



Interactive Multimedia Modules to Enhance Family Support in Hypertension Management: A Digital Health Approach

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ABSTRACT

Background: Hypertension remains a leading global risk factor for morbidity and mortality, with family support playing a critical role in adherence to lifestyle modifications and treatment. Digital health interventions offer scalable solutions to improve disease management, yet limited studies have explicitly integrated and evaluated family engagement as a core component. **Objective:** This study aimed to evaluate the effectiveness of interactive multimedia modules in enhancing family support, blood pressure control, and health-related quality of life among hypertensive adults compared with usual care. **Methods:** A quasi-experimental study with repeated measures was conducted among 200 adults with hypertension and their primary family caregivers recruited from outpatient clinics. Participants were assigned to either the intervention group (n = 100), which received interactive multimedia modules delivered via a mobile platform, or the control group (n = 100), which received standard clinic-based education. Outcomes included family support (Hypertension Self-Care Activity Level Effects–adapted questionnaire), blood pressure (validated digital sphygmomanometer), and quality of life (WHOQOL-BREF). Measurements were obtained at baseline, immediately post-intervention, and 12-week follow-up. Data were analyzed using two-way repeated measures ANOVA. **Results:** At baseline, no significant differences were observed between groups in sociodemographic or clinical characteristics ($p > .05$). Over time, significant time \times group interaction effects were observed for family support ($F[2, 396] = 48.72, p < .001$, partial $\eta^2 = 0.20$), systolic blood pressure ($F[2, 396] = 61.45, p < .001$, partial $\eta^2 = 0.24$), diastolic blood pressure ($F[2, 396] = 52.13, p < .001$, partial $\eta^2 = 0.21$), and overall quality of life ($F[2, 396] = 39.74, p < .001$, partial $\eta^2 = 0.17$). Participants in the intervention group demonstrated greater improvements in family support, clinically meaningful reductions in blood pressure, and significant increases in quality of life scores compared with the control group. Qualitative feedback confirmed high acceptability and usability of the modules. **Conclusion:** Interactive multimedia modules delivered via digital health platforms significantly improved family support, blood pressure control, and quality of life among hypertensive adults. Incorporating family caregivers into digital self-management interventions provides a scalable and sustainable strategy for enhancing hypertension outcomes. Further studies should evaluate long-term impacts, cost-effectiveness, and integration into primary care systems.

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1. INTRODUCTION

Hypertension remains a leading, modifiable driver of global cardiovascular morbidity and mortality. In 2019, an estimated 1.28 billion adults aged 30–79 years had hypertension, and fewer than one in two were aware of their diagnosis; global control rates among those with hypertension were just 23% for women and 18% for men, with marked geographic inequities (NCD Risk Factor Collaboration [NCD-RisC], 2021). Contemporary guidelines emphasize comprehensive strategies that combine accurate out-of-office blood pressure assessment, risk-factor modification, and adherence support delivered through team-based care (Mancia et al., 2023; Shimbo et al., 2020). Yet, even where effective pharmacotherapy is available, medication nonadherence and suboptimal self-management remain persistent barriers that substantially undermine blood pressure (BP) control (Choudhry et al., 2022). This implementation gap suggests that information alone is insufficient; interventions must also address behavioral capability, sustained motivation, and supportive home environments that determine day-to-day adherence.

Family support is often positioned as a key contextual determinant of hypertension self-management, but evidence remains inconsistent because “support” varies greatly in quality, alignment with clinical goals, and behavioral specificity. Observational and synthesis evidence indicates that stronger family and social support can improve adherence and self-management behaviors (Almuhtadi et al., 2021). In community-based models where support is structured and embedded in care delivery, benefits can be substantial. For example, the HOPE 4 cluster-randomized trial combined non-physician health workers with community/family engagement and simplified regimens, improving BP control and cardiovascular risk compared with usual care (Schwalm et al., 2019). In contrast, when family involvement is operationalized as a passive “support partner” role—without skills training, shared routines, or clear behavior targets—effects may be muted. Consistent with this mechanism-based explanation, a 2024 randomized clinical trial found that adding a social support partner to remote BP monitoring via bidirectional texting did not improve BP control over usual care (Mehta et al., 2024). Taken together, these findings suggest that mixed effects are not simply contradictory results; rather, they reflect differences in intervention “dose” and function—whether family members are activated as competent behavioral supporters versus nominal participants.

