

Global Research Trends in Digital Health Applications for Enhancing Hypertension Patient Adherence: A Bibliometric Analysis

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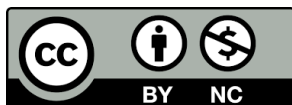
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ABSTRACT

Background: This study aims to examine global research trends on the use of digital applications for improving adherence among patients with hypertension through a bibliometric approach.

Methods: This study employed a bibliometric analysis using a PRISMA-guided systematic approach. Data were retrieved from the Scopus database through a TITLE-ABS-KEY search using Boolean combinations related to hypertension, digital health technologies, and patient adherence. The search covered publications from 2016 to 2025. After duplicate removal, screening, eligibility assessment, and inclusion procedures, 50 articles met the predefined criteria. The selected records were exported in CSV format, and data cleaning and keyword normalization were performed prior to analysis. Bibliometric mapping, including network, overlay, and density visualizations, was conducted using VOSviewer to identify research trends, thematic structures, and keyword relationships.

Results: A total of 50 articles were analyzed. The results showed a marked increase in publications after 2019, reflecting growing global interest in digital health applications for hypertension adherence. Network visualization identified patient, medication adherence, and self-management as the most prominent research themes. Overlay visualization indicated a shift from basic mobile-phone-based interventions toward telemedicine, mHealth, and remote monitoring technologies. Density visualization showed that adherence-related topics remain the dominant focus, while nursing-related digital health interventions and integrated monitoring technologies represent emerging areas for future research.

Conclusion: This study shows that the use of digital applications plays an important role in improving the compliance of hypertensive patients and continues to develop towards integrating more complex technology. This finding provides a basis for the development of innovative strategies in hypertension management based on digital technology.

Keywords: Hypertension; Digital health; Mobile health; Compliance treatment; Bibliometric analysis; Telemedicine; Management independent; Patient involvement

INTRODUCTION

Hypertension is one of the significant global health problems and is a main risk factor for cardiovascular disease, stroke, and early death. The prevalence of hypertension continues to increase all over the world, requiring an effective and sustainable management strategy. One of the main challenges in managing hypertension is low patient compliance with treatment and recommended lifestyle changes (1).

Patient compliance with hypertension therapy is very important to achieve optimal blood pressure control. However, various studies show that many patients do not follow the treatment regimen consistently, which results in increased disease complications and burden on the health system. This non-compliance is often caused by a lack of understanding, motivation, and limitations in monitoring health conditions independently (1).

In recent years, the development of digital technology has opened new opportunities to improve patient compliance. Mobile-based health applications, or mobile health (mHealth), are some of the many innovations used in managing chronic diseases, including hypertension. This technology allows patients to monitor blood pressure, arrange treatment schedules, and receive health education in real time (2).

Use of smartphone-based applications for managing hypertension has long been developed and shows potential to improve monitoring as well as patient compliance (3). Studies show that intervention-based applications can significantly increase compliance levels and assist patients in managing their health conditions independently (4). In addition, digital applications can also enhance patient involvement in the care process through interactive features and personalized services.

In addition to improving compliance, digital applications also contribute to controlling blood pressure. Several studies have shown that using mHealth applications can significantly lower systolic and diastolic blood pressure through regular monitoring and treatment reminders (4). This indicates that digital technology not only impacts patient behavior but also clinical outcomes.

Developments in the field of mHealth have shown a rapid increase in recent years. Bibliometric analyses have previously disclosed that the number of publications related to mobile health applications continues to increase globally, with a focus on managing chronic diseases and improving treatment compliance (5). This reflects the growing attention of researchers toward the utilization of digital technology in the health field.

Moreover, research trends also indicate the existence of topic diversification, such as the use of telemedicine, wearable devices, and artificial intelligence in hypertension management. This technology allows for remote patient monitoring as well as more accurate and faster clinical decision-making (6). The integration of various technologies has the potential to significantly increase the effectiveness of health interventions.

