

Digital Health Intervention to Improve Healthy Lifestyle and to Prevent Complications in Hypertension Patients: A Systematic Review

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ABSTRACT

This study aimed to systematically review the use of digital health interventions in improving healthy lifestyles and preventing complications in hypertension patients. This study was a systematic review. Article searches were conducted through the journal sites databases PubMed, ScienceDirect, SCOPUS, Web of Science, ProQuest, and Sage. The articles that study digital intervention to improve lifestyle and prevent complications in hypertension patients, published between 2019 and 2024 in English and Full Open Access, were selected to be reviewed. This study adheres to the PRISMA checklist for systematic review. The methodological quality of the studies was assessed using JBI. The results were analyzed by data synthesis.

Of the 3,407 identified articles, 20 were reviewed, involving 36,385 patients, primarily from middle to high-income countries (95.24%). The application uses smartphones and web pages, providing educational content, reminders, blood pressure monitoring, diet guidance, medication adherence support, and collaboration with healthcare professionals. The findings of this systematic review suggest that using technology-based applications can improve the management of hypertension. However, applications that will enhance the healthy lifestyle of hypertensive patients still need to be developed.

KEYWORDS: Digital Health Intervention, Healthy Lifestyle, Prevent Complications, Hypertension, Non-Communicable Disease, Systematic Review

INTRODUCTION

In the last decade, digital transformation has significantly impacted healthcare¹. Digital health² enhances patient participation, aiding in informed decision-making through online information and mobile health applications. Smartphones have led to increased use of these apps, which have proven effective in innovating health services³. One key application is the management of non-communicable diseases (NCDs) within communities.

Hypertension is a common non-communicable disease (NCD). A global health target aims to reduce its incidence between 2010 and 2030. In Indonesia, the 2018 Basic Health Research reported that 34.1% of adults have hypertension, with East Java at 13.1%⁴. Out of 15 million affected, only 4% manage it effectively⁵. The rise in hypertension reflects a widespread lack of healthy lifestyles⁶. While adopting

healthier habits can prevent hypertension and its complications, many struggle to maintain them⁷.

Health education can improve knowledge and attitudes toward managing uncontrolled hypertension in rural areas⁸. Distance education offers convenience for patients, saves time, and facilitates adherence to treatment⁹. Multimedia methods enhance understanding and engagement, providing a cost-effective and user-friendly approach for patients and caregivers¹⁰. In-person education often faces limitations due to time, location, and educator availability. Research shows that technology-based interventions can boost knowledge, improve home blood pressure monitoring, and promote better self-management¹¹⁻¹³, making digital tools valuable for preventing hypertension complications.

Despite extensive research^{14,15,16} on digital technology for hypertension patients, key questions remain. Do these interventions promote healthier lifestyles and prevent complications? While digital health apps are widely used, their effectiveness varies, with some studies showing only occasional positive impacts on health. Concerns also exist regarding misinformation and unintended effects on users and healthcare services. This study aims to systematically review the literature on digital health interventions to assess their role in promoting healthy lifestyles and preventing complications in hypertension patients.

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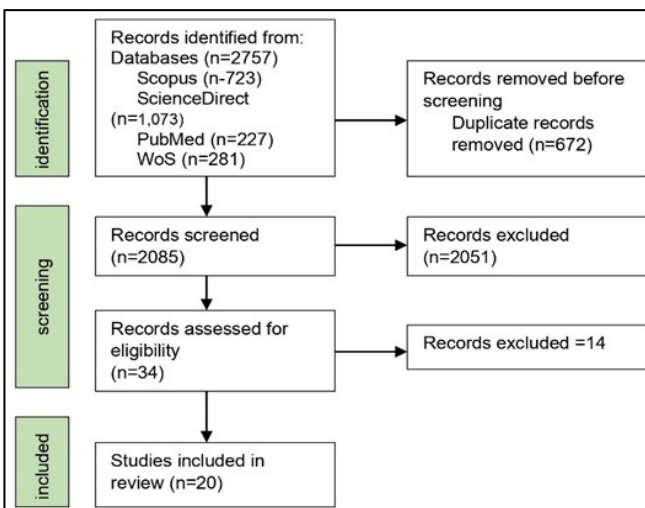


METHODOLOGY

Search Process

All articles indexed as of May 2019 in the PubMed, Web of Science, SCOPUS, ScienceDirect, SAGE, and Google Scholar databases were searched. A combination of search terms was used, including *mHealth, digital, internet-based, mobile, app, apps, application, applications, smartphone, smartphone, technology* (for digital health intervention); *hypertension, hypertensive, hypertensives, or blood pressure* (for the disease type); *healthy lifestyle, healthy habit, healthy behavior, OR complications prevention* (for disease management); *intervention, trial, program, programme, experiment, pilot, study, effect, experience, or experiences* (for intervention).

Figure I: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the literature screening process



Selection Strategy

Included studies were those conducted among hypertension patients, involving a mobile app or digital app to facilitate a healthy lifestyle and hypertension complication prevention, aiming to test the app or system experience (Figure I).