Digital health interventions offer scalable approaches to narrow the hypertension implementation gap, but their effects are similarly heterogeneous. Systematic reviews and meta-analyses show that telemonitoring, text messaging, and app-based programs can produce modest BP reductions and improve reach among populations facing disparities; however, effects often attenuate when programs rely on generic messaging, lack behavioral tailoring, or do not embed accountability and support structures that sustain adherence over time (Katz et al., 2023; Liu et al., 2025). Moreover, digital interventions frequently target patients in isolation, assuming that self-regulation occurs independently of household dynamics. In settings where medication-taking, diet, and physical activity are interdependent with family routines, the absence of a family-facing component may limit translation from intention to sustained action.

Interactive multimedia may address several reasons why both family-support and digital interventions yield mixed outcomes, because it can strengthen the behavioral mechanisms that are typically weak in usual education or text-only digital formats. Hypertension self-management

includes procedural tasks (e.g., correct self-measured BP monitoring [SMBP] technique, interpreting readings, timing medication, planning low-salt meals) that require more than declarative knowledge. Multimedia formats (videos, infographics, interactive quizzes) can improve comprehension, retention, and procedural fidelity through demonstration and immediate feedback, potentially reducing errors and cognitive burden that contribute to nonadherence (Choudhry et al., 2022). Supporting this rationale, a randomized trial showed that virtual-reality hypertension education outperformed traditional clinician-led verbal education on objective knowledge acquisition, including home BP monitoring steps, with high acceptability (Jiravská Godula et al., 2023). However, multimedia alone may still be insufficient if it does not deliberately mobilize social reinforcement and shared routines that occur outside the clinic.

A critical gap, therefore, lies at the intersection of *how* family members are engaged and *what* the digital content enables them to do. Many prior programs “add” family or social support superficially (e.g., forwarding BP data or sending reminders), without developing family members as skilled supporters who can provide targeted prompts, problem-solving assistance, and reinforcement aligned with specific self-care behaviors (Katz et al., 2023; Mehta et al., 2024). This limitation is especially salient given guideline recommendations for SMBP and team-based care, where day-to-day execution depends on home routines and shared responsibilities (Mancia et al., 2023; Shimbo et al., 2020). In addition, implementation science reporting remains limited: few studies provide engagement and fidelity indicators that allow readers to judge whether null effects reflect intervention inefficacy or insufficient uptake (Katz et al., 2023; Liu et al., 2025).

To address these gaps, we evaluate *Interactive Multimedia Modules to Enhance Family Support in Hypertension Management*, a digital approach that integrates structured multimedia learning with explicit caregiver participation and SMBP routines. The intervention is designed to improve outcomes through three linked behavioral pathways: (1) strengthening *capability* by teaching concrete, observable skills (e.g., correct SMBP technique, medication-taking routines, diet planning); (2) increasing *opportunity* by embedding family members as active co-regulators who shape home environments and daily schedules; and (3) enhancing *motivation* through feedback, reinforcement, and shared goal-setting that sustains behavior beyond clinic encounters. Accordingly, we hypothesize that, compared with standard education, this family-focused multimedia intervention will (1) increase perceived and enacted family support for hypertension self-management, (2) improve medication adherence and SMBP behaviors, and (3) achieve greater BP reductions over follow-up.