Although there is potential, the implementation of digital applications in clinical practice still faces various challenges. Some studies show that the level of adoption by healthcare providers is still limited, especially because of a lack of information, training, and integration with existing health service systems (7). In addition, factors such as digital literacy and data security are also important concerns.

From the patient's perspective, mHealth applications are assessed as useful in supporting self-management of hypertension, including monitoring blood pressure and lifestyle changes. However, the successful use of these applications is highly dependent on the level of user involvement as well as the convenience of using the application (8). Therefore, user-friendly design is an important factor in increasing the effectiveness of the intervention.

Although research on digital applications in hypertension management has grown rapidly, important gaps remain in the existing bibliometric literature. Previous bibliometric studies have examined hypertension research, digital health interventions, or mHealth applications separately, but few have specifically focused on the intersection between digital health applications, hypertension management, patient adherence, self-management, and nursing-related approaches. Most existing studies have emphasized publication trends or the effectiveness of individual interventions

without comprehensively mapping the conceptual relationships and thematic evolution of adherence-oriented digital health strategies.

A comprehensive understanding of these research trends is essential for identifying dominant themes, scientific collaboration networks, emerging technologies, and underexplored areas that may guide future research and clinical innovation. Bibliometric analysis provides a systematic method for evaluating publication growth, mapping conceptual relationships, and identifying future research opportunities.

To the best of our knowledge, no previous bibliometric study has comprehensively mapped the intersection between digital health applications, hypertension management, patient adherence, self-management, and nursing-oriented interventions within the global scientific literature. This study therefore offers a novel contribution by integrating these dimensions into a single bibliometric mapping of global research trends and by identifying the knowledge structure, thematic evolution, and emerging research directions related to adherence-oriented digital health strategies in hypertension management.

Therefore, this study aims to analyze global research trends in digital health applications for improving adherence among patients with hypertension using a bibliometric approach. The findings are expected to provide valuable insights for researchers, nurses, healthcare professionals, and policymakers in developing more effective and sustainable digital health interventions for hypertension care.

Recent bibliometric studies have examined digital health or hypertension separately, but few have specifically mapped the intersection between digital health applications, hypertension, patient adherence, and nursing related approaches. In addition, previous studies have generally focused on broader digital health trends without providing a detailed analysis of adherence oriented interventions in hypertension management. Therefore, this study offers a novel contribution by integrating these dimensions into a single bibliometric mapping of global research trends.

METHODS

This research uses a bibliometric approach combined with a systematic framework to identify, filter, and analyze scientific literature related to the use of digital applications in improving compliance among hypertensive patients. This approach was chosen because it is capable of providing a quantitative and visual description regarding research trends, collaboration patterns, as well as the development of scientific themes globally (9).

The primary data source for this study was the Scopus database, which was selected because of its broad coverage of peer-reviewed health science journals, extensive citation indexing, and comprehensive bibliographic metadata that support robust bibliometric analysis. The literature search was conducted using a structured Boolean query applied to the TITLE-ABS-KEY field, covering the concepts of hypertension, digital health technologies, and patient adherence.

Before analysis, the dataset underwent a data cleaning and preprocessing procedure. Duplicate records were removed, and author keywords were standardized to minimize inconsistencies. Synonymous terms such as mHealth, mobile health, and mobile-health were merged into a single keyword category, while related terms such as telemedicine/telehealth and adherence/compliance were normalized to improve the reliability of the keyword co-occurrence analysis. These procedures were performed to enhance the transparency, reproducibility, and validity of the bibliometric results.

The literature search was conducted using a Boolean keyword combination that includes three main concepts: hypertension, digital health technology, and patient compliance. The Scopus search was performed on 13 March 2026 using the TITLE – ABS – KEY field with the following query: TITLE – ABS-KEY ((hypertension OR "blood pressure") AND ("digital health" OR mHealth OR eHealth OR telemedicine OR "mobile app*" OR smartphone OR "remote monitoring") AND (adherence OR compliance OR "self-management")). Data cleaning was conducted by removing duplicate records and standardizing author keywords. Keywords normalization included merging synonymous terms such as mHealth/mobile health, telemedicine/telehealth, and

compliance/adherence before analysis in VOSviewer.

