



Digital Health Technologies for Blood Pressure Monitoring and Hypertension Management: A Scoping Review

Rifkal Artha Yuda, S.Kep., Ners^{1*}, Pramudya Ratna Putri, S.Kep., Ners¹, Shilfa Caesarean, S.Kep., Ners¹

¹ Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia.

* Corresponding Author. Email: rifkalarthayuda16@gmail.com

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ABSTRACT

Background: Conventional healthcare systems rely on episodic care, limiting long-term hypertension management. Digital health technologies are promising alternatives, but evidence remains fragmented. **Purpose:** This scoping review mapped current evidence on digital health technologies for blood pressure monitoring and hypertension management. **Methods:** Guided by the Arksey and O'Malley framework and PRISMA-ScR guidelines, a comprehensive search was conducted in January 2026 across seven databases for English primary studies published between 2021 and 2026. **Results:** Twenty-five studies met the inclusion criteria, revealing four technology clusters: Remote Patient Monitoring (RPM), mHealth apps/digital education groups, IoT-enabled wearables, and AI-based systems. These interventions consistently improved blood pressure control, medication adherence, and self-care. However, barriers included patient disengagement, low digital literacy among older adults, privacy/cybersecurity concerns, inadequate system interoperability, and a lack of clear reimbursement policies. **Conclusion:** Digital health technologies significantly enhance hypertension management. Successful implementation demands human-centered design, supportive policies, interoperable infrastructure, equitable access, and professional well-being alongside technical innovation. **Implications for Nursing:** Nurses are critical in assessing digital literacy, coordinating remote monitoring, supporting patient self-management, and integrating standardized telenursing into routine hypertension care models.

Keywords: Blood pressure monitoring, Digital health technology, Hypertension, Remote patient monitoring.

What does this paper add?

1. This review provides a comprehensive synthesis of recent evidence on digital health technologies for hypertension monitoring, clarifying the range of tools used including remote monitoring, mobile health, telehealth, Internet of Things-based systems, and Artificial Intelligence.
2. The findings show that digital interventions not only improve blood pressure control, but also enhance medication adherence, self-care behaviors, health literacy, and patient engagement compared with usual care.
3. This paper identifies key implementation factors, such as digital literacy, usability, workflow integration, and financing that determine whether digital hypertension care can be successfully adopted in practice.
4. The review highlights the essential role of nurses in supporting patient education, remote monitoring, and sustained engagement to ensure effective and

equitable use of digital technologies in hypertension management.

Introduction

Hypertension represents one of the most significant global public health challenges and serves as a major risk factor for cardiovascular diseases and premature mortality worldwide (Mills et al., 2020). Over the past three decades, the prevalence of hypertension has risen substantially from approximately 650 million to 1.28 billion adults globally (Harris, 2023). However, this figure is not evenly distributed; rather, it is heavily concentrated in low- and middle-income countries (LMICs), particularly in Sub-Saharan Africa and South Asia. This geographical variation is driven by rapid urbanization, lifestyle changes, and the limitations of health systems in early detection and long-term chronic disease management (Adeyemo, 2025).

Although hypertension can be managed through available therapeutic interventions, blood pressure control rates remain low worldwide. Many individuals are unaware of their hypertensive status, and a substantial proportion of those who have been diagnosed fail to achieve optimal blood pressure targets (Zuin et al., 2025). This situation is associated with persistent clinical challenges in routine practice, including poor long-term medication adherence, difficulties in sustaining healthy lifestyle modifications, and limited capacity for continuous blood pressure monitoring (Parati et al., 2021). Conventional healthcare systems continue to rely primarily on infrequent clinic visits and episodic blood pressure measurements, resulting in limited longitudinal monitoring and delayed clinical responses. This model of care reflects a sporadic approach, characterized by discontinuous care, the absence of real-time data-driven management, and inadequate support for the long-term monitoring of chronic diseases (Milani et al., 2017).

In this context, digital health technologies—encompassing mobile health (mHealth) applications, telehealth, telemonitoring, home-based monitoring devices, wearable technologies, and artificial intelligence (AI)-driven systems—have emerged as an innovative approach to address the limitations of conventional care systems (Hu et al., 2025; Kario, 2020). By integrating these tools, digital interventions can improve patients' knowledge, support digital health education, and reinforce continuous self-monitoring

routines (Akhu-Zaheya et al., 2023).

Nevertheless, despite the rapid advancement of digital health technologies, the existing scientific evidence remains fragmented. This fragmentation is reflected in the diversity of technologies evaluated, variations in study designs, heterogeneity of reported outcomes (such as blood pressure control, treatment adherence, health literacy, and patient engagement), and differences in implementation across healthcare systems (Pellegrini et al., 2020). Furthermore, implementation-related aspects—including integration into clinical workflows, user acceptance, and the influence of social and healthcare system factors—have not yet been comprehensively synthesized (Abd-Alrazaq et al., 2025).