2. METHODS

Study Design

This study employed a quasi-experimental, non-randomized repeated-measures design with assessments at baseline (T0), immediately post-intervention (T1), and 12-week follow-up (T2). Participants were allocated to the intervention or control group using a non-random allocation approach based on clinic scheduling and participant availability during the recruitment period. Random sequence generation and allocation concealment were therefore not implemented.

This pragmatic design was selected due to ethical and operational constraints within routine outpatient care, where random assignment could disrupt service delivery and caregiver involvement. Given the absence of randomization, causal inferences are interpreted cautiously, and the analysis focuses on differential change over time between groups rather than definitive treatment effects. To mitigate selection bias, baseline sociodemographic and clinical characteristics were compared between groups, with no statistically significant differences observed at study entry (all $p > .05$).

Sample

The study was conducted among adult patients with diagnosed hypertension and their primary family caregivers recruited from outpatient clinics in [City/Province], Indonesia. Eligible patients were aged 30–70 years, had a confirmed hypertension diagnosis for at least six months, were receiving outpatient treatment, and were accompanied by a primary family caregiver involved in daily health-related activities. Additional inclusion criteria included the ability of both patients and caregivers to read and understand Bahasa Indonesia and access to a smartphone or tablet with internet connectivity.

Exclusion criteria were severe hypertension-related complications (e.g., stroke, heart failure, renal failure), cognitive or psychiatric disorders that could interfere with participation, or unwillingness of patients or caregivers to engage with the digital modules.

Sample size was calculated using G*Power version 3.1 for repeated-measures ANOVA (effect size $f = 0.25$, $\alpha = 0.05$, power = 0.80, three measurement points), yielding a minimum of 90 participants per group. To account for potential attrition, the target sample was increased by 10%, resulting in 200 participants (100 intervention; 100 control). Consecutive sampling was employed, whereby all eligible patient–caregiver dyads attending the clinics during the recruitment period were invited until the required sample size was reached.

Intervention: Interactive Multimedia Family-Support Program

The intervention consisted of five structured interactive multimedia modules delivered via a mobile application over a four-week period, with an average exposure of 15–20 minutes per module. The modules were designed to be completed sequentially but remained accessible asynchronously, allowing flexibility in use according to participants' schedules. All content was intended for joint engagement by patients and their primary family caregivers to encourage shared learning and coordinated self-management practices.

The module content addressed key domains of hypertension self-management. The first module focused on understanding hypertension and cardiovascular risk, including causes, potential complications, and the importance of daily self-management behaviors. The second module addressed medication adherence and routines, emphasizing correct timing, use of reminders, and problem-solving strategies for missed doses. The third module provided training on self-measured blood pressure monitoring (SMBP), covering correct measurement techniques, interpretation of readings, and systematic logging of results. The fourth module emphasized lifestyle management within the household, including dietary salt reduction, physical activity planning, and shared meal preparation strategies. The final module focused on effective family support skills, including

communication techniques, encouragement, monitoring behaviors, and joint goal setting. Across all modules, content was delivered using short instructional videos, infographics, interactive quizzes, and reflective prompts to reinforce learning, improve retention, and promote active engagement.

The intervention was designed to influence hypertension outcomes through interrelated behavioral mechanisms targeting capability, opportunity, and motivation. Procedural capability was strengthened through multimedia demonstrations and quizzes that reinforced practical skills such as correct SMBP technique and medication-taking routines. Opportunity was enhanced by positioning family caregivers as active co-regulators who shape daily home environments and routines supportive of adherence. Motivation was supported through digital feedback, reminders, and shared goals that encouraged sustained engagement and accountability. Together, these mechanisms were intended to move beyond informational education toward structured behavioral skill-building embedded within everyday family contexts.

Family caregivers played an explicit and active role throughout the intervention. They were instructed to review modules alongside patients, assist with SMBP routines and medication reminders, provide encouragement and problem-solving support, and reinforce lifestyle modifications within household routines. Through this structured involvement, caregivers functioned as trained behavioral supporters rather than passive observers or recipients of generic reminders.

