Implementation of Mobile Application-Based Health Education for Hypertension Prevention in Young Adults

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ABSTRACT

Hypertension among young adults is increasing due to modern lifestyles, yet conventional health education is often ineffective for this digital-native generation. This narrative review summarizes evidence from 2020–2025 on the effectiveness of mobile application-based health education for improving hypertension prevention behaviors and lowering blood pressure in young adults. Fifteen publications (meta-analyses, RCTs, feasibility studies, and protocols) were reviewed, focusing on mHealth interventions incorporating education, self-monitoring, reminders, feedback, and behavior change techniques (BCTs). Most studies found that apps with interactive educational features, blood pressure monitoring, adaptive reminders, and personalized feedback improved sodium intake, physical activity, and medication adherence. Meta-analyses reported an average systolic blood pressure reduction of 4–6 mmHg compared to controls. The highest effectiveness was seen in multi-component interventions lasting 3–6 months that applied BCTs such as goal setting, performance feedback, and self-monitoring. In conclusion, mobile app-based education is effective for hypertension prevention in young adults when designed with BCT principles. Implementation in campus and workplace settings offers a pragmatic strategy to expand the reach of hypertension prevention for young populations.

Keyword : mHealth; health education; young adults; hypertension prevention; behavior change techniques

Introduction

Hypertension that appears in young adulthood is now a growing public health problem because it can increase long-term cardiovascular risk and premature mortality[1,2]. Epidemiological evidence indicates that the surge in hypertension prevalence among individuals aged 18–35 years is closely associated with lifestyle changes, particularly increased consumption of high-sodium foods, lack of

physical activity, psychosocial stress, and sleep disturbances due to modern work patterns and lifestyles[3,13,14]. According to data from the 2023 Indonesian Health Survey (SKI), which is integrated with the Basic Health Research (Riskesdas), the prevalence of hypertension based on sphygmomanometer measurements in the 18–24 age group has reached 10.7%, and in the 25–34 age group, it is 17.4% in Indonesia[16]. If not prevented early on, hypertension in young adults can cause structural and functional changes in blood vessels that accelerate the onset of coronary heart disease and stroke during productive years[1,2].

Conventional educational approaches such as face-to-face counseling or public health campaigns are often ineffective in reaching young adults who are digital natives. They are more responsive to interactive, personalized communication that is easily accessible via mobile devices[4,12]. Mobile-based applications (mHealth) offer advantages such as the ability to deliver evidence-based brief education, provide automatic reminders, enable self-monitoring, and provide data-based feedback that can motivate users to maintain healthy behaviors[5,11].

In addition, the development of Behavior Change Techniques (BCT) concepts has enabled digital interventions to be designed based on scientific principles of behavioral change, such as goal setting, performance feedback, and self-monitoring of behavior/outcomes, which have been proven to contribute to blood pressure reduction in various meta-analysis studies[3,7]. In the context of young adults, the application of these strategies through digital media not only facilitates access to education but also increases engagement and long-term retention, which are key to the success of hypertension prevention programs[4,9,12].

The increasing availability of smartphones and internet access strengthens the potential for mHealth implementation in Indonesia, especially in higher education and workplaces. However, the effectiveness of digital interventions depends on the design of educational content, duration of implementation, and integration with primary health services for follow-up on cases of high blood pressure[8,11,15]. Therefore, it is important to summarize the latest evidence on the effectiveness of mobile applications as a medium for health education for the prevention of hypertension in young adults.

Objective

- Present a summary of evidence from 2020–2025 on the effectiveness of mobile app-based health education for the prevention of hypertension in young adults
- Identify intervention design elements (content and features) that support behavioral change
- Provide pragmatic evaluation recommendations for implementation on campuses and in work environments

Material and Methods

A focused literature search was conducted on PubMed/MEDLINE and JMIR ecosystem-

related journals, JAMA Network Open, Frontiers, and cardiovascular journals for the period 2020–2025 with the keywords: "young adults," "prehypertension," "hypertension prevention," "mobile app," "mHealth", "health education", "behavior change techniques", and "randomized"[1–6,10]. Inclusion criteria included English-language publications from 2020–2025 that evaluated mobile app/message interventions with educational components and reported behavioral outcomes, clinical BP, or engagement indicators[1–6]. Exclusion criteria included studies on children, non-mobile interventions, publications outside the specified time frame, and studies that did not allow identification of the role of education. From the selection process, ≥15 articles were prioritized, including meta-analyses, RCTs, feasibility studies, and pragmatic protocols[1–6,15].