Several recent systematic reviews and meta-analyses have already attempted to evaluate these digital interventions. For instance, a systematic review by Motta-Yanac et al. (2025) synthesized the clinical efficacy of smartphone applications on blood pressure control. However, existing systematic reviews face inherent methodological restrictions; they predominantly focus on narrow clinical effectiveness—such as pooled effect sizes of blood pressure change—within specific technology subtypes, and often overlook broader variations in technological characteristics, system features, or non-clinical outcomes. Consequently, the wider evidence landscape regarding the interaction between advanced digital ecosystems and real-world implementation remains fragmented. This fragmentation is reflected in the high diversity of technologies evaluated, variations in study designs, heterogeneity of reported outcomes (such as self-efficacy, health literacy, and patient engagement), and unresolved operational factors across healthcare systems (Abd-Alrazaq et al., 2025; Pellegrini et al., 2020). Furthermore, while approximately 66% of the global population has internet access, adoption faces significant challenges related to the digital divide, including disparities in device access, variations in digital literacy, and structural healthcare infrastructure constraints that limit sustainability in resource-limited settings (Teke et al., 2026).

Therefore, a scoping review approach is uniquely justified over a standard systematic review to comprehensively map the wide, evolving spectrum of digital health technologies—ranging from basic SMS to intelligent AI systems. This methodology adds

significant value by capturing a heterogeneous mix of clinical and non-clinical outcomes, while systematically identifying cross-cutting implementation factors, user barriers (such as technophobia in older adults), and multi-level healthcare system determinants. Consequently, this review aims to map the current evidence on digital health technologies for blood pressure monitoring and hypertension management by identifying technology types, key features, clinical and behavioral outcomes, implementation strategies, and the diverse factors influencing their adoption across various healthcare settings.

Methods

Study Design

This study employed a scoping review methodology to map the existing scientific evidence on the use of digital health technologies for blood pressure monitoring and hypertension management. A scoping review was chosen, because it enables the identification and mapping of a broad range of evidence in a rapidly evolving field characterized by diverse intervention approaches. The primary objectives of this review were to identify the types of digital health technologies used in hypertension management, summarize the reported clinical and non-clinical outcomes, and examine the factors influencing their implementation. In this review, digital health technologies were defined as the use of digital tools to support blood pressure monitoring, patient education, communication, clinical decision-making, and hypertension management. Interventions included within this definition comprised telehealth, mobile health (mHealth), health applications, wearable devices, remote patient monitoring, the Internet of Things (IoT), and artificial intelligence (AI)-based systems.

Methodological Framework

This scoping review was conducted in accordance

with the methodological framework proposed by Arksey & O'Malley (2005) which comprises five stages: (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies that meet the eligibility criteria, (4) charting the data, and (5) collating, summarizing, and reporting the results. The reporting of this review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018). A methodological quality assessment or risk of bias appraisal was not performed, because the primary objective of a scoping review is to map the characteristics, types, and extent of the available evidence rather than to evaluate intervention effectiveness or generate pooled effect estimates, as is typically undertaken in a systematic review. This approach is consistent with the recommendations of the Arksey and O'Malley framework.

Research Question

This study aimed to answer the primary research question: How are digital health technologies utilized for blood pressure monitoring and hypertension management based on the available scientific evidence? To clarify the scope of the review, three sub-questions were formulated: (1) What types and characteristics of digital health technologies have been used for blood pressure monitoring and hypertension management? (2) What clinical and non-clinical outcomes have been reported from the use of digital health technologies? and (3) What barriers, facilitating factors, and implementation strategies have been identified for the adoption of digital health technologies in hypertension management?

PCC Framework

This review employed the Population-Concept-Context (PCC) framework to define the scope of the review.

Table 1. Population-concept-context (PCC) framework

Component	Description
Population	Adults diagnosed with hypertension.
Concept	The use of digital health technologies for blood pressure monitoring and hypertension management.
Context	Hypertension care and management in community and healthcare settings.

The PCC framework was used to develop the

literature search strategy, establish the inclusion and

exclusion criteria, and guide the study selection process. Only studies that met all predefined PCC components were included in this review.

Literature Search Strategy

The literature search was conducted in January 2026 across seven electronic databases: ScienceDirect, PubMed, ProQuest, Wiley Online Library, EBSCOhost, SAGE Journals, and SpringerLink. The selection of these seven electronic databases was strategically designed to optimize multi-disciplinary coverage across medical, technical, and behavioral healthcare literature. While individual indices, such as CINAHL, Scopus, and Web of Science were not directly queried, a comprehensive preliminary review indicated that a significant majority of core nursing and biomedical journals tracked by those platforms are widely cross-indexed and successfully retrieved through PubMed and EBSCOhost. Therefore, the utilized search strategy was

deemed sufficiently robust and efficient to capture the foundational evidence base while minimizing duplicate records across platforms.

The search was limited to full-text articles published in English between January 2021 and January 2026. This time frame was selected to capture the most recent evidence reflecting the rapid development and adoption of digital health technologies, particularly following the COVID-19 pandemic, including telehealth, mobile health (mHealth), wearable devices, artificial intelligence (AI), and remote patient monitoring. The search strategy employed a combination of keywords related to hypertension and digital health technologies, including hypertension, blood pressure monitoring, digital health, telehealth, mobile health, remote patient monitoring, wearable devices, and artificial intelligence. These keywords were combined using the Boolean operators AND and OR. The complete search strategies for each database are presented in Table 2.