Criteria for inclusion in this study include journal articles written in English and available in full-text form. Documents besides journal articles, such as conference papers, editorials, and short reviews, are excluded to guard against consistency in data quality. All data that meet the criteria are then exported in CSV format, which includes important information such as title, author, year of publication, affiliations, abstracts, and keywords.

The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The selection process was conducted through the stages of identification, screening, eligibility, and inclusion. PRISMA is a systematic method used to enhance transparency and accuracy in the identification and selection of scientific literature. This approach is widely applied in modern bibliometric studies to ensure the validity and reproducibility of research (11).

The stage in PRISMA is identification, which is the search process beginning with articles from the database. At this stage, all articles that match the predetermined keywords are collected without considering duplication or relevance. The initial search results yielded 600 articles from the Scopus database based on the predetermined search strategy. Next, the deletion process of duplications is carried out, resulting in 550 unique articles ready for the next filtering stage (12).

The screening stage, namely the filtering process, involves assessing articles based on title and abstract. At this stage, articles that are not relevant to the research topic will be eliminated, including those that do not discuss hypertension, are not related to digital technology, or do not relate to patient compliance. A total of 350 articles were removed due to irrelevance to the research topic, such as not discussing hypertension or digital technology or not studying aspects of patient compliance. Thus, the remaining 200 articles proceed to the next stage. This process is important for narrowing down the focus of the research to be more specific and relevant (13).

At the retrieval stage, all the remaining articles (n = 200) were successfully obtained

in full-text form and continued to the evaluation eligibility stage. There are no articles that cannot be accessed at this stage, so all articles can be further analyzed.

The eligibility stage involves a further evaluation of articles that have passed the screening stage. At this stage, the articles are checked in a thorough manner (full-text review) to ensure their suitability for the research objectives. Inclusion criteria for this study include journal articles written in English, Scopus indexed and published within the range of 2016-2025. Articles that do not meet these criteria will be excluded from analysis (11). At this stage, 150 articles were excluded for various reasons: not relevant to digital health (n = 70), not focused on hypertension (n = 40), not discussing patient compliance (n = 30), and not being research articles, such as reviews or editorials (n = 10).

The inclusion stage in PRISMA is the determination of the final articles that will be analyzed, resulting in a total of 50 articles that fulfilled the inclusion criteria and were used as the final dataset for the bibliometric analysis. Articles that have passed all stages of selection are then used as the main dataset in the bibliometric analysis. This process ensures that only relevant and quality literature is used in the research (12).

PRISMA Flow Diagram of Study Selection Process

The study selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency and reproducibility in identifying and selecting relevant literature.

The initial search identified 600 records. After removing 50 duplicate records, 550 unique records remained for title and abstract screening. During the screening stage, 350 records were excluded because they were not relevant to hypertension, digital health technology, or patient adherence. Consequently, 200 full-text articles were assessed for eligibility.