Intervention fidelity and engagement were monitored using backend analytics from the mobile application. Engagement indicators included module access frequency, module completion, and interaction with videos, quizzes, and reminder features. Overall, 88% of participants completed all modules, with a mean completion rate of 4.6 out of five modules. Video-based components demonstrated the highest levels of engagement, followed by quizzes and digital reminders. These metrics were used descriptively to assess feasibility, adherence, and fidelity to the intervention protocol.

Participants in the control group received standard clinic-based hypertension education routinely provided in outpatient services. This education consisted of a single face-to-face session lasting approximately 20–30 minutes, delivered by nursing staff during routine clinic visits. Content covered general information on hypertension, medication adherence, dietary salt restriction, and physical activity. Educational materials were delivered verbally and supported by printed leaflets commonly used in the clinic. No structured follow-up sessions, interactive components, digital materials, or caregiver-targeted education were provided to control group participants.

Instruments

Family support for hypertension management was measured using the Family Support in Hypertension Management Questionnaire, which was adapted from the Hypertension Self-Care Activity Level Effects (H-SCALE) instrument originally developed by Warren-Findlow and Seymour (2011). The instrument consists of 26 items covering domains such as medication adherence, diet, physical activity, weight management, and family support. Each item is rated on a five-point Likert scale ranging from “never” to “always,” with higher scores indicating

stronger family support. The original instrument reported a Cronbach's alpha of 0.82, while the Bahasa Indonesia version validated, demonstrated a Cronbach's alpha of 0.85 with strong construct validity confirmed through factor analysis.

Blood pressure was measured using a standardized digital sphygmomanometer (Omron HEM series), which has been clinically validated. Measurements were taken twice on the right arm in a seated position following a five-minute rest period, and the mean value was used for analysis. The device is endorsed by the European Society of Hypertension and is commonly used in Indonesian clinical practice.

Health-related quality of life was assessed using the World Health Organization Quality of Life–BREF (WHOQOL-BREF) developed by the WHOQOL Group. This instrument contains 26 items distributed across four domains: physical health, psychological health, social relationships, and environment. Each item is rated on a five-point Likert scale, and domain scores are transformed into a 0–100 scale. Higher scores indicate better quality of life. The original version demonstrated a Cronbach's alpha of 0.89, while the Indonesian validation reported a Cronbach's alpha of 0.88.

Procedure

The study protocol was approved by the Institutional Review Board of UMI under the reference number [0428/KEPK/UMI/2024]. Eligible participants were approached during outpatient visits and provided with verbal and written information about the study. Written informed consent was obtained from both patients and caregivers prior to enrollment. At baseline, sociodemographic and clinical data were collected, along with blood pressure, family support, and quality-of-life measures. Following enrollment, participants were given access to interactive multimedia modules delivered through a mobile application.

The modules comprised video tutorials, infographics, quizzes, and digital reminders designed to promote knowledge and skills related to hypertension management. Family members were encouraged to review the modules with patients and to apply supportive behaviors in daily practice. Basic implementation and engagement data were monitored through the application backend. Engagement indicators included module access frequency, completion of multimedia modules, and interaction with quizzes and reminder features. Overall, 88% of participants in the intervention group completed all modules, with a mean module completion rate of 4.6 out of 5 modules. Video-based components showed the highest engagement, followed by quizzes and digital reminders.

Participants in the control group received standard clinic-based hypertension education routinely provided in outpatient services. This education consisted of a single face-to-face session (approximately 20–30 minutes) delivered by nursing staff during clinic visits, covering general information on hypertension, medication adherence, dietary salt restriction, and physical activity. Educational content was provided verbally and supported by printed leaflets routinely used in the clinic. No structured follow-up sessions, interactive components, digital materials, or caregiver-targeted education were included for the control group.

Data collection was repeated immediately after completion of the modules and at twelve weeks post-intervention. At the conclusion of the study, structured debriefing sessions were

conducted to obtain participants' feedback regarding usability, acceptability, and perceived benefits of the intervention.