Table 2. Search keywords

Database	Search strategy
PubMed	((("Hypertension"[Mesh] OR hypertens* OR "high blood pressure") AND ("Telemedicine"[Mesh] OR telemedicine OR telehealth OR telemonitor* OR "remote patient monitoring" OR "remote blood pressure monitoring" OR "remote monitoring" OR "Mobile Applications"[Mesh] OR mHealth OR "mobile health" OR app* OR "digital health" OR wearable* OR "Internet of Things" OR IoT OR "home blood pressure monitoring" OR "blood pressure self-monitoring" OR SMBP OR "Artificial Intelligence"[Mesh] OR "artificial intelligence" OR AI OR "clinical decision support" OR "decision support"))
ProQuest, EBSCOHost	(hypertension* OR "high blood pressure") AND ("digital health" OR mHealth OR "mobile health" OR app* OR telemedicine OR telehealth OR telemonitor* OR "remote patient monitoring" OR "remote blood pressure monitoring" OR "remote monitoring" OR wearable* OR "home blood pressure monitoring" OR "blood pressure self-monitoring" OR SMBP OR "Internet of Things" OR IoT OR "artificial intelligence" OR AI OR "clinical decision support" OR "decision support")
ScienceDirect, Wiley Online Library, Sage Journals, SpringerLink	(hypertension* OR "high blood pressure") AND ("digital health" OR mHealth OR "mobile health" OR app* OR telemedicine OR telehealth OR telemonitor* OR "remote patient monitoring" OR "remote blood pressure monitoring" OR "remote monitoring" OR wearable* OR "blood pressure monitor*" OR "home blood pressure monitoring" OR "blood pressure self-monitoring" OR SMBP OR "Internet of Things" OR IoT OR "artificial intelligence" OR AI OR "clinical decision support" OR "decision support")

Inclusion and Exclusion Criteria

Studies were included in this scoping review if they were primary research employing quantitative, qualitative, or mixed-method designs; involved adults

diagnosed with hypertension; and evaluated the use of digital health technologies for blood pressure monitoring or hypertension management. Eligible articles were required to be available in full text,

published in English, and published between January 2021 and January 2026. Studies were excluded if they were review articles, editorials, commentaries, letters to the editor, or study protocols. Studies were also excluded if they did not focus on hypertension, did not evaluate digital health technologies as the primary component of the intervention, or did not report outcomes relevant to the objectives of this review.

Study Selection

The articles retrieved from the database searches were imported into Rayyan to facilitate the screening process. Duplicate records were identified and removed using Rayyan's built-in deduplication feature. Subsequently, two reviewers independently screened the titles and abstracts according to the predefined inclusion and exclusion criteria. Articles that met the eligibility criteria or were considered potentially relevant proceeded to the full-text review stage. Any disagreements between the two reviewers were resolved through discussion until consensus was reached. When consensus could not be achieved, a third reviewer made the final decision. The entire study selection process was documented using the PRISMA Extension for Scoping Reviews (PRISMA-ScR) flow diagram (Tricco et al., 2018), which reports the number of records identified, screened, assessed for eligibility, and ultimately included, along with the reasons for exclusion at the full-text review stage.

Data Analysis and Synthesis

The extracted data was analyzed descriptively and synthesized using a narrative approach. Findings from the included studies were compared to identify similarities and differences in the characteristics of digital health technologies, reported outcomes, implementation strategies, and factors influencing the adoption of these technologies. The synthesized findings were subsequently organized into key themes based on similarities in intervention characteristics, reported outcomes, and the primary focus of each study.

Results

Selection of Sources of Evidence

A comprehensive literature search was conducted across seven indexed electronic databases. The initial search identified 487 records from PubMed, 396 from ScienceDirect, 411 from ProQuest, 121 from SAGE

Journals, 995 from SpringerLink, 158 from Wiley Online Library, and 943 from EBSCOhost, yielding a total of 3,511 potentially relevant records. After the removal of 1,000 duplicate records, 2,511 articles remained for the screening stage. During title and abstract screening, 2,238 articles were excluded, because the preliminary information clearly indicated that they did not meet the review objectives. Specifically, these studies either did not evaluate digital health interventions or did not focus on hypertension as the primary condition of interest.

Full-text reports were sought for 273 records, though 10 could not be retrieved due to institutional subscription or publisher limitations. The remaining 263 articles were assessed for eligibility, and 238 were excluded for the following reasons: irrelevant population or non-essential hypertension ($n = 90$); irrelevant concepts or unassessed digital health effectiveness ($n = 75$); ineligible healthcare or community contexts ($n = 45$); study protocols without empirical findings ($n = 12$); conference abstracts lacking complete quantitative data ($n = 11$); and clinical guidelines or opinion papers without primary data ($n = 5$). Ultimately, 25 primary studies met all eligibility criteria and were included in the final synthesis to ensure a rigorous and robust evidence base. The selection process is illustrated in the diagram shown in Figure 1.