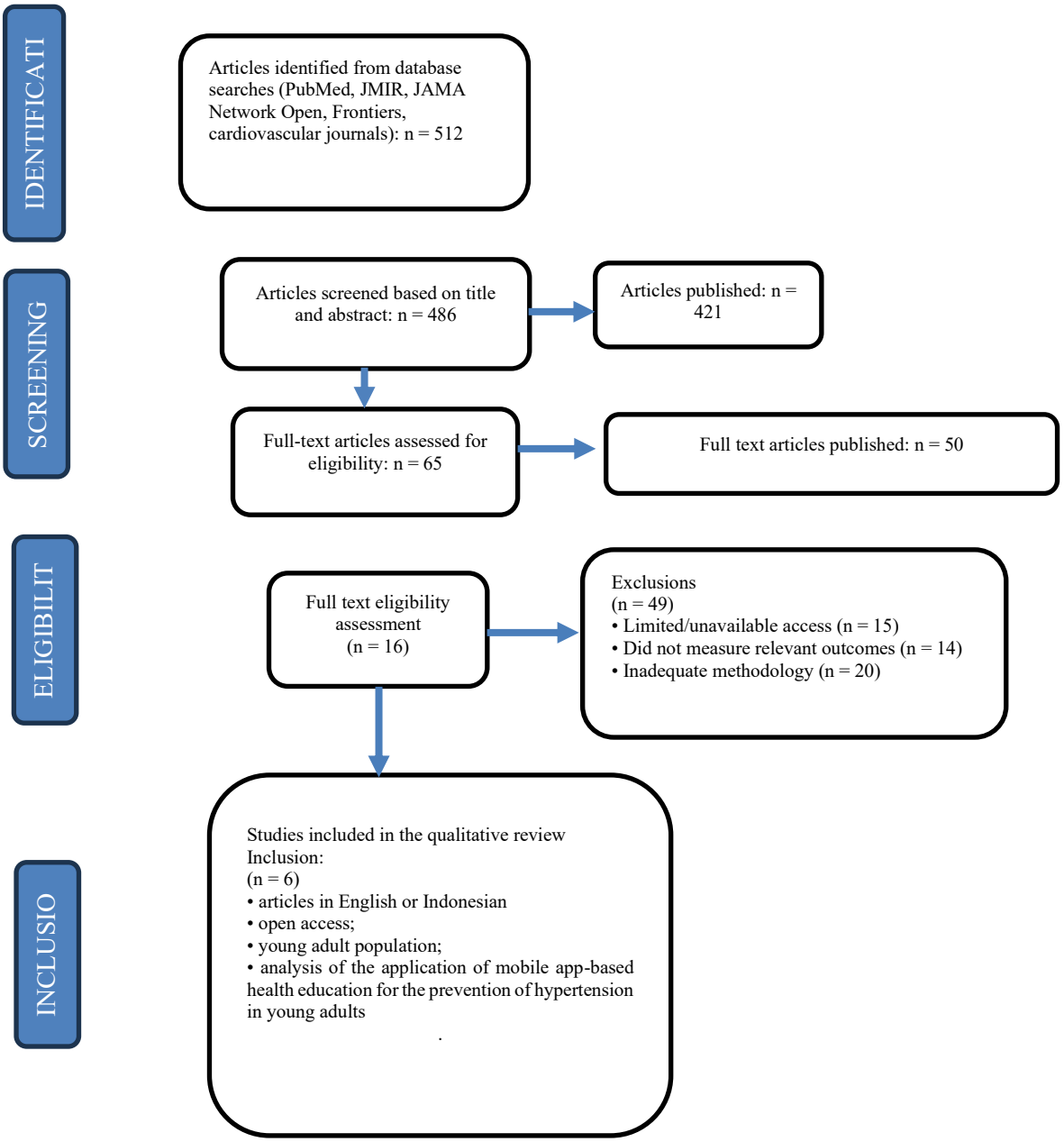

Figure 1. Flow diagram of the literature search

Result and Discussion

Effectiveness on blood pressure

Two large meta-analyses reported that digital health interventions reduced SBP by an average of approximately 4–6 mmHg in adult populations compared to controls, with variations depending on study design and duration[1,2]. A review of the presence of behavioral change techniques in mHealth applications shows that applications that combine self-monitoring, feedback, and goal setting tend to produce more consistent blood pressure reductions[3]. Several RCTs show that combining home BP monitoring with coaching via smartphone provides additional benefits in blood pressure control compared to simple monitoring alone[5,11].