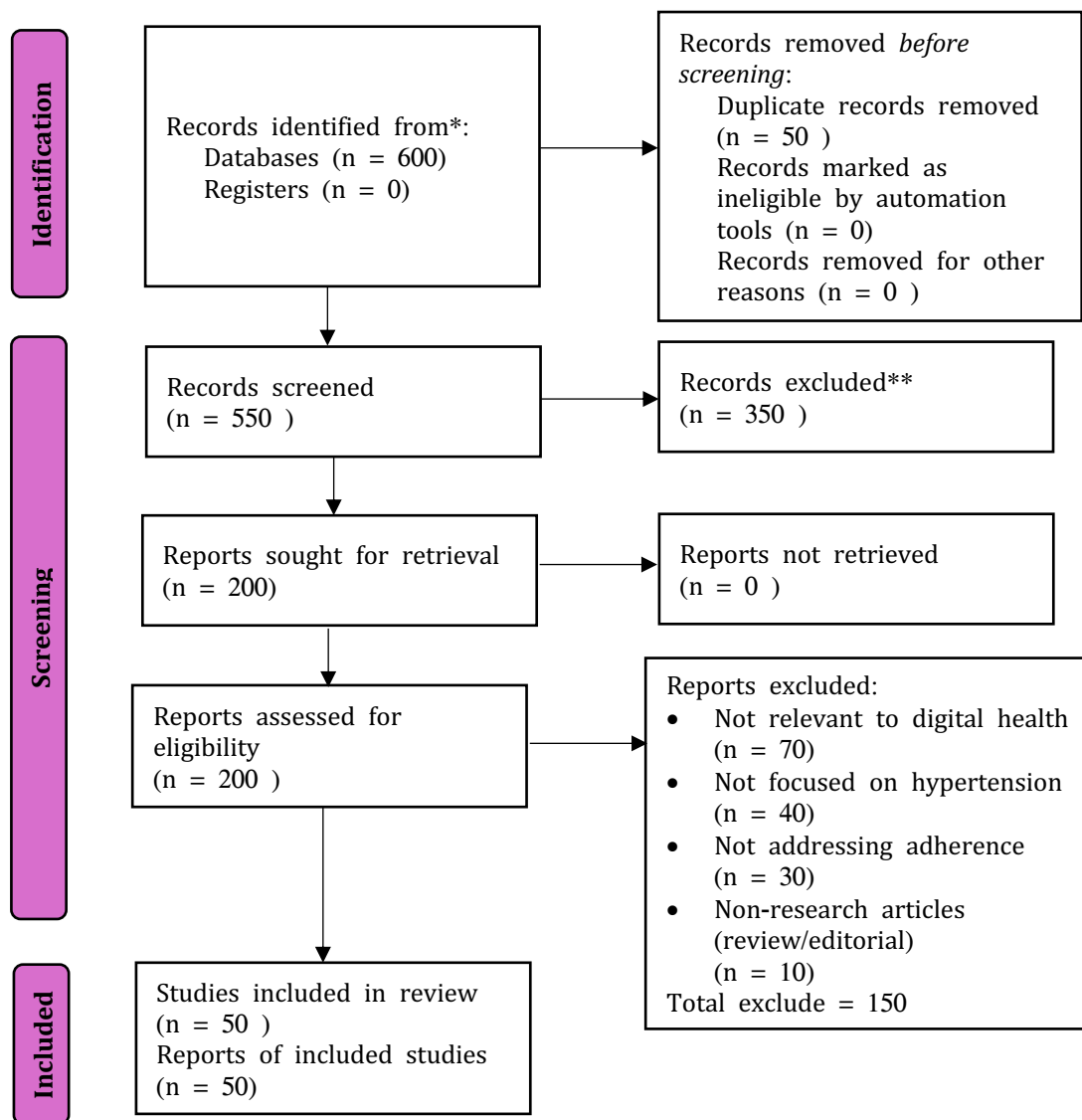
A full-text evaluation resulted in the exclusion of 150 articles for the following reasons: not related to digital health (n = 70), not focused on hypertension (n = 40), not addressing patient adherence (n = 30), and non-research

articles such as reviews or editorials (n = 10). Finally, 50 articles met all inclusion criteria and were included in the bibliometric analysis (Figure 1).

The selected records were exported in CSV format and analyzed using VOSviewer. The

software was used to visualize co-authorship networks, keyword co-occurrence, and co-citation relationships, which facilitated the identification of collaboration patterns, thematic structures, and the intellectual development of research in this field.

Figure 1: The PRISMA Flow Diagram



Three visualization approaches were applied: network visualization, overlay visualization, and density visualization. Network visualization was used to examine relationships among bibliometric elements, overlay visualization to identify temporal trends based on publication year, and density visualization to determine the concentration of dominant research topics.

To enhance the validity and reproducibility of the analysis, a data cleaning and preprocessing procedure was conducted before the VOSviewer analysis. Duplicate records were removed, author keywords were standardized, and synonymous terms such as mHealth, mobile health, and mobile-health were merged into a single category. Related terms such as telemedicine/telehealth and adherence/compliance were also normalized to

improve the accuracy of the keyword co-occurrence analysis.