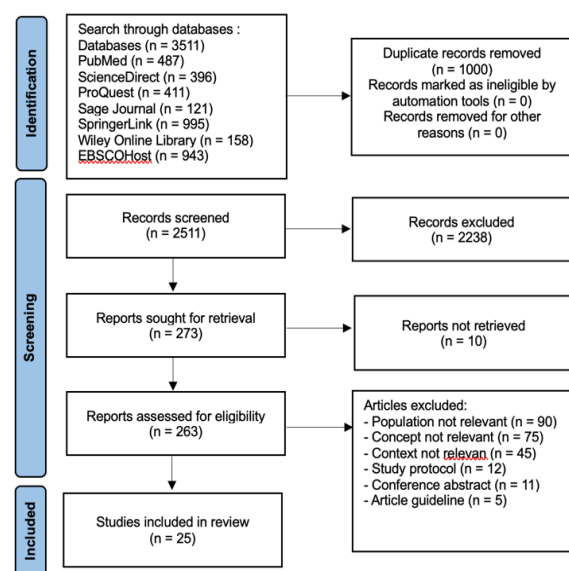


Figure 1. Study selection process

Characteristics and Geographical Distribution of the Included Studies

Ultimately, 25 primary studies published between

2021 and 2026 met all explicit eligibility criteria and were included in the final synthesis. Geographically, the evidence base represents a highly diverse global landscape spanning high-income nations and developing healthcare systems, including the United States, China, Indonesia, Türkiye, South Korea, Taiwan, Germany, Saudi Arabia, Iran, Russia, Australia, Singapore, and the United Kingdom. This extensive distribution provides a multifaceted perspective on digital adoption, contrasting highly centralized clinical infrastructures with emerging mobile health frameworks. The cumulative sample size across these studies exceeds 9,000 participants, reflecting a wide spectrum of clinical population densities. Individual study samples ranged from tight, data-rich qualitative cohorts of 21 participants designed to uncover deep user-experience barriers, to large registry-based retrospective cohorts of up to 5,432 individuals that provided substantial statistical power for hard clinical endpoints.

Methodologically, the synthesis incorporates a robust and heterogeneous mix of research designs to effectively

triangulate quantitative clinical efficacy and qualitative implementation realities. The quantitative paradigm is heavily represented by 5 randomized controlled trials, which serve as the methodological benchmark for evaluating digital blood pressure control, alongside 9 quasi-experimental studies capturing real-world clinical applications and pre-post intervention dynamics. Broader programmatic trends are mapped through 2 retrospective cohorts and 2 cross-sectional studies, while the integration of 3 qualitative evaluations and 3 mixed-method studies successfully bridges the gap between clinical endpoints and localized contextual barriers. Additionally, the inclusion of 1 individualized N-of-1 trial highlights the growing paradigm of hyper-personalized digital medicine. Operationally, the intervention durations ranged from short-term acute tracking periods of 4 weeks to longitudinal self-management surveillance lasting up to 12 months, offering critical insights into immediate user engagement and long-term sustainability, with comprehensive study profiles systematically detailed in Table 3.

Table 3. Characteristics of included studies and main findings

No.	Author(s) (Year)	Country	Study Design & Setting	Participants (N)	Digital Intervention (Duration)	Main Outcomes
1	Eze et al. (2024)	USA	Cross-sectional study; outpatient clinic	Adults with hypertension (N = 412)	Remote Blood Pressure Monitoring (RBPM), 3 months	Participation in remote monitoring was influenced by technology usability and behavioral factors.
2	Yilmaz & Yakut (2025)	Türkiye	Quasi-experimental study; hospital/clinic	Patients with chronic hypertension (N = 151)	Telenursing, 8 weeks	Reduced systolic blood pressure and improved self-care ability.
3	Xu et al. (2024)	China	Observational study; community/cardiac center	Older adults with hypertensive heart disease (N = 185)	IoT-based management, 6 months	Improved self-management and clinical prognosis.
4	Letzelter et al. (2024)	USA	Observational cohort; remote monitoring setting	Patients with essential hypertension (N = 1,250)	Remote Patient Monitoring (RPM), 12 months	Higher engagement was associated with more stable blood pressure reduction.
5	May et al. (2025)	United Kingdom	Qualitative study; primary care and clinics	Healthcare professionals (N = 24)	mHealth application (single evaluation)	Technology acceptance depended on workflow integration and reimbursement support.
6	Zhao et al. (2025)	China	Open-label cluster-randomized controlled trial; 8 rural villages	Adults with uncontrolled hypertension (N = 95)	WeChat mini-program “eKongya” (blood pressure logging, education, online consultations), 24 weeks	Notable reduction in mean systolic blood pressure and increased hypertension control rate in rural areas.
7	Hermansyah et al. (2025)	Indonesia	Quasi-experimental study; community health center	Adults with hypertension (N = 84)	mHealth application, 4 weeks	Increased patient knowledge and medication adherence.

