# Impact of Mobile Technology Solution on Self-Management in Patients with Hypertension: Advantages and Barriers

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*Abstract:*

*Hypertension is a major risk factor for cardiovascular morbidity and mortality. It is a condition that increases the high risk of heart, liver, and other diseases. Since hypertension is one of the biggest global public health issues, patients require more interventions to manage their blood pressure. The vast use of mobile phones and applications with medication features has turned a smartphone into a medical device. These tools are helpful for a physician in the treatment of hypertension.*

*Mobile health applications are utilised to manage hypertension at the moment; however, there is a lack of information regarding their efficacy. Smartphones and their applications are evolving quickly hence the rise in the innovation of mobile health applications. Mobile-based applications are helpful in-patient education and reinforce the behaviour through constant reminders, medication, and appointment alarms.*

*The main objective of this study is to determine the impact of mobile health applications on self-management in patients with hypertension and its advantages and disadvantages. We used publications from 2015 and later as a time frame and searched on the first five pages of Google Scholar, JSTOR, Hindawi, PubMed, and ResearchGate. We group all associated terms that might turn up articles on this subject in the search results. The total number of database records that we identified were 213, and the duplicate identified and removed were 117; hence the screened records were 96. The reports excluded based on abstract and title were 31. Articles with full text and have been accessed for final inclusion were 65. The excluded articles were 51, and the studies included in the qualitative analysis were 14.*

*Keywords: impact; self-management; mHealth; Hypertension.*

## 1. INTRODUCTION

Hypertension is a global health challenge in which patients need to be more careful and take more measures to control blood pressure. It is a chronic disease that requires self-management which is the most effective treatment for the patient with hypertension. It is one of the major risks of heart disease, stroke, and renal failure [1]. Despite knowing the fact of the danger of this disease, hypertensive patients do not control their blood pressure [2] . So, it is necessary to encourage them by using smartphone applications.

The arteries in the body are impacted by the prevalent condition of high blood pressure and hypertension. The blood's constant pressure against the artery walls is too high if you have high blood pressure [3]. Worldwide, hypertension is a major contributor to cardiovascular and cerebral events risk and poses a serious threat to public health. With population expansion and aging, it is predicted that

more than one in four persons globally have hypertension. A blood pressure reading of 130/80 mm Hg or greater is generally considered hypertension [3]. Hypertension is categorised into four that is normal blood pressure, elevated blood pressure, stage 1 hypertension and stage 2 hypertension [4, 5]. Most people with hypertension do not have symptoms but the few that have experience headaches, nosebleeds and shortness of breath [3].

Mobile application is a type of application software designed to run on a mobile phone, such as a smartphone or tablet PC [6]. Apps are typically small, independent software modules with constrained storage. The mobile applications can be gaming applications, business applications, education applications or travel applications. Mobile applications are developed for Android, IOS and Windows operating systems. Mobile applications are categorised depending on the following factors: the intended users of the app, technology used to develop the app and the expected performance of the application [6].

Mobile health applications have had numerous positive impacts on patients. Mobile health technology, as opposed to a conventional and ineffective telephone connection to doctors and healthcare organisations, allow patients to instantly send secure messages, make appointments, and connect to clinicians 24/7 for telemedicine visits [7].

It is difficult for doctors to keep track of a patient's adherence once they leave the hospital, and with poor medication adherence, the patient's condition can worsen and result in readmission. The mobile health applications will keep track of the patient's medication adherence. The mobile health applications will help in remote monitoring just like home care. The patients will enter data on the mobile applications that will be transmitted to the doctors. This data will include their weight, diet, and blood pressure levels without the need to visit the hospital physically [7]. Mobile health technology means the use of smartphones for health care and self-management [8]. It can integrate everyday life with health care and collects and deliver health services and information in an accessible, convenient, and interactive mode [9]. The use of smartphones and other devices like tablets, and iPad is rapidly increasing. Mobile phones are important in health as they have become an important platform for using health care applications.

Self-management attempts to give patients with chronic diseases the power to take charge of their care [10]. Mobile health applications have proven to have a positive impact on the level of self-management among patients with chronic conditions. Mobile health applications improve self-management by allowing hypertension patients to record and track their blood pressure levels, diet intake and exercise therapy. Patients with

hypertension require self-management on a daily basis because they need to check on their exercise therapy and diet intake [11]. Additionally, several nations have found that increasing self-management is an effective way to lower hypertension [10]. Multiple studies have revealed that remote patient self-monitoring without feedback from healthcare professionals has a negligible impact on lowering blood pressure. The most effective treatment for hypertension is self-management, it concludes the role of patients to manage the symptoms, physical effects, psychosocial, treatment, and changing lifestyle [12]. It is hard to achieve the optimum level of self-management as it needs considerable attention from patients. Therefore, self-management is an important part of healthcare management, as it's important to get patients to become more involved in managing their blood pressure [4, 13].

## 2. RESEARCH METHOD: -

We searched the first five pages of Google Scholar, JSTOR, Hindawi, PubMed, and ResearchGate, with articles published as far back as 2015 as a deadline. We include all relevant terms whose search results can find articles related to this topic. We decided to use an integrated review to determine the impact of mobile applications on patients with hypertension and factors affecting the use of mHealth applications. The review was conducted to establish both the positive and negative impact that mobile health applications have had on the self-management of patients with hypertension. The review was done according to the PRISMA guidelines. The selection and extraction of data were conducted on inclusion and exclusion criteria. The articles that were included were dated from 2015 to 2022 and were concerned with the self-management of hypertension patients.

Out of all the 213 records identified, only 14 studies were included in the qualitative analysis (Figure 1). Some were excluded basis of title and abstract, and others due to reasons related to no topics of self-management and mobile health applications for hypertension patients.