This study assumes that the Scopus database provides sufficient coverage of high-quality international publications to represent global research trends in digital health applications for hypertension adherence. Although Scopus is one of the largest multidisciplinary databases, the authors acknowledge that relevant studies indexed in other databases may not have been captured, which should be considered when interpreting the findings

Data that has been selected were exported in CSV format and analyzed use device soft VOSviewer. This device is used For visualize network bibliometrics such as co-authorship (collaboration) author), co-occurrence (the appearance of keywords), and co-citation (the relationship between reference). This analysis helps in understanding structure intellectual and research developments in the field being studied (9).

In addition, the analysis carried out using network visualization, overlay visualization, and density visualization approaches. Network visualization is used For see connection between research elements, while overlay visualization is used For identify temporal trends based on year publication. Density visualization is used For see density the most dominant research topics in the literature (9).

For ensure validity results, this study also follows procedure standards in studies bibliometrics, including data cleaning (data cleaning) for avoid keyword duplication and inconsistency terms. By integrating PRISMA method and analysis bibliometrics use VOSviewer, this research is expected capable give description comprehensive about global trends in related research digital applications in improving compliance of hypertension patients (10).

In addition, to enhance the validity of the analysis, the data extraction and selection processes were conducted systematically and transparently in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. This approach ensures that the analyzed articles are relevant and aligned with the objectives of the study.

RESULT

The bibliometric analysis included 50 Scopus-indexed articles that met the predefined inclusion criteria. The publications originated from various countries and institutions, indicating that research on digital health applications for hypertension adherence has developed as a multidisciplinary field involving healthcare, information technology, and behavioral sciences.

The annual publication distribution demonstrated a marked increase after 2019, suggesting growing international interest in the use of digital technologies for hypertension management. This trend may reflect the wider adoption of mHealth, telemedicine, and remote monitoring systems, as well as the increasing demand for flexible healthcare delivery models for chronic disease management.

Development mobile health (mHealth) technology and telemedicine are factors the main driving force increased research in this area. Digital applications allow patients to monitor condition health in a way independent, improve involvement in care, as well as support communication with power health in real-time. This makes digital technology as important components in management modern hypertension (15).

In addition, the increase in research is also influenced by progress technology information and communication is increasingly easy accessible to the public. Integration between mobile devices, internet, and systems health has open new opportunities in management disease chronic in a way sustainable. Research shows that utilization this technology can increase efficiency service health at a time improve patient clinical outcomes (5).

In a way overall, trend improvement This publication reflects existence shift paradigm in service health, from approach conventional going to approach digital-based. This confirms that use digital applications in improving Hypertension patient compliance is not only a growing research topic, but also an important part of transformation system global health (1).

Network Visualization

The network visualization revealed several interconnected keyword clusters representing the conceptual structure of research on digital health applications and hypertension adherence.