8	Cho & Park (2024)	South Korea	Quasi-experimental study; elderly community center	Older adults with hypertension (N = 95)	App-based telenursing, 12 weeks	Improved self-care behaviors and blood pressure stability.
9	Nau et al. (2021)	USA	Quasi-experimental study; primary healthcare clinic	Adults with hypertension (N = 150)	SMS-, web-, and video-based mHealth, 3 months	Supported lifestyle modification and blood pressure control.
10	Upoyo et al. (2024)	Indonesia	Quasi-experimental study; community setting	Patients with hypertension (N = 90)	WhatsApp-based education group, 4 weeks	Improved blood pressure, knowledge, motivation, self-efficacy, and self-care.
11	Liu et al. (2023)	China	Randomized controlled trial; healthcare center	Patients with primary hypertension (N = 297)	Android-based mHealth application, 3 months	Increased motivation for self-management and healthy behaviors.
12	Chen et al. (2025)	Taiwan	Quasi-experimental study; urban community center	High-risk and hypertensive individuals (N = 175)	Home Blood Pressure Monitoring (HBPM) + WaCare telemonitoring, 6 months	Improved blood pressure control, knowledge, attitudes, and self-management.
13	Xie et al. (2026)	China	Retrospective analysis; integrated care center	Patients with chronic hypertension (N = 102)	Intelligent Hypertension Diagnosis and Treatment Center (IHDTTC), 6 months	Improved blood pressure control, medication adherence, knowledge, quality of life, and reduced anxiety/depression.
14	Al Fraidan (2025)	Saudi Arabia	N-of-1 trial / case study; specialized clinic	Adults with hypertension (N = 60)	GPT-4-based AI assistant, 2 months	Provided emotional support and reinforced healthy behaviors.
15	Wang et al. (2025)	China	Randomized controlled trial; outpatient hospital	Patients with hypertension (N = 140)	Telehealth/mHealth platform, 3 months	Improved patient-reported outcomes and reduced blood pressure.
16	Karami et al. (2023)	Iran	Quasi-experimental study; cardiology outpatient clinic	Patients with hypertension (N = 98)	Programmed mHealth instruction, 3 months	Improved health literacy, medication adherence, and blood pressure control.
17	Smith et al. (2024)	USA	Retrospective cohort; electronic health records	Patients with chronic hypertension (N = 5,432)	RPM integration, 12 months	Associated with lower mortality risk and fewer hospital readmissions.
18	Bozorgi et al. (2021)	Iran	Quasi-experimental study; cardiac outpatient clinic	Patients with hypertension (N = 115)	Blood pressure management mobile application, 3 months	Improved medication adherence, dietary compliance, physical activity, and home monitoring.
19	Wengemuth et al. (2025)	Germany	Mixed-methods study; community setting	Hypertensive patients using IoT devices (N = 205)	Home IoT system, 6 months	Technology use was influenced by routines, financial resources, attitudes toward technology, and social support.
20	Eze et al. (2023)	USA	Quasi-experimental study; primary care clinic	Patients with hypertension (N = 130)	Telemonitoring using eHealth Literacy Framework, 4 months	Improved blood pressure control; implementation was influenced by knowledge, motivation, skills, systems, and behavior.
21	Song et al. (2021)	Australia	Qualitative thematic analysis; focus group/interview	35 participants (24 patients and 11 healthcare providers)	mHealth smartphone application, 3 months	Enhanced self-management support and promoted behavior change.
22	Solmaz & Altay (2024)	Türkiye	Randomized controlled trial; home care setting	Older adults with hypertension (N = 90)	IoT medication reminder smartwatch, 8 weeks	Improved medication adherence, self-care, and blood pressure reduction.

23	Ionov et al. (2021)	Russia	Multicenter randomized controlled trial; clinical setting	High-risk hypertensive patients (N = 350)	RPM with telemonitoring and counseling, 6 months	Improved blood pressure reduction, target achievement, quality of life, and cost-effectiveness.
24	Teo et al., (2023)	Singapore	Qualitative evaluation study; home setting	13 patients & 8 healthcare professionals	IoT + RPM intervention, 3 months	Improved monitoring habits, self-management capacity, and perceived security.
25	Heredia et al. (2025)	USA	Mixed-methods/descriptive quantitative study	Patients with hypertension (N = 47)	RPM deployment, 6 months	Technology was acceptable and easy to use; adoption was influenced by age and behavioral intention.

Thematic Analysis and Technology Clusters

To address the objectives of this review in an integrated manner and avoid fragmented reporting of the evidence, the findings from the 25 included primary studies were synthesized according to specific categories of digital health technologies. Each technology category was analyzed in terms of its implementation context, clinical effectiveness, and impact on patient behavior, as conceptually summarized in Table 3.

Remote Patient Monitoring (RPM) and Telemonitoring

Remote Patient Monitoring (RPM) and Remote Blood Pressure Monitoring (RBPM) emerged as the most prominent digital health modalities for supporting long-term clinical stability in hypertension management. A key characteristic of these technologies is their ability to automatically transmit patients' blood pressure data in real time from the home environment to healthcare providers through digital monitoring platforms or clinical dashboards (Chen et al., 2025; Eze et al., 2024; Letzelter et al., 2024). Clinically, RPM has been shown to effectively maintain sustained blood pressure reduction by enabling healthcare professionals to adjust treatment promptly in response to changes in patients' blood pressure readings (Ionov et al., 2021). At the population level, large-scale implementation of RPM over an extended period (12 months) demonstrated the greatest clinical benefit, significantly reducing mortality risk and hospital readmission rates among patients with hypertension (Smith et al., 2024). From a behavioral perspective, RPM promoted consistent self-monitoring practices and enhanced patients' psychological sense of security by providing reassurance that they remained under continuous supervision by healthcare professionals (Teo et al., 2023).