Data Extraction

Two researchers reviewed selected papers, considering details like the first author, year of publication, and language. They excluded articles that (1) focused on apps for disease screening or detection; (2) addressed app design without participant usage experiences; (3) were aimed at healthcare providers rather than patients; (4) involved children; (5) relied on non-smartphone technology or text messaging; (6) were not in English; or (7) included only abstracts without full texts. The reviewed articles were analyzed using data synthesis techniques.

RESULTS & DISCUSSION

This review analyzed 20 articles (Table I) conducted in various countries: one in Singapore¹⁷, four in China¹⁸⁻²¹, one in France²², one in Saudi Arabia²³, six in the United States²⁴⁻²⁹, one in Germany³⁰, one in Spain³¹, three in Iran³²⁻³⁴, one in Japan³⁵, and one in Portugal³⁶. Most studies (19 articles, 95.24%) were in developed countries, while only one was in developing countries.

Sample Characteristics

A total of 36,385 participants aged 20 to 80 were included in this study, all diagnosed with hypertension. Hypertension is characterized by a systolic blood pressure of 130 to 139 mmHg, a diastolic blood pressure of 80 to 89 mmHg³², or individuals taking anti-hypertensive medications¹⁷ for at least six months³².

Table I: Articles for Digital Health Intervention to Improve Healthy Lifestyle and Prevent Complications in Hypertension Patients

Author	Results
Xiang, Li*, Zhang, 2022	The Random Forest model outperforms LSTM in BP prediction.
Bakre et al., 2022	There was a decrease in the average systolic and diastolic blood pressure in the participants.
Poblete et al., 2023	There was a change in mean systolic and diastolic blood pressure before and after intervention.
Liu et al., 2023	mHealth app-based interventions may boost health knowledge and support better lifestyle choices for improved blood pressure control, but more research is needed.
Alzahrani et al., 2023	Mobile health apps can help Saudis change their unhealthy lifestyles.
Li et al., 2023	The Internet-based pharmaceutical (IPC) method can control blood pressure.
Postel-Vinay et al., 2024	The Hy-Result web app enhances patient care by enabling independent blood pressure monitoring and reporting.
Lisón et al., 2020	Our internet-based intervention used diverse learning techniques to promote lifestyle changes, yielding positive health benefits for obese patients with hypertension.
Chen et al., 2023	Internet-based health management has a long-term effect on improving blood pressure control in patients with hypertension.
Zahed et al., 2023	mHealth coaching intervention helps participants improve beliefs regarding hypertension self-management.
Brewer et al., 2023	A culturally tailored mHealth app, supported by CHW assistance, may improve hypertension management for under-resourced African American individuals at FQHCs. A future efficacy trial is needed.
Schneider et al., 2023	Reducing salt intake in PA patients lowers blood pressure and depression, with RAAS blockade enhancing these effects.
Lim et al., 2024	Patient portal usage was associated with higher self-efficacy scores in patients with hypertension.

Darabi et al., 2024	DASH diet education based on the self-efficacy concept for 12 weeks with a smartphone application improved subjects' self-efficacy and reduced their blood pressure at the end of the intervention compared to the control group.
Sakane et al., 2023	The SHG-specific KENPO app was feasible and induced modest but significant weight loss in obese adults.
Karami et al., 2023	The application of programmed instruction through mHealth has shown a positive effect on the health literacy of uncontrolled hypertensive patients.
Still et al., 2021	The behavioral interventions using technology can potentially improve self-management outcomes among African American populations.
Branch et al., 2022	A hypertension care program powered by AI with coaching was associated with a clinically meaningful reduction in SBP.
Pinto et al., 2024	Intervening in health education for people with AHT is a priority to minimize the onset of cardiovascular diseases and complications of AHT.
Bozorgi et al., 2023	Considering the widespread use of smartphones, mHealth interventions can be effective in self-management and better patient adherence to treatments.

Different studies define hypertension with varying criteria, such as a systolic range of 120 to 159 mmHg or a diastolic range of 80 to 99 mmHg, including those on blood pressure-lowering medications³⁷ and with recent readings of 140/90 mmHg or higher³⁸. Some studies may also require a history of hypertension within the last year, being overweight or obese, and having a smartphone with basic phone literacy³².

Types of Health Apps and Their Functions

The reviewed articles highlight various digital interventions that utilize smartphones^{19,24,32-35,37}, Bluetooth²⁶ technology for connections to weight measurement apps, and websites^{17,28,31}. These interventions often include health education media like multimedia modules^{19,31,33}, smoking cessation programs³⁴, and health articles¹⁷, along with links to important health information³⁷. Many applications are integrated with health service management systems, enabling users to find needed services¹⁷, access health records²¹, and manage appointments, medication purchases, laboratory results, payments, and home blood pressure monitoring¹⁷.