Behavioral changes (sodium, activity, compliance)

Interventions that include DASH/sodium education, goal setting, and self-monitoring are generally successful in reducing self-reported sodium intake and increasing light-to-moderate physical activity[2,6,13]. The behavioral change techniques most often associated with effectiveness include self-monitoring of behavior/outcomes, feedback on performance, goal setting, and prompting/reinforcement[3,7].

Acceptance and engagement among young adults

Feasibility studies among college students and young adult populations report high adoption rates, daily usage frequency, and user satisfaction with short/interactive educational formats on apps[4,9,12]. However, many formative studies are small-scale and short-term, so detection of clinical effects on BP is often limited; a minimum duration of 3–6 months is recommended to capture stable BP changes[4,10,15].

Current pragmatic protocols and approaches

Just-in-time adaptive interventions (JITAI) models and pragmatic protocols combining physical activity, dietary modification, and adaptive reminders are being tested to optimize the timing and personalization of messages[10,15]. Cluster trials and web/app-based multicomponent interventions show that integration with clinical referral pathways and monitoring can increase the likelihood of follow-up when BP findings require clinical intervention[8].

Study Limitations

Several limitations should be considered when interpreting the overall findings on the effectiveness of digital interventions for hypertension. First, most of the evidence comes from single-arm designs, formative trials, or small-scale studies with short intervention durations, particularly in young adult populations, so the ability to detect long-term clinical effects on blood pressure is still limited[4,9,12]. Second, the variability of intervention components—such as the type of education, intensity of coaching, self-monitoring methods, and the presence of behavioral reinforcement—results in considerable heterogeneity between studies[3,7,14]. Third, several studies rely on self-reported behavior (sodium, physical activity, and medication adherence), which has the potential to cause

information bias and reduce the accuracy of lifestyle change estimates[2,6,13]. Fourth, most studies were conducted in academic settings or specific populations (e.g., university students), so external validity and generalization to the general young adult population still require caution[4,9]. Finally, few trials have integrated the application with clinical referral pathways or healthcare professional supervision, so the impact of the intervention on the systemic quality of hypertension care cannot yet be strongly concluded[8,11].

Recommendations for Further Research

Several research directions should be considered to improve the quality of evidence. First, future studies should use RCT or cluster-RCT designs with a duration of ≥3–6 months to capture more stable blood pressure changes and evaluate long-term clinical effects[4,10,15]. Second, interventions should integrate components of behavior change that have been proven effective including self-monitoring, feedback, goal setting, and adaptive reminders so that they can be evaluated in a more standardized manner across studies[3,7,14]. Third, the use of objective measurements (certified device-based home BP monitoring, accelerometers for physical activity, and more accurate sodium estimation methods) is recommended to reduce self-report bias[2,6,13]. Fourth, further research should involve a more diverse young adult population, including in communities, workplaces, and primary care settings, to strengthen the generalizability of findings[9,12,16]. Additionally, evaluating the JITAI model and integrating the application with clinical service systems, including automatic referral mechanisms when blood pressure increases, are important areas for developing more pragmatic and scalable interventions[10,15].