Mobile Health (mHealth) Applications and Digital Education Groups

Mobile health (mHealth) applications and digital communication platforms (e.g., WhatsApp groups, SMS) are widely used to promote independent health behavior changes in hypertension patients. Unlike Remote Patient Monitoring (RPM), which requires clinical infrastructure, mHealth focuses on upstream care: patient education, health literacy, self-monitoring, and medication reminders (Bozorgi et al., 2021; Karami et al., 2023; Yilmaz & Yakut, 2025). Structured mHealth interventions are prominently linked to enhanced medication adherence and reductions in systolic blood pressure (Zhao et al., 2025), while supporting self-management and behavioral changes (Song et al., 2021). Similarly, familiar platforms, like WhatsApp-based educational groups, effectively enhance patient motivation, health knowledge, and self-efficacy in adopting healthy lifestyles, such as physical activity and low-sodium diets (Hermansyah et al., 2025; Nau et al., 2021; Upoyo et al., 2024).

Internet of Things (IoT), Wearable Devices, and Telenursing

Digital nursing interventions offer a patient-centered approach for older adults by integrating Internet of Things (IoT)-enabled wearables and structured telenursing. Combined application-based telenursing and direct nursing interventions significantly reduce systolic blood pressure and improve self-care capacity among community-dwelling older adults with hypertension (Cho & Park, 2024; Yilmaz & Yakut, 2025). Additionally, IoT innovations, like smartwatches with digital medication reminders, simplify daily self-management. In a clinical trial (n = 90), this technology significantly improved medication adherence, self-care

behaviors, and blood pressure control (Solmaz & Altay, 2024). These IoT-enabled technologies also demonstrate favorable prognostic outcomes, particularly for hypertensive patients with coexisting chronic cardiovascular diseases (Xu et al., 2024).

Intelligent Systems and Artificial Intelligence (AI)

Recent hypertension management has increasingly shifted toward personalized care through artificial intelligence (AI). A retrospective analysis of the Intelligent Hypertension Diagnosis and Treatment Center (IHDTCT) demonstrated that AI technology improves blood pressure control and enhances quality of life by reducing anxiety and depression symptoms in chronic hypertension patients (Xie et al., 2026). Additionally, generative AI-based conversational assistants (e.g., GPT-4) serve as accessible digital companions that complement conventional care. Evidence from an N-of-1 case study suggests that these systems promote positive health behaviors while providing continuous, interactive, and geographically accessible emotional support for better condition management (AI Fraidan, 2025).

Implementation Barriers and Human Determinants

The synthesis reveals that regardless of technological advancement, clinical effectiveness ultimately depends on human factors. At the individual level, sustained engagement with Remote Patient Monitoring (RPM) and mHealth interventions is strongly influenced by patients' digital literacy, age, and routine integration. For instance, a descriptive study (n

= 47) found that older adults frequently experience anxiety when using unfamiliar digital devices, which negatively affects technology adoption (Eze et al., 2024; Heredia et al., 2025).

Beyond individual characteristics, social ecosystem factors—including active family support, financial resources for devices and internet access, and effective clinician-patient communication—are key determinants of sustained digital health technology use (Wengemuth et al., 2025). At the healthcare system level, professional acceptance largely depends on seamless workflow integration without increasing workloads, alongside clear reimbursement policies and government or institutional regulatory support (Eze et al., 2023; May et al., 2025).

Synthesis of Findings by Outcome Themes

To comprehensively evaluate digital health technologies in hypertension management, findings from the 25 included studies were synthesized using thematic analysis. Based on data characteristics, clinical focus, and intervention outcomes, the evidence was organized into five major outcome themes: blood pressure control and clinical stability; medication adherence and self-management; reduction in mortality and hospitalization; quality of life and psychological well-being; and determinants and barriers influencing technology implementation. The distribution of supporting studies, technology categories, and a summary of findings for each theme are presented in Table 4.

Table 4. Thematic synthesis of digital health interventions for hypertension management

No.	Thematic Outcome Area	Digital Technology Categories	Supporting Studies	Synthesized Findings
1	Blood Pressure Control and Clinical Stability	Telenursing, mHealth, RPM, Telemonitoring	Yilmaz & Yakut (2025); Letzelter et al. (2024); Zhao et al. (2025); Cho & Park (2024); Nau et al. (2021); Upoyo et al. (2024); Chen et al. (2025); Xie et al. (2026); Wang et al. (2025); Karami et al. (2023); Eze et al. (2023); Solmaz & Altay (2024); Ionov et al. (2021)	Digital interventions consistently supported blood pressure reduction and improved achievement of treatment targets through continuous monitoring, remote feedback, and structured follow-up.