Data Analysis

All statistical analyses were performed using IBM SPSS Statistics version 29. Descriptive statistics including means, standard deviations, frequencies, and percentages were calculated to describe participant characteristics. Data distribution was tested using the Kolmogorov–Smirnov test. Changes in outcomes across the three measurement points were examined using repeated-measures analysis of variance (ANOVA). When Mauchly's test indicated a violation of sphericity, the Greenhouse–Geisser correction was applied. Post hoc pairwise comparisons were performed with Bonferroni adjustment. Effect sizes were calculated using partial eta squared. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

A total of 200 participants were enrolled, comprising 100 in the intervention group and 100 in the control group. The mean age of participants was 54.2 years (SD = 9.1), and 58.5% were female. Most participants had completed secondary education (62%) and had lived with hypertension for more than five years (53%). Baseline demographic and clinical characteristics, including blood pressure levels, comorbidities, and medication use, were not significantly different between the two groups (all $p > .05$), confirming comparability at study entry (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Participants (N = 200)

Variable	Intervention (n = 100)	Control (n = 100)	p-value
Age, mean (SD), years	54.6 (9.3)	53.8 (8.9)	0.52
Female sex, n (%)	59 (59.0)	58 (58.0)	0.88
Education level, n (%)			0.77
– Primary	18 (18.0)	20 (20.0)	
– Secondary	62 (62.0)	62 (62.0)	
– Tertiary	20 (20.0)	18 (18.0)	
Duration of hypertension ≥ 5 years, n (%)	54 (54.0)	52 (52.0)	0.77
Baseline SBP, mean (SD), mmHg	146.3 (10.4)	145.7 (10.1)	0.68
Baseline DBP, mean (SD), mmHg	91.2 (7.4)	91.5 (7.8)	0.82

Note. No statistically significant differences were observed between groups at baseline ($p > .05$), indicating comparability at study entry, SBP = systolic blood pressure; DBP = diastolic blood pressure.

At baseline (T0), family support scores did not differ significantly between groups (intervention: $M = 72.6$, $SD = 8.3$; control: $M = 73.1$, $SD = 8.6$; $p = .72$). Over time, scores in the intervention group increased to 82.4 ($SD = 7.7$) at post-intervention (T1) and 86.1 ($SD = 7.1$) at 12-week follow-up (T2), whereas scores in the control group showed only marginal changes (T1: $M = 74.1$, $SD = 8.2$; T2: $M = 74.6$, $SD = 8.4$). A two-way repeated measures ANOVA demonstrated a significant time \times group interaction, $F(2, 396) = 48.72$, $p < .001$, partial $\eta^2 = 0.20$, indicating that the intervention produced significantly greater improvements in family support compared with control (Table 2).

Table 2. Family Support Scores Across Time by Group

Time Point	Intervention Mean (SD)	Control Mean (SD)	F (time \times group)	p-value	Partial η^2
Baseline (T0)	72.6 (8.3)	73.1 (8.6)			
Post (T1)	82.4 (7.7)	74.1 (8.2)	48.72	<.001	0.20
12 wk (T2)	86.1 (7.1)	74.6 (8.4)			

At baseline, mean systolic blood pressure (SBP) was comparable between the groups (intervention: $M = 146.3$ mmHg, $SD = 10.4$; control: $M = 145.7$ mmHg, $SD = 10.1$; $p = .68$). By T1, SBP in the intervention group declined to 138.2 mmHg ($SD = 9.1$) and further to 134.0 mmHg ($SD = 8.5$) at T2. In contrast, the control group showed minimal reductions (T1: $M = 144.2$ mmHg, $SD = 9.7$; T2: $M = 143.5$ mmHg, $SD = 9.4$). For diastolic blood pressure (DBP), the intervention group decreased from 91.2 mmHg ($SD = 7.4$) at T0 to 86.0 mmHg ($SD = 6.9$) at T1 and 83.8 mmHg ($SD = 6.4$) at T2, while the control group remained relatively stable (T0: 91.5 mmHg, $SD = 7.8$; T1: 90.7 mmHg, $SD = 7.5$; T2: 90.2 mmHg, $SD = 7.1$). The interaction effect between time and group was significant for both SBP, $F(2, 396) = 61.45$, $p < .001$, partial $\eta^2 = 0.24$, and DBP, $F(2, 396) = 52.13$, $p < .001$, partial $\eta^2 = 0.21$ (Table 3).

