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Research Article

Enhancing Knowledge and Attitude Through mHealth App-Assisted Patient Education Among Elderly Patients with Uncontrolled Hypertension

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ABSTRACT

Hypertension remains a critical health challenge worldwide, with uncontrolled hypertension being a significant contributor to cardiovascular morbidity and mortality. Elderly patients often face difficulties in hypertension management due to limited knowledge, adherence barriers, and lack of education. This study aimed to evaluate the impact of an mHealth-assisted patient education intervention on knowledge and attitude among elderly patients with uncontrolled hypertension. A pre-experimental one-group pre-test and post-test design was conducted among 39 patients aged 46–55 years (48%) and 56-65 years (52%). Patients accessed an mHealth application featuring interactive hypertension management modules. Knowledge and attitude were assessed using validated questionnaires pre- and post-intervention. Results showed a significant improvement in both knowledge and attitude scores post-intervention ($p < 0.05$). The mHealth-based approach effectively increased patient understanding and encouraged a positive attitude towards hypertension management. The study highlights the potential of mHealth applications in enhancing hypertension knowledge and attitude among elderly patients, emphasizing the need for integrating digital tools in routine hypertension care

INTRODUCTION

Hypertension is a major global health concern, with more than 80% of the global burden of high blood pressure weighs heavy on low- and middle- income countries, including Indonesia (Lawes, 2008). Based on data from the World Health Organization (WHO) in 2019, an estimated 1.3 billion adults worldwide were living with hypertension, particularly the elderly (WHO, 2023). In Indonesia, approximately 51.3 million adults aged 30-79 years have been diagnosed with hypertension, with more than 50% requiring appropriate and effective treatment (Kementerian Kesehatan RI, 2023). As a chronic condition characterized by persistently high blood pressure, uncontrolled hypertension leads to severe complications, including stroke, myocardial infarction, and renal failure (Mancia *et al.*, 2023). Uncontrolled hypertension is characterized by sustained blood pressure of ≥140/90, determined by the average of three separate measurements, in patients who are either receiving antihypertensive medication or nor undergoing treatment (Kurnia *et al.*, 2020). Uncontrolled hypertension also significantly increases the risk factors for cardiovascular disease and premature death worldwide (Mills *et al.*, 2020).

Despite available hypertension management strategies, adherence to hypertension management remains a major challenge, particularly among elderly patients

(Burnier and Egan, 2019). Several factors, including lack of knowledge and negative attitudes towards hypertension management contribute to poor adherence and ineffective disease control. Patients diagnosed with hypertension in Indonesia are still relatively low-level knowledge about hypertension management. Many patients do not consider their health a priority, because they believe that hypertension does not significantly interfere with their daily activities and assume that their blood pressure will normalize on its own within a few days (Tarigan *et al.,* 2018). Based on a recent study, an estimated 60% of hypertensive patients still exhibit a negative attitude toward hypertension management. Many patients continue engaging in activities that contribute to uncontrolled blood pressure and increase the risk of complications. In fact, knowledge and attitude toward hypertension play a crucial role in adherence to treatment (Kurnia *et al*., 2020).

Traditional educational interventions, such as face-to-face counseling and printed materials, have been widely implemented but often fail to engage elderly individuals effectively due to accessibility limitations and low health literacy levels (Milani *et al*., 2017). Given these challenges, there is an urgent need for innovative, scalable, and personalized interventions to improve patient education and engagement in hypertension management.

While traditional educational programs exist, mobile Health or mHealth-based interventions for elderly patients with hypertension remain underexplored (Qiu *et al*., 2025). These mHealth applications provide an opportunity to enhance patient education through interactive, self-paced learning, which is particularly beneficial for elderly individuals who may struggle with traditional learning formats. This study introduces an mHealth-assisted patient education approach, focusing on enhancing knowledge and attitude through a customized educational app. This research integrates interactive learning tools, reminders, and real-time monitoring.

This study aims to evaluate the impact of an mHealth-assisted patient education intervention on knowledge and attitudes among elderly patients with uncontrolled hypertension. By leveraging digital tools to deliver personalized and interactive educational content, the research seeks to address the limitations of traditional educational interventions. The findings of this study will contribute to the growing body of evidence on the effectiveness of mHealth solutions in chronic disease management and provide insights into their potential for improving hypertension outcomes among elderly populations.