2	Medication Adherence, Self-Care, and Self-Management	mHealth applications, IoT-based reminder devices, Telehealth education, WhatsApp-based programs	Yilmaz & Yakut (2025); Xu et al. (2024); Liu et al. (2023); Hermansyah et al. (2025); Cho & Park (2024); Upoyo et al. (2024); Chen et al. (2025); Karami et al. (2023); Bozorgi et al. (2021); Song et al. (2021); Solmaz & Altay (2024); Teo et al. (2023)	Digital technologies enhanced medication adherence, health literacy, self-efficacy, dietary compliance, physical activity, and overall self-management behaviors among patients with hypertension.
3	Reduction in Mortality and Hospitalization Risk	Remote Patient Monitoring (RPM)	(Smith et al., 2024)	Long-term RPM implementation was associated with lower mortality risk and reduced hospital readmissions, indicating potential long-term clinical benefits.
4	Quality of Life and Psychological Well-Being	AI-based assistant systems, Intelligent Hypertension Centers, Telehealth	Xie et al. (2026); Al Fraidan (2025); Wang et al. (2025); Ionov et al. (2021)	Digital interventions contributed to improved quality of life, better patient-reported outcomes, emotional support, and reductions in anxiety and depression.
5	Implementation Determinants, Acceptability, and Adoption Barriers	RPM, IoT, mHealth, Telemonitoring	Eze et al. (2024); May et al. (2025); Wengemuth et al. (2025); Eze et al. (2023); Teo et al. (2023); Heredia et al. (2025)	Successful implementation depended on technology usability, digital literacy, age, workflow integration, financial resources, healthcare provider engagement, and family or social support. Human-related factors remained critical determinants of technology adoption and sustained use.

Discussion

Clustering and Evidence Mapping of Digital Health Interventions

This scoping review mapped the characteristics, effectiveness, and implementation barriers of digital health technologies for hypertension management across 25 included studies. Interventions were categorized into four technology clusters: Remote Patient Monitoring (RPM)/telemonitoring, mobile health (mHealth) applications, Internet of Things (IoT)-enabled wearables, and Artificial Intelligence (AI)-based systems. Findings indicate that global digital health transformation in hypertension management is non-uniform. Technology adoption remains highly heterogeneous, primarily shaped by regional digital infrastructure readiness, geographical contexts, and patient sociodemographic characteristics.

Clinical Effectiveness in Blood Pressure Control and Limitations of Long-Term Evidence

Digital health technologies, particularly Remote Blood Pressure Monitoring (RBPM) and IoT-based systems, reduce systolic blood pressure more effectively than conventional care (Letzelter et al., 2024; Xu et al., 2024). From a methodological perspective, this advantage is largely attributable to the ability of digital monitoring technologies to minimize measurement bias associated with the *white-coat hypertension* and *masked*

hypertension phenomena by continuously collecting real-time blood pressure data (Xu et al., 2024). Moreover, combining telemonitoring with telenursing interventions improves quality of life, enhances clinical precision, and is associated with lower rates of mortality and major cardiovascular complications (Ionov et al., 2021; Letzelter et al., 2024; Smith et al., 2024; Wang et al., 2025; Yilmaz & Yakut, 2025; Zhao et al., 2025).

Despite promising findings, the effectiveness of digital health interventions is not conclusive. Several evaluated studies reported null or non-significant statistical differences in blood pressure reduction compared to standard care, particularly when tools lacked personalized feedback or clinical oversight (Karami et al., 2023; Wengemuth et al., 2025). Moreover, due to a "novelty effect," initial patient engagement and daily data logging frequently suffer from high attrition, declining drastically within 4 to 12 weeks due to alert fatigue and the manual burden of data entry (Karami et al., 2023; Liu et al., 2023).

Technology adoption also triggers unintended negative consequences; continuous monitoring can inadvertently elevate psychological distress, causing anxiety and "data obsession" as patients over-analyze minor blood pressure fluctuations (Xie et al., 2026). Consequently, reported blood pressure reductions must be interpreted cautiously. Currently, robust evidence for sustained clinical outcomes is primarily limited to large-

scale observational cohort studies (Smith et al., 2024) which highlight critical clinical correlations rather than definitive causal effects.

The Role of mHealth in Health Literacy and Self-Care

Behaviorally, mHealth applications and digital platforms (e.g., WeChat mini-programs, WhatsApp groups) effectively improve digital health literacy and self-care capacity (Hermansyah et al., 2025; Upoyo et al., 2024). Structured mHealth interventions—such as SMS reminders, Android applications, and educational videos—reduce forgetfulness, a primary barrier to chronic disease treatment adherence (Liu et al., 2023; Nau et al., 2021). By overcoming geographical barriers, these tools help establish regular blood pressure and vital signs of self-monitoring routines (Zhao et al., 2025). Qualitative evidence highlights that mHealth empowers patients to manage their conditions actively (Song et al., 2021), while continuous monitoring fosters a psychological sense of professional support, indirectly enhancing medication adherence and sustained lifestyle modifications (Letzelter et al., 2024).

However, improvements in patient motivation and self-management are not automatic. Their effectiveness depends largely on technology usability, particularly user interface quality and timely, meaningful feedback (Liu et al., 2023). When platforms lack intuitive blood pressure trend visualizations, patients struggle to understand their clinical progress. Evidence indicates that poor data visualization and overly repetitive reminders contribute to psychological fatigue and reduced engagement (Karami et al., 2023). Consequently, rather than empowering patients, technologies that are difficult to use or disruptive to daily routines can diminish self-efficacy and increase intervention discontinuation rates (Chen et al., 2025; Liu et al., 2023).