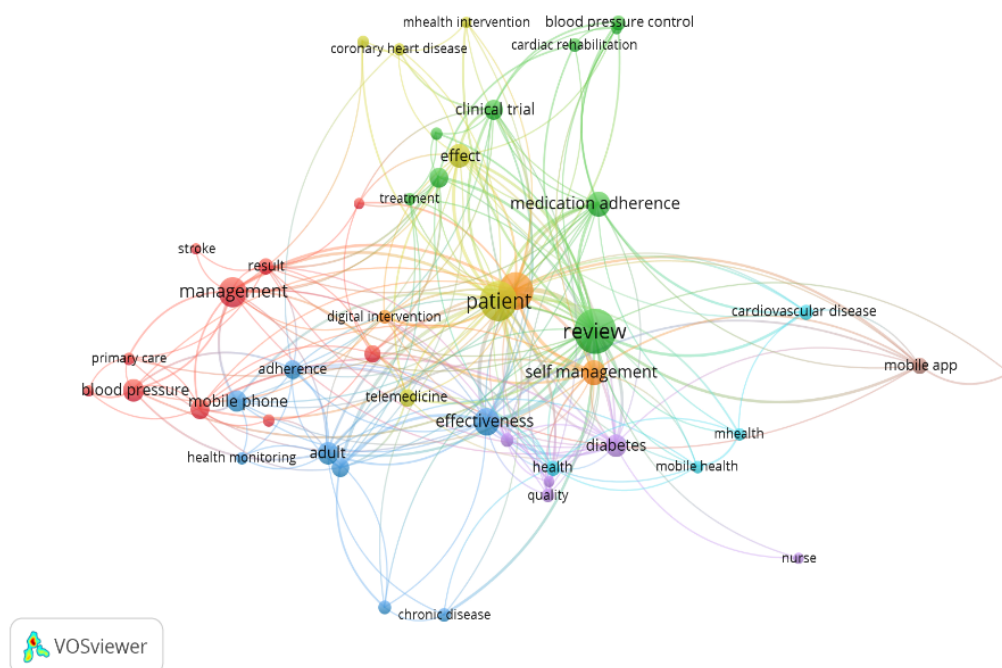
The largest nodes were patient, medication adherence, and self-management, indicating that these concepts constitute the core research focus within the analyzed literature. Their high degree of connectivity suggests that current studies primarily emphasize patient engagement and behavioral support strategies rather than technology development alone.

A second cluster included blood pressure, management, and primary care, representing

the traditional clinical perspective of hypertension management. In contrast, another cluster containing telemedicine, mobile phone, digital intervention, and effectiveness reflects the increasing integration of digital technologies into hypertension care.

The connections between these clusters demonstrate that the field has evolved from a predominantly clinical orientation toward a multidisciplinary framework that integrates clinical care, digital technology, and patient behavior. This finding suggests that digital health interventions are increasingly viewed not only as communication tools but also as mechanisms for supporting adherence, self-management, and continuous monitoring (Figure 2).

Figure 2: Visualization Related Research Keyword Network Digital Applications and Compliance of Hypertensive Patients



Overlay Visualization

The overlay visualization illustrates the temporal evolution of research topics within the 2016–2025 dataset. Earlier publications in the dataset were primarily associated with terms such as blood pressure, primary care, and mobile phone, indicating an initial focus on the use of relatively simple digital tools to support hypertension management.

Publications from the 2017–2019 period showed a gradual shift toward topics including self-management, telemedicine, and effectiveness, suggesting increasing attention to evaluating the impact of digital interventions on adherence and clinical outcomes (Figure 2).

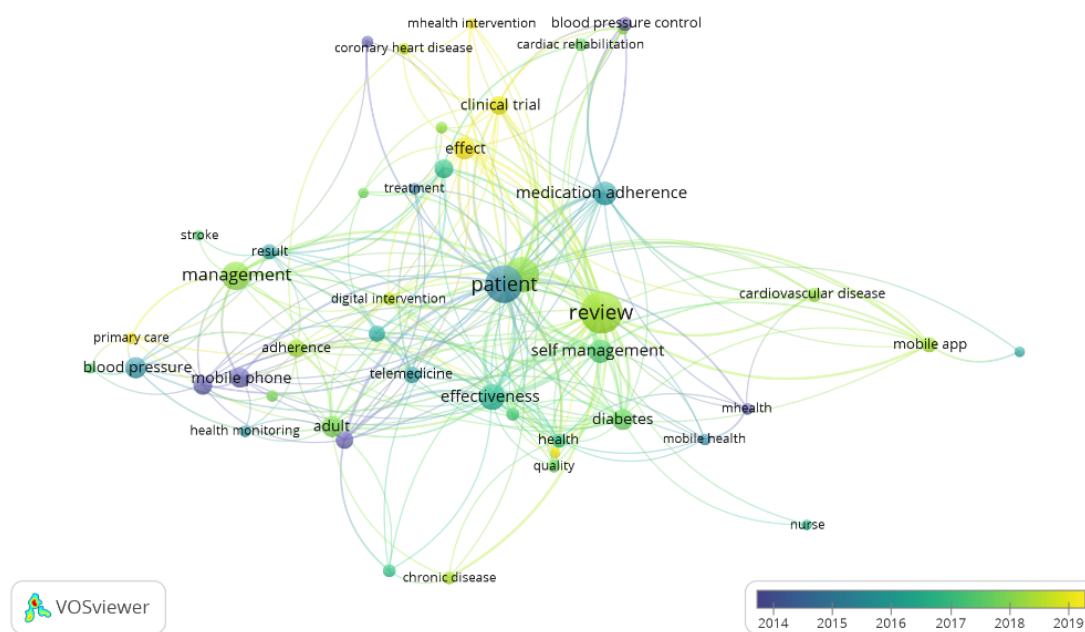
More recent publications were characterized by the emergence of mHealth, mobile health, remote monitoring, and cardiovascular disease, reflecting an expansion of digital

