningful reductions in both systolic and diastolic blood pressure.

The main strength of this intervention lies in its comprehensive approach, combining direct interaction with nurses and continuous support through accessible digital media. This integration enables patients to gain better understanding while sustaining adherence behavior through repeated reinforcement. In addition, the intervention is practical, low-cost, and has strong potential for wider implementation in primary healthcare facilities, particularly in resource-limited settings.

However, several limitations should be acknowledged. This study was conducted in a single healthcare setting, which may limit the generalizability of the findings. The relatively short duration of the intervention also limits the ability to assess long-term sustainability. Furthermore, medication adherence was measured using a self-reported instrument, which may introduce response bias.

Therefore, future studies are recommended to adopt multi-center designs with larger sample sizes to enhance generalizability. Longer follow-up periods are also needed to evaluate the sustainability of behavioral changes and long-term blood pressure control. In addition, the use of more objective adherence measures, such as electronic monitoring or pharmacy records, is recommended to improve the accuracy of findings.

Further development of the hybrid nurse-led self-management model may incorporate more interactive digital technologies, such as mobile-based applications, while maintaining the essential role of direct nurse–patient interaction. This approach is expected to evolve into an adaptive, effective, and sustainable model for hypertension management in primary healthcare.

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