Human Factors and Barriers to Digital Health Adoption among Older Adults

A major limitation in current digital health discourse is overlooking the physical and psychological barriers experienced by older adults, despite this population having the highest hypertension prevalence. A significant challenge is technophobia, where older patients experience anxiety, unfamiliarity, and fear of technical mistakes damaging the devices. Evidence

suggests that psychological readiness and user willingness to engage with technology are more influential in determining successful adoption than the technological sophistication of the intervention itself (Eze et al., 2024; Heredia et al., 2025).

These challenges are compounded by age-related cognitive decline, which hinders older adults from navigating complex, multi-step mobile interfaces. Additionally, physical and sensory impairments—such as presbyopia-related vision loss and hand tremors—pose substantial obstacles. Although IoT innovations, like smartwatches, improve medication adherence (Solmaz & Altay, 2024), small fonts and poorly responsive interfaces increase data-entry errors. Without age-friendly designs and active family support, digital health innovations may inadvertently widen the digital divide, limiting older adults' equitable access to healthcare services (Cho & Park, 2024).

Systemic, Operational, and Ecosystem Challenges in Digital Health Implementation

The long-term sustainability of digital transformation in hypertension management faces substantial systemic and operational challenges. A significant barrier is the lack of platform interoperability; the absence of standardized data systems forces nurses to manually re-enter patient data into electronic health records, increasing clinical workload and reducing workflow efficiency (May et al., 2025). This challenge is further complicated by the emergence of intelligent systems, such as the Intelligent Hypertension Diagnosis and Treatment Center (IHDTTC). While the IHDTTC demonstrates potential in retrospectively identifying cardiovascular risk and potentially alleviating patient psychological distress (Xie et al., 2026), routine clinical implementation of AI-driven systems remains constrained by ethical considerations, multidisciplinary collaboration needs, concerns regarding algorithm reliability and transparency, and the limited availability of high-quality evidence beyond N-of-1 case studies (Al Fraidan, 2025).

In addition, wireless data transmission from patients' homes raises cybersecurity and data privacy concerns, particularly in countries with underdeveloped medical data regulations. Operational challenges are exacerbated by infrastructure disparities; advanced systems, such as the WaCare telemonitoring platform, perform optimally in urban settings with reliable connectivity (Chen et al.,

2025; Wengemuth et al., 2025). Conversely, rural implementation is frequently hindered by limited network coverage, high internet costs, and unstable electricity. Financially, the absence of formal reimbursement policies for telenursing and AI-assisted care forces patients or financially constrained healthcare institutions to absorb the costs of digital devices and technologies (May et al., 2025).

Implications for Nursing

The findings highlight the evolving role of nurses as coordinators of digital care in hypertension management. Before implementation, nurses should assess patients' digital health literacy using standardized instruments, such as the eHealth Literacy Framework, to ensure that interventions match individual capabilities (Eze et al., 2023). Additionally, developing standardized operating procedures (SOPs) for telenursing is essential to define clinical thresholds, escalation protocols, and referral pathways for safe home-based monitoring (Teo et al., 2023). However, digital adoption presents operational challenges: system interoperability issues force duplicate manual documentation, increasing administrative workloads and the risk of occupational fatigue or burnout among frontline staff (May et al., 2025). Therefore, it is highly recommended that nursing organizations and healthcare regulators consider establishing standardized competencies for telenursing, developing clear regulatory and legal frameworks, and promoting the integration of community-based digital health interventions to support long-term patient adherence and continuity of care.

Implications for Future Research

This scoping review identifies several critical evidence gaps to guide future nursing research. First, longitudinal studies exceeding one-year follow-ups are needed to evaluate the long-term clinical and cost-effectiveness of digital health interventions. Second, future research should focus on developing age-friendly IoT technologies that accommodate older adults' cognitive and physical limitations, while examining the impact of digital tools on nurses' occupational stress and burnout. Finally, greater attention must be directed toward establishing robust cybersecurity standards and strengthening telenursing regulatory frameworks, particularly in low- and middle-income countries. Accordingly, future research should transcend

technological innovation alone, focusing instead on developing digital health ecosystems that are patient-centered, inclusive of vulnerable populations, and supportive of healthcare professionals' well-being.

Limitations

Several methodological limitations must be considered when interpreting these findings. First, the search was restricted to full-text primary studies published in English, potentially omitting relevant research in other languages or indexed in excluded databases. Second, consistent with scoping review methodology, this study did not perform a formal quality appraisal or risk-of-bias assessment of the included literature. Consequently, variations in methodological rigor and internal validity across the evaluated digital health interventions were not systematically analyzed or compared.

Conclusions

Evidence from the 25 included studies indicates that digital health technologies—spanning RPM, mHealth, IoT solutions, and AI-driven systems—are prominently associated with positive trends in systolic blood pressure reduction and enhanced patient self-care. However, global digital transformation in hypertension management remains non-uniform. Clinical effectiveness depends heavily on human factors and healthcare infrastructure readiness. Key implementation challenges include a lack of long-term evidence, patient disengagement, cognitive and physical barriers among older adults, poor system interoperability, and the absence of clear reimbursement policies. Ultimately, successful digital health integration demands a shift beyond mere technological innovation toward patient-centered implementation strategies, supportive health system policies, and sustainable digital infrastructure.

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Conflict of Interests

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