health research beyond basic hypertension management toward broader chronic disease care and integrated healthcare systems.

This temporal shift indicates that research has progressed from exploring the feasibility of

digital tools toward investigating evidence-based and scalable digital health interventions that can support long-term hypertension management.

Figure 2: Visualization Trend Research Development Based on Year Publication



Density Visualization

The density visualization identified patient, medication adherence, and self-management as the most frequently occurring and strongly connected topics in the literature. This concentration indicates that improving adherence remains the central research priority in digital health interventions for hypertension.

Keywords such as blood pressure, management, and mobile phone formed areas of moderate density, suggesting that these topics represent the established foundation of the research field. In contrast, terms including mHealth, mobile apps, nursing, and remote monitoring appeared with lower density, indicating that these themes are emerging areas with substantial opportunities for future investigation (Figure 3).

The visualization also suggests a gradual transition from studies focused on single digital tools toward research examining integrated digital health ecosystems, including telemedicine platforms, wearable technologies, and real-time monitoring systems. This

pattern may indicate a future research direction emphasizing personalized, technology-supported, and patient-centered hypertension care.

Overall, the network, overlay, and density visualizations consistently demonstrate that research on digital health applications for hypertension adherence has undergone a substantial conceptual evolution. The field has shifted from focusing on basic mobile communication tools toward more integrated approaches involving telemedicine, remote monitoring, patient empowerment, and multidisciplinary collaboration. These findings provide evidence that digital health is becoming an increasingly important component of contemporary hypertension management research.