Table 3. Blood Pressure Outcomes Across Time by Group

Time Point	Intervention SBP Mean (SD)	Control SBP Mean (SD)	Intervention DBP Mean (SD)	Control DBP Mean (SD)	F (time × group)	p-value	Partial η^2
Baseline (T0)	146.3 (10.4)	145.7 (10.1)	91.2 (7.4)	91.5 (7.8)			
Post (T1)	138.2 (9.1)	144.2 (9.7)	86.0 (6.9)	90.7 (7.5)	61.45 (SBP)	<.001	0.24
12 wk (T2)	134.0 (8.5)	143.5 (9.4)	83.8 (6.4)	90.2 (7.1)	52.13 (DBP)	<.001	0.21

Baseline overall WHOQOL-BREF scores were not significantly different between groups (intervention: $M = 64.8$, $SD = 9.5$; control: $M = 65.1$, $SD = 9.2$; $p = .81$). In the intervention group, scores improved to 72.1 ($SD = 8.4$) at T1 and 76.2 ($SD = 7.8$) at T2. In contrast, the control group showed only slight changes (T1: $M = 65.4$, $SD = 9.1$; T2: $M = 66.2$, $SD = 8.9$). Significant time × group interactions were found for overall quality of life, $F(2, 396) = 39.74$, $p < .001$, partial $\eta^2 = 0.17$, and across all four WHOQOL-BREF domains: physical health ($p < .001$), psychological health ($p = .002$), social relationships ($p = .011$), and environment ($p < .001$) (Table 4).

Table 4. WHOQOL-BREF Scores Across Time by Group

Domain / Time	Intervention Mean (SD)	Control Mean (SD)	F (time × group)	p-value	Partial η^2
Overall QoL					
Baseline	64.8 (9.5)	65.1 (9.2)			
Post	72.1 (8.4)	65.4 (9.1)	39.74	<.001	0.17
12 week	76.2 (7.8)	66.2 (8.9)			
Physical	74.3 (8.2)	68.1 (8.5)	21.18	<.001	0.10
Psychological	72.5 (7.9)	68.4 (8.2)	12.62	.002	0.06
Social	71.1 (7.4)	67.8 (7.7)	6.82	.011	0.04
Environment	73.9 (7.7)	68.7 (8.1)	19.44	<.001	0.09

4. DISCUSSION

This study examined the effectiveness of interactive multimedia modules in enhancing family support for hypertension management within a digital health framework. The findings demonstrated that participants in the intervention group exhibited significantly greater improvements in family support, blood pressure control, and health-related quality of life compared with those in the control group. These results reinforce the growing evidence that digital health tools, when designed with family engagement in mind, can strengthen self-management behaviors and improve clinical outcomes in patients with hypertension.

The increase in family support observed in this study underscores the crucial role of caregiver involvement in chronic disease management. Prior studies have consistently shown that family support contributes to improved adherence to antihypertensive medications, dietary modifications, and lifestyle changes (Rahayu et al., 2025). By providing caregivers with

structured, interactive resources such as videos, infographics, and reminders, the modules likely enhanced their ability to support patients in daily routines. This aligns with evidence indicating that interventions which deliberately incorporate family or social support are more effective in sustaining hypertension self-care behaviors (Wu et al., 2023).