The application includes a 30-day calendar, daily task tracking, and the ability to monitor daily and weekly blood pressure and weight trends. It features automatic reminders for daily measurements²⁶, food logging²³, and medication notifications via SMS²⁸ and phone³⁷. Users receive support¹⁹ from a team of experts who create personalized diet and exercise plans, offer health management services²¹, and provide coaching on healthy lifestyle choices³⁹. The team collaborates with medical professionals³⁴, and a conversational AI³⁹ feature offers real-time feedback. The intervention durations vary, ranging from two months to 12 months.

Apps for Maintaining a Healthy Lifestyle

Applications were developed to change self-efficacy³², attitudes, and perceived benefits regarding self-management and increase the motivation²⁶, increase compliance with monitoring daily blood pressure measurements^{26,35}, reduce blood pressure^{19,30,38,39}, increase patients' self-management^{19,28}, decrease salt intake^{19,30}, improve diet adherence³², improve medication adherence¹⁹, increase physical activity¹⁹, and improve decision-making³³.

Regular use of the application aids in predicting blood pressure levels¹⁸ and helps medical personnel group data at clinics³⁷. Health coaching prompts patients to watch educational videos of at least two minutes²⁶, improving their health and fitness²³. The program monitors participant engagement²⁴ and adherence by tracking completed activities³¹.

This review indicates that many developed countries have created applications for managing hypertension, reflecting the rising demand for digital technology in healthcare⁴⁰. It highlights variations in diagnosing hypertension, with some using thresholds of over 130 mmHg³², 120 mmHg³⁷, or 140 mmHg³⁸. These criteria can differ based on the research context, and guidelines for managing hypertension often vary between populations, such as Asians and Westerners⁴¹.

This review found that the application supports health management with a 30-day calendar, daily blood pressure and weight tracking, and automatic medication reminders. It offers an electronic portal for accessing appointments and lab results, and a team of experts provides personalized diet and exercise plans and coaching for healthy habits. Application development has also progressed considerably, such as smartphones^{19,24,32-35,37}, Bluetooth that connects to other apps (weight measurement), and websites^{17,28,31}. The widespread ownership of mobile phones and laptops has dramatically facilitated the use of mobile applications and websites⁴². Choosing between a mobile app and a web app involves several considerations: time, cost, expertise, and security needs⁴³. Mobile apps offer features like geolocation and can work offline, while web apps are more accessible across devices and ideal for e-learning due to real-time updates⁴². Moreover, smartphone apps typically reach a broader community audience than websites⁴⁴.

The digital interventions being developed also utilize health education media, such as multimedia modules^{19,31,33}, motivational and supportive programs for smoking cessation³⁴, and health articles¹⁷, combined with links connected to health information³⁷. The study highlights the importance of personalized education in raising awareness about disease impacts to encourage behavior change. Effective health

education improves patients' self-management, exercise knowledge, and overall satisfaction^{45,46}. From these findings, education programs tailored to specific applications have effectively changed the behavior of hypertension patients.

The developed application was connected to a health-services account management system, facilitates patients to search for health services¹⁷, affords access to health record²¹, and uses an electronic portal to access appointments, purchase drugs, view laboratory results, make payments, and record blood pressure at home¹⁷. The findings suggest that developing applications requires collaboration with the health services used by patients. This collaboration can benefit patients and their families by helping them access health services while using digital health applications to improve their health. Users can receive expert support for personalized diet and exercise plans and coaching on healthy habits⁴⁷, collaborating with medical professionals and getting feedback from a conversational AI. In line with World Health Organization recommendations for managing hypertension, such as maintaining a low-salt diet, losing weight, and staying active, the app's features effectively address the specific needs of individuals with hypertension.

The review shows that intervention durations in various studies ranged from 2 to 12 months. One study noted no systolic or diastolic blood pressure change after 4 weeks on a high-sodium diet⁴⁸. Habits can be formed by consistently repeating an action in the same context, and small changes are encouraged to prevent discouragement. Typically, it takes about 10 weeks of daily repetition to establish a habit⁴⁹. The review suggests that promoting healthy behavior changes in patients with hypertension requires interventions of at least two months.

The application enhances self-management by boosting motivation and compliance with daily blood pressure measurements. Its goals include reducing blood pressure, decreasing salt intake, improving diet and medication adherence, and increasing physical activity. Regular use can help predict blood pressure and assist medical personnel in clinic management. Health coaching promotes educational videos to improve health and fitness among Saudi adults, while participant engagement is monitored to assess adherence to the program^{17-21,23-26,28-39,50,51}. These findings suggest that digital health apps can enhance patient adherence to diet and medication, reduce blood pressure, and modify health behavior.

CONCLUSION

This systematic review shows that hypertension guidelines vary by population. Smartphone applications effectively influence hypertension patients' behavior. Collaboration with health services is essential for creating applications that meet patient and family needs. The app includes blood pressure monitoring features, aligns with WHO standards, and

encourages behavior changes when used for at least two months. Digital health apps can also improve adherence to diet and medication, ultimately reducing blood pressure.

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AUTHOR CONTRIBUTION

Tristiana RD: Performed search strategy, review and writing the manuscript.

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