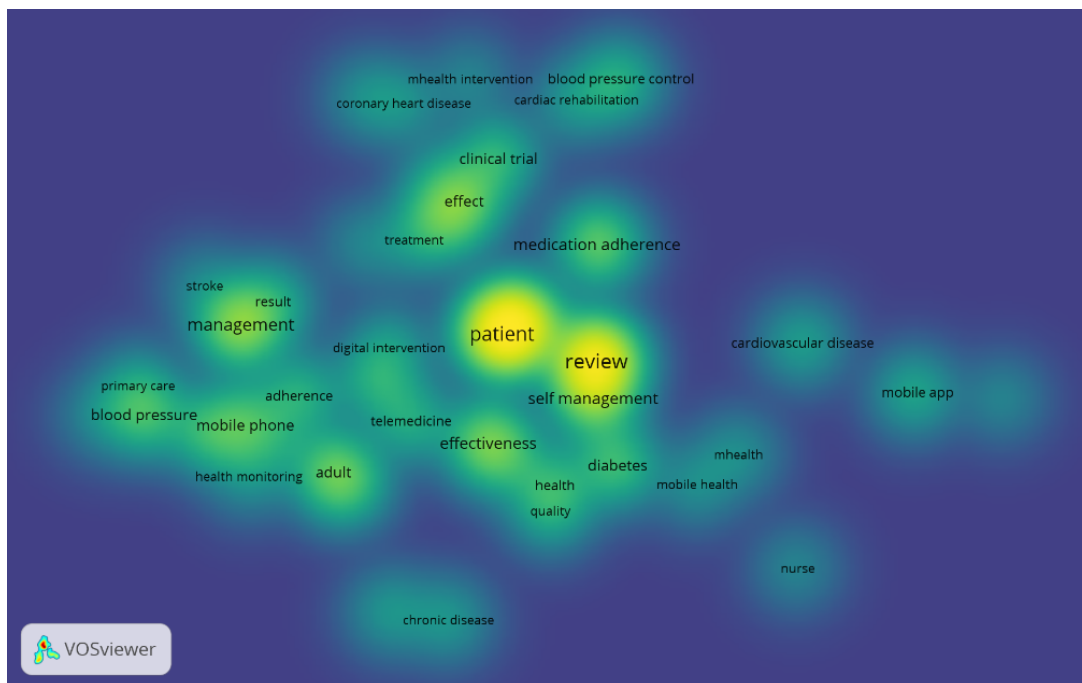
DISCUSSION

This study provides a novel contribution by mapping the knowledge structure and research development trends related to digital applications in improving hypertension patient adherence. Unlike previous studies that primarily focused on the effectiveness of

individual interventions, this study highlights the relationships between concepts and the global evolution of research topics. Therefore, the findings not only reinforce existing

evidence but also offer new perspectives for developing technology-based strategies in hypertension management.

Figure 3: Visualization Keyword Density That Shows Focus Main Research



Compared to studies previously, this study confirmed that digital technologies, particularly mHealth and telemedicine, have develop from just tool supporters become components main in the system management disease chronic. Use Mobile apps don't just work as a monitoring medium, but also as means intervention capable behavior increase patient compliance significant. The study showed that intervention mHealth-based has impact positive to control pressure blood and obedience treatment (15), and emphasized that digital applications can increase patient involvement in the care process (18).

In addition, the results of this study show existence increasing integration strong between digital technology and approaches clinical based evidence, as seen from increasing use clinical trial in evaluating effectiveness digital intervention. This indicates that this field has enter stage maturity scientific, where technology is not only developed, but also tested in a way systematic. This finding is consistent with studies bibliometrics previously shown that digital health research is increasingly leading to evaluation evidence based for ensure effectiveness and safety intervention (19).

The observed increase in publications after 2019 may not solely reflect technological advancement. Other contributing factors may include the acceleration of telemedicine adoption during the COVID-19 pandemic, increased global funding for digital health research, broader smartphone penetration, and growing policy attention to chronic disease management. Therefore, the publication growth should be interpreted as the result of multiple interacting technological, social, and health-system factors rather than a single causal trend.

This study has several limitations. First, the data were obtained from a single database, which may have led to the exclusion of relevant studies. Second, bibliometric analysis relies on available metadata, which may limit the depth of interpretation. Therefore, future studies are recommended to include multiple databases and combine bibliometric methods with other systematic approaches.

Additional limitations should also be considered. First, the retriction to English language publications may have intoduced language bias. Second, bibliometric indicators are influenced by publication bias and citation

bias, where highly cited articles tend to receive disproportionate attentions regardless of methodological quality. Third, database indexing bias may occur because journals indexed in Scopus are more likely to originate from certain regions and publication networks, potentially underrepresenting research from low and middle income countries

CONCLUSION

This bibliometric study indicates that digital applications have become an increasingly prominent research focus in efforts to support hypertension patient adherence and self-management. The findings reflect the growing scientific interest in mHealth, telemedicine, and remote monitoring technologies, although the present analysis does not directly evaluate the clinical effectiveness of these interventions.

These findings are expected to serve as a foundation for the development of policies and technology-based innovations to sustainably improve hypertension patient adherence. Future studies should explore AI-driven adherence systems, the integration of wearable monitoring technologies, and nursing-centered digital interventions to enhance hypertension management and patient adherence across diverse healthcare settings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to the publication of this article.

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AUTHOR CONTRIBUTIONS

DFR: Responsible in conceptualizing research, development methodology, data collection, data analysis and compilation draft early manuscript.

DP: Contribute to the supervision of the research process, validation methodology, review critical, data interpretation, manuscript revision for cargo important intellectuals, as well as agreement end to the version that will be published.

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