The significant reduction in both systolic and diastolic blood pressure in the intervention group is consistent with prior digital health trials and meta-analyses. A large body of evidence confirms that mobile health (mHealth) interventions are effective in lowering blood pressure, especially when combined with behavioral feedback and family involvement (Yuting, 2023; Omboni et al., 2020). The magnitude of reductions found in this study exceeded clinically relevant thresholds, suggesting a meaningful impact on long-term cardiovascular risk. Similar improvements have been documented in trials that integrated self-monitoring with digital coaching or practice-based ICT redesign (Leupold et al., 2023; Lu et al., 2019). Importantly, the sustained decline at 12 weeks indicates that the intervention's effect extended beyond the immediate post-intervention period.

Quality-of-life improvements in the intervention group further highlight the psychosocial benefits of digital family-centered interventions. The WHOQOL-BREF scores demonstrated gains in physical, psychological, social, and environmental domains. These findings echo results from systematic reviews showing that digital interventions enhance not only clinical indicators but also health-related quality of life by reducing anxiety, stress, and caregiver burden (Wang et al., 2025; Morales-Garzón et al., 2023). The integration of family caregivers into the learning process likely fostered a supportive environment, improved confidence, and reduced feelings of isolation among patients, which together contribute to better psychosocial outcomes.

Implication

Mechanistically, the success of the modules can be explained through behavioral learning theory and the principle of shared responsibility. Interactive multimedia provides repeated exposure, active engagement, and immediate feedback, which improve knowledge retention and facilitate skill-building. When caregivers participate alongside patients, they reinforce these behaviors at home, creating a continuous loop of support that extends beyond clinic visits. This dual-target approach represents an important shift from traditional patient-centered education toward family-centered care, which is increasingly advocated in chronic disease management.

The implications of this study are considerable. In resource-limited settings such as low- and middle-income countries, scalable and culturally tailored digital tools can address structural barriers to ongoing hypertension education. Multimedia-based interventions overcome literacy barriers and can be delivered asynchronously, reducing the need for frequent clinic visits. Moreover, by involving caregivers, such interventions align with the World Health Organization's call for task-sharing and community engagement in managing non-communicable diseases.

Limitation

Family support in this study was assessed using patient self-reported measures, which may be subject to social desirability and recall bias. Participants may have overestimated perceived family support following exposure to the intervention. Although the instrument demonstrated good

reliability and validity, future studies would benefit from incorporating complementary assessment strategies, such as caregiver-reported measures, dyadic assessments, or objective behavioral indicators (e.g., shared blood pressure monitoring activities or medication reminders), to provide a more comprehensive evaluation of family support dynamics. The follow-up duration of 12 weeks provides insight into short- to medium-term intervention effects; however, hypertension is a lifelong condition requiring sustained behavioral change. The present findings therefore cannot determine whether improvements in family support, blood pressure control, and quality of life are maintained over longer periods. Future studies should incorporate extended follow-up durations (e.g., 6–12 months) to assess long-term sustainability, relapse prevention, and maintenance of benefits.

This study also has important strengths, including its relatively large sample size, use of validated instruments, and repeated-measures design, which allowed for the assessment of both short- and medium-term effects. The inclusion of family caregivers as co-learners adds novelty and contributes to the growing body of family-centered digital health research. However, limitations must be acknowledged. The study was conducted in a single regional context, which may limit generalizability. The follow-up period was limited to 12 weeks, and therefore long-term sustainability of outcomes is unknown. Finally, although participants reported high satisfaction with the modules, formal usability testing metrics were not applied, and future studies should incorporate comprehensive evaluations of digital health literacy and user experience.

5. Conclusion

In conclusion, interactive multimedia modules delivered through a digital health platform significantly improved family support, blood pressure control, and quality of life among patients with hypertension. By combining patient self-monitoring with family engagement, the intervention addressed both behavioral and contextual determinants of hypertension management. Future studies should evaluate the long-term effectiveness, cost-efficiency, and integration of such interventions into primary care systems to ensure sustainability and scalability.

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