METHODS

This study employed a pre-experimental one-group pre- and post-test design. Participants were recruited using purposive sampling from three community health centers in Kulon Progo Regency, Special Region of Yogyakarta, Indonesia. Health center staff identified eligible patients from their hypertension registries based on inclusion criteria, and these patients were contacted either during routine clinic visits or by telephone. A total of 60 patients were approached, of whom 45 agreed to participate. After screening for eligibility and obtaining informed consent, 39 participants were enrolled in the study, yielding a response rate of 75%. All participants had been diagnosed with uncontrolled hypertension, defined as blood pressure ≥140/90 mmHg despite receiving treatment. The inclusion and exclusion criteria were also met by the participants. The inclusion criteria required participants to meet the following conditions: (1) diagnosed with uncontrolled hypertension for at least six months, (2) owning or having access to a smartphone, and (3) willing to participate in the mHealth-based education program. Exclusion criteria included patients with cognitive impairments or severe comorbidities. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia (approval No. 267/EC-KEPK FKIK UMY/VIII/2024). All written informed consent was obtained from participants prior to the administration of the questionnaire. Meanwhile, participant's anonymity and confidentiality were maintained throughout the study with data securely stored and accessible only to the research team.

Participants were provided access to a custom-designed mobile health application aimed at improving their hypertension management. The mHealth application, developed specifically for this study, featured a structured and user-friendly interface tailored for elderly users.

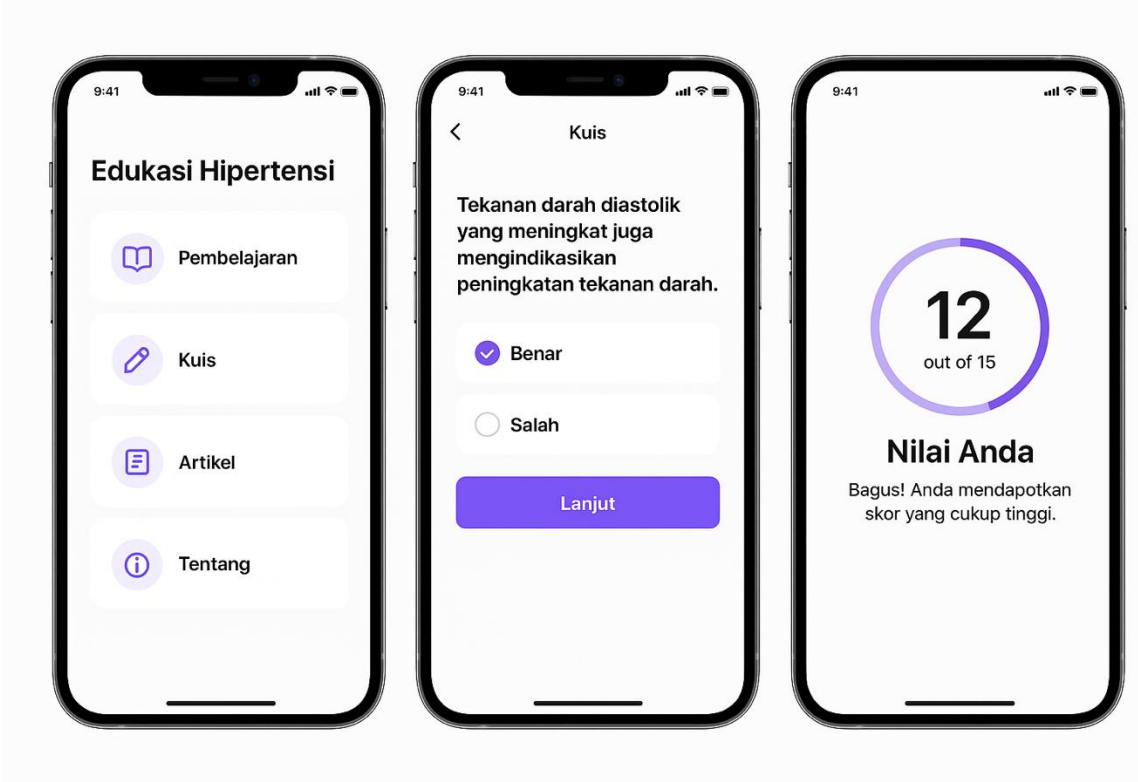

Figure 1. Screenshots of the mobile app utilized in the study.

The educational content was divided into four core modules: (1) Understanding Hypertension, which explained blood pressure readings, risk factors, and symptoms, sourced from the Guidelines for the Recognition and Management of Resistant Hypertension in Indonesia by the Indonesian Society of Hypertension; (2) Medication Adherence, which covered types of antihypertensive medications, dosage schedules, and strategies to avoid missed doses; (3) Lifestyle Modifications, which addressed dietary changes (e.g., reducing sodium intake, adopting the DASH diet), physical activity recommendations, and smoking cessation; and (4) Complications and Monitoring, which informed patients about the potential consequences of uncontrolled hypertension and the importance of regular monitoring. Each module consisted of short articles, infographics, and 2–3-minute videos in the Indonesian language. At the end of each module, participants completed a 5-question interactive quiz designed using a multiple-choice format. Immediate feedback was provided after each response, with explanations for correct and incorrect answers to reinforce learning. The quizzes, as shown in Figure 1, were adapted from the Hypertension Knowledge-Level Scale (HK-LS) content areas to ensure alignment with validated educational outcomes. Other features included daily push notifications for medication reminders, step-tracking and exercise logging, and a secure messaging platform for teleconsultation with healthcare professionals. The app also allowed users to bookmark important content and track their progress through a dashboard showing completed modules and quiz scores.

The intervention lasted for four weeks and involved guided participation, which entailed scheduled weekly check-ins via WhatsApp by trained staff to provide encouragement, troubleshoot technical issues, and remind participants to complete assigned modules. To monitor engagement and adherence, the mHealth application was equipped with built-in analytics that recorded each participant's login frequency, time spent on each module, quiz completion rates, and interaction with features such as reminders and teleconsultation. The data were reviewed weekly to assess participant's regularity in accessing the app and to identify those who needed additional support.

Data were collected at two time points: baseline (Week 0) and post-intervention (Week 4). Pre-test and post-test assessments were conducted using validated instruments, including the Hypertension Knowledge-Level Scale (HK-LS) and the Hypertension Attitude Scale (HAS). The HK-LS, developed in previous

study (Erkoc *et al*., 2012), has demonstrated good internal consistency with a Cronbach's alpha of 0.82. It assesses knowledge across domains such as lifestyle, medication, complications, and monitoring. The Indonesian version used in this study was culturally adapted and pretested among a group of 20 patients, yielding a Cronbach's alpha of 0.79, indicating acceptable reliability. This questionnaire consists of 17 questions with assessment score given by selection of the "true" value of 1, and "wrong" value of 0. A total score of 13-17 are categorized as "good", score of 10-12 are categorized as "fair" and score 0-9 are categorized as "poor". The HAS questionnaire been employed to assess their perceptions and attitudes toward hypertension management. This questionnaire, derived from study (Kurnia *et al*., 2020) and adopted originally from the study (Shrestha *et al*., 2016), also showed good reliability in the current study context, with a Cronbach's alpha of 0.76. This questionnaire consists of 5 questions with assessment score given by selection of the "true" value of 1, and "wrong" value of 0. A total score of 4-5 are categorized as "good", score of 3 is categorized as "fair", and score 1-2 are categorized as "poor". Content validity for both instruments was assessed through expert review by two cardiologists and one public health educator to ensure clarity, relevance, and appropriateness for the local elderly population. Additionally, physical activity in this study was defined as any structured or intentional bodily movement performed for health benefits, including walking, aerobic exercise, light jogging, stretching, or participation in senior exercise classes (e.g., elderly gymnastics). During baseline data collection, participants were asked whether they engaged in such activities at least three times per week for a minimum of 30 minutes per session. Responses were recorded as "Yes" for those meeting this threshold and "No" otherwise.

The data analysis was conducted using descriptive statistics and the Wilcoxon Signed Rank Test. Descriptive statistics, including mean, standard deviation, and frequency distributions, were used to summarize the demographic characteristics of participants. The Wilcoxon Signed Rank Test was employed to determine differences in knowledge and attitude scores between pre- and post-intervention assessments. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Demographic Characteristics of Participants by Gender, Age, Education, Employment and the Old Suffer Hypertension

Table 1 presents the demographic characteristics of the study participants, showing that the majority were female, accounting for 60% (23 out of 39 participants). The distribution of participants across age groups was relatively balanced, with the largest proportion (28%, n=11) were within the 51-55 age group. In terms of marital status, the majority (72%, n=28) participants were married. Regarding educational background, 54% (n=21) had completed only primary education level, and 38% (n=15) were unemployed. A total of 51% (n=20) of participants had been diagnosed with hypertension for 1-5 years, 39% (n=15) for more than 5 years, and only 10% (n=4) for less than one year. Additionally, the majority of participants were non-smokers (69%, n=27)) and did not engage in regular physical activity or exercise (64%, n=25).

Table 1. Demographic characteristics of participants

No	Variable	N (%)
1.	Gender	
	Male	16 (40%)
	Female	23 (60%)
2.	Age (years)	
	46-50	8 (20%)
	51-55	11 (28%)
	56-60	10 (26%)
	61-65	10 (26%)
3.	Marital Status	
	Married	28 (72%)
	Single/Widowed	11 (28%)
4.	Education Level	
	No Formal Education	2 (5%)
	Primary Education	21 (54%)
	Secondary Education	12 (30%)
	Higher Education	4 (10%)
5.	Employment Status	
	Employed	14 (36%)
	Unemployed	15 (38%)
	Retired	10 (26%)
6.	Hypertension Duration	
	<1 year	4 (10%)
	1-5 years	20 (51%)
	>5 years	15 (39%)
7.	Smoking Status	
	Smoker	12 (31%)
	Non-Smoker	27 (69%)
8.	Physical Activity (Exercise)	
	Yes	14 (36%)
	No	25 (64%)

Table 2. Overview of pre- and post-intervention knowledge scores in patients with uncontrolled hypertension

Knowledge	Pre-Test		Post-Test	
	F	%	F	%
Good	0	0.0	29	75.6
Fair	5	12.2	9	22.0
Poor	34	87.8	1	2.4
Total (N)	39	100.0	39	100.0

F = Frequency; the number of participants in each score category.

Table 3. Overview of pre- and post-intervention attitude scores in patients with uncontrolled hypertension

Attitude	Pre-Test		Post-Test	
	F	%	F	%
Good	9	22.0	25	65.0
Fair	15	39.0	14	34.1
Poor	15	39.0	0	0.0
Total (N)	39	100.0	39	100.0

F = Frequency; the number of participants in each score category.

Table 4. Results of descriptive statistics and Wilcoxon signed rank test

Variable	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	*p*-value
Knowledge Score	10.3 ± 2.1	15.8 ± 1.7	0.001
Attitude Score	3.2 ± 1.1	4.5 ± 0.8	0.002

SD, standard deviation.

Based on the Table 2, out of 39 participants before the knowledge intervention, a total of 34 participants (87.8%) were categorized as having poor knowledge, 5 participants (12.2%) were in the fair category, and none had a high knowledge score. However, after the knowledge intervention, there was an improvement with 29 participants achieving a high knowledge score. A total of 9 participants were in the fair category, and 1 participant remained in the poor category.

Based on Table 3, before the attitude intervention, 15 (39%) participants were categorized as having poor attitudes, and 15 (39%) participants were in the fair category. The remaining 9 (22%) participants had a high attitude score. After the attitude intervention, there was an increase in scores, with 25 (65%) participants achieving a high attitude score and the remaining 14 (34.1%) participants in the fair category. Notably, no participants were categorized as having a poor attitude.

Wilcoxon Test Result

The effectiveness of the mHealth-assisted education intervention was assessed using the Wilcoxon Signed Rank Test to compare pre- and post-test scores. As presented in Table 4, participant's mean knowledge score significantly increased from 10.3 ± 2.1 at baseline to 15.8 ± 1.7 post-intervention. The Wilcoxon test yielded a z-value of -5.28 and an exact *p*-value of 0.001, indicating a statistically significant improvement. The corresponding effect size, calculated using Cohen's d = 2.82, denotes a large effect. This marked increase in knowledge suggests that the mHealth application's interactive features—such as instructional videos, quizzes with feedback, and daily reminders—contributed meaningfully to participants' understanding of hypertension management. Likewise, the mean attitude score improved from 3.2 ± 1.1 to 4.5 ± 0.8 following the intervention. The Wilcoxon Signed Rank Test produced a z-value of -3.12 and an exact *p*-value of 0.0018. The effect size for attitude improvement, Cohen's d = 1.27, also indicates a large magnitude of change, supporting the intervention's effectiveness in fostering more positive attitudes toward self-management of hypertension.

App engagement was assessed using in-app analytics data, which recorded individual user activity. Engagement was operationally defined based on frequency of logins, total time spent using the application, number of

completed educational modules, and completion of interactive quizzes. To examine the relationship between app engagement and outcomes, Spearman's rank correlation coefficient (r) was used, as the data were not normally distributed. A strong positive correlation was found between app engagement and improvement in knowledge scores ($r = 0.72$, $p < 0.01$), indicating that participants who interacted more frequently and consistently with the app experienced greater knowledge gains. A similar, though slightly weaker, positive correlation was observed between engagement and attitude improvement, suggesting that consistent interaction with reminders and educational content was associated with more favorable attitudes toward hypertension management.

The present study identified that participants exhibited relatively low baseline knowledge regarding hypertension management, with 87.8% categorized within the "poor" knowledge level. This result is consistent with prior investigations in the Indonesian context, which have reported limited exposure to structured health education among elderly populations, accompanied by persistent misconceptions about the chronic nature and potential risks of hypertension (Rahayu *et al*., 2018). The predominance of "fair" pre-intervention attitude scores further suggests a general complacency or insufficient understanding of hypertension's long-term health consequences. Contributing factors to negative attitudes likely include continued consumption of high-sodium foods, routine caffeine intake, and limited physical activity, all of which have been observed in earlier studies (Artiyaningrum and Azam, 2016). Negative attitudes toward hypertension management among participants were often reflected in their continued engagement in unhealthy lifestyle behaviors. These included frequent consumption of high-sodium foods, regular intake of caffeinated beverages such as coffee, and a lack of participation in physical activities designed for older adults, such as senior exercise classes (e.g., gymnastics seniors). Such behaviors suggest limited awareness of lifestyle modifications necessary for effective hypertension control and may contribute to poor adherence to management guidelines. Additionally, the duration of hypertension appears to play a contributory role; the majority of respondents had lived with the condition for over one year, which may impact their perceptions and behaviors. Suciana has noted that individual disease experience contributes significantly to the development of knowledge and behavioral responses (Suciana *et al*., 2022).

Analysis of demographic characteristics in relation to changes in knowledge and attitude scores revealed observable patterns, although no formal statistical tests (e.g., correlation analysis or subgroup comparisons) were conducted to confirm the significance of these associations. Descriptive trends indicated that female participants appeared to show greater improvements in knowledge scores post-intervention than their male counterparts. This observation is consistent with prior studies reporting higher levels of engagement in health education and preventive care among women (Tomaszewski *et al*., 2017). Similarly, older participants (particularly those aged 56–65 years) appeared to demonstrate less pronounced improvements in attitude scores, suggesting that behavior change may be more challenging with advancing age. This pattern aligns with previous behavioral health literature highlighting the need for more intensive reinforcement strategies among older adults (Guasti *et al*., 2022). Additionally, participants with higher levels of educational attainment tended to show greater gains in knowledge, which supports findings that health literacy plays a critical role in chronic disease management (Ownby *et al.,* 2017). However, these interpretations should be treated with caution, as the study did not apply inferential statistical tests to evaluate the strength or significance of these relationships.

Descriptive patterns in the data suggest that employment status may have influenced attitude improvements, with employed participants appearing to report more favorable post-intervention attitudes. This trend may reflect the influence of structured daily routines and workplace health awareness, as noted in previous studies (Zhou *et al*., 2022). Similarly, participants with a longer history of hypertension (over five years) appeared to have higher baseline knowledge but demonstrated less improvement after the intervention. This may be attributed to their previous exposure to similar health information, potentially leading to a ceiling effect in knowledge acquisition (Shen *et al*., 2021). Behavioral factors may also have played a role in shaping the observed outcomes. For example, non-smokers appeared to show greater improvements in both knowledge and attitude scores compared to smokers, which is consistent with prior research linking smoking with lower health literacy and weaker adherence to medical advice (Hasan *et al*., 2019). Likewise,

participants who reported engaging in regular physical activity tended to exhibit more substantial positive shifts in attitude following the intervention. This observation is in line with existing literature suggesting that physical activity contributes to greater motivation for lifestyle modification and disease self-management (Basso *et al.,* 2022). However, it is important to note that these trends were not tested statistically in the present study. As such, while the patterns appear consistent with existing evidence, the relationships between demographic or behavioral variables and outcome improvements should be interpreted as exploratory and descriptive rather than confirmatory. Future studies should employ formal inferential analyses to examine these associations in a statistically robust manner.

The study findings indicate that mHealth applications may serve as effective platforms for delivering health education, particularly among elderly populations. The combination of interactivity, multimedia content, and user autonomy facilitated greater engagement and retention of educational material. This observation is consistent with findings from previous studies demonstrating that digital health interventions can improve disease literacy and foster better understanding of chronic disease management principles (Garner *et al*., 2020; Morrissey *et al*., 2018). The app's features—such as audiovisual content, knowledge quizzes with instant feedback, and automated reminders—likely contributed to the significant improvement observed in knowledge scores.

Beyond cognitive outcomes, the intervention also elicited a meaningful improvement in participants' attitudes towards hypertension management. Users reported increased confidence and motivation in self-managing their condition, likely resulting from the structured guidance and behavioral reinforcement provided through the application. Similar outcomes have been observed in other studies, which have documented the efficacy of mHealth tools in enhancing patient self-efficacy and promoting adherence through digital engagement (Li *et al*., 2020; Morawski *et al*., 2018). These attitudinal shifts are particularly important given the well-documented association between motivation and long-term compliance with chronic disease treatment regimens.

The intervention demonstrated specific advantages tailored to the needs of elderly patients. The ability to access content asynchronously and self-paced reduced cognitive burden and improved engagement. Interactive features helped sustain user interest, while personalized recommendations based on progress metrics offered individualized support. Remote monitoring functionalities further allowed healthcare providers to track adherence and provide timely feedback. Collectively, these elements help to bridge common gaps in traditional hypertension education, especially among older adults who may experience barriers to in-person learning (Ghozali, 2024; McLean *et al*., 2016).

Nevertheless, this study has several limitations that must be acknowledged. First, the relatively small sample size (n = 39) may restrict the generalizability of the findings to larger or more diverse populations. Second, the short intervention period (four weeks) limits the ability to assess long-term outcomes such as sustained behavior change, blood pressure control, and continued app usage. Third, variability in digital literacy among participants posed a challenge. While all participants had access to smartphones, differences in technological proficiency may have influenced their ability to fully engage with the app. These limitations suggest that the results may underrepresent the full potential of mHealth interventions and should be interpreted with caution. To enhance the evidence base, future research should implement randomized controlled trials with larger sample sizes and longer follow-up durations. These studies should aim to evaluate not only knowledge and attitude retention but also clinical outcomes such as blood pressure control and incidence of hypertension-related complications. Furthermore, integrating features such as simplified user interfaces and gamified elements—such as progress badges or health challenges—may improve sustained user engagement. Future implementations should also consider incorporating caregiver or peer support components to overcome digital barriers faced by some elderly users.

In terms of clinical practice, the findings suggest that mHealth interventions can be effectively integrated into hypertension management strategies, particularly as supplements to routine care. Incorporating app-based education into primary care workflows, such as post-consultation follow-up or remote patient monitoring, could enhance treatment adherence and patient empowerment. Additionally, national public health initiatives targeting chronic disease management may

benefit from embedding validated mHealth tools into broader population health strategies, especially in resource-limited settings where in-person education is constrained.

CONCLUSIONS

The analysis of knowledge assessment revealed a significance value of $p<0.001$ ($p< 0.05$), while the attitude assessment demonstrated a significance value of $p=0.002$ ($p<0.05$). These findings indicate a significant correlation between mHealth applications and both knowledge and attitude. The interactive and accessible tools of mHealth applications have the potential to enhance hypertension knowledge and attitude among elderly patients with uncontrolled hypertension. The findings of this study emphasize the necessity for further research on the integrating of digital tools into routine hypertension care.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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