Tabel 1. Literature Review of Key Studies on the Application of Mobile Application-Based Health Education for Hypertension Prevention in Young Adults

Author and Year	Title	Objectives	Method	Key Findings
Katz ME, Ehrenfeld L, Liang K, Xie Y, Ramsey A, Fletcher RD, et al. (2024)	Digital health interventions for hypertension management in US populations experiencing health disparities: a systematic review and meta-analysis	Assessing the effectiveness of digital interventions in populations with health disparities in the US.	Systematic review & meta-analysis RCT/kohort.	Digital interventions reduce SBP by ~4 mmHg; most effective when culturally tailored.
Boima V, Doku A, Agyekum F, Tuglo LS, Agyemang C (2024)	Effectiveness of digital health interventions on blood pressure control, lifestyle behaviours and adherence in LMICs: a systematic review	Evaluating the impact of digital interventions on blood pressure and lifestyle in LMICs.	Systematic review & meta-analysis RCT.	SBP decreased significantly (−4.4 mmHg); improved blood pressure control and medication adherence.

	and meta-analysis of randomized controlled trials			
Zhou Y, Li S-J, Huang R-Q, Ma H-M, Wang A-Q, Tang X-Y, et al. (2024)	Behavior change techniques used in self-management mHealth app interventions for hypertension: systematic review and meta-analysis	Identifying behavior change techniques in mHealth applications and their effects on blood pressure.	Systematic review & meta-analysis	mHealth lowers SBP by ~5.8 mmHg; effective techniques: self-monitoring & feedback.
Tran DMT, Alicea-Planas J, Martinez S, Barengo NC, Alpert JS, Flahault A (2024)	mHealth intervention for elevated blood pressure among college students: single-arm intervention study	Assessing the feasibility of mHealth for high blood pressure in students with elevated blood pressure.	Single-arm intervention study (28 days).	Feasible and well accepted; increased awareness and monitoring of blood pressure .
Liu F, Xue H, Zhao H, Lu Y, Zhang M, Wang J, et al. (2023)	Efficacy of an mHealth app to support patients' self-management of hypertension: randomized controlled trial	Assessing the effectiveness of mHealth applications for hypertension management.	RCT with intervention and control groups.	Decreased blood pressure and increased compliance compared to controls.
Yuting Z, Wei Q, Huang G, Wen Y, Ma L, Chen X, et al. (2023)	Effectiveness of an mHealth intervention on hypertension risk factors in low-resource rural settings: a randomized controlled trial	Testing mHealth interventions in hypertensive patients in rural areas.	RCT for 12 weeks.	Significant decrease in SBP (−7 mmHg); increased compliance and self-efficacy.

A summary of evidence from 2020–2025 indicates that mobile app-based education can improve preventive behaviors (sodium reduction, increased activity, compliance) and reduce mild to moderate SBP when the intervention is multi-component, of adequate duration, and applies theory-based BCT[1–3,7]. Successful implementation depends on the quality of educational content, user experience design tailored to young adult preferences (micro-learning, personalization, progress visualization), and adequate measurement (home BP) and feedback features[4,5,12]. Research limitations include outcome heterogeneity (self-reported vs. objective), variations in intervention duration and intensity, and the need for larger samples and longer follow-up periods to capture

clinically significant effects on BP[1,2,11,14]. For practice, integrating data interoperability with primary care services and referral mechanisms when BP readings are consistently high is important for digital interventions to serve as both a prevention tool and an early detection mechanism[8,11].

Practical design implications

Based on available evidence, practical intervention design recommendations include:

- **Content**: short interactive modules (DASH/sodium, structured physical activity, stress and sleep management, alcohol/tobacco reduction)[3,13].
- **Features**: self-monitoring of BP/activity, goal setting, adaptive reminders, measurable progress feedback, and light gamification to maintain engagement[3,5,10].
- **Implementation:** user-friendly interface for young adults, optional integration with primary care services for clinical follow-up, and brief training for users on how to measure BP correctly[8,11].
- **Evaluation:** combination of behavioral outcomes (sodium intake, MVPA, adherence) and clinical outcomes (SBP/DBP) with a minimum follow-up of 3–6 months and analysis of the role of engagement as a mediator of effects[1,2,10].

Conclusion

Mobile application-based health education is a potential strategy for preventing hypertension in young adults if it is designed to be multi-component and behavior theory-based; applies relevant BCTs such as self-monitoring, feedback, and goal setting; and is implemented for at least 3–6 months with pragmatic evaluation mechanisms. Implementation in campus and workplace settings is recommended, with the caveat that integration of clinical referral pathways and mid-term evaluation is necessary to ensure sustained clinical effects. In Indonesia, the potential for implementation is relatively high given the high penetration of smartphone use among young adults, the increasing need for promotive-preventive services, and the suitability of digital interventions with existing non-communicable disease (NCD) control programs in primary health care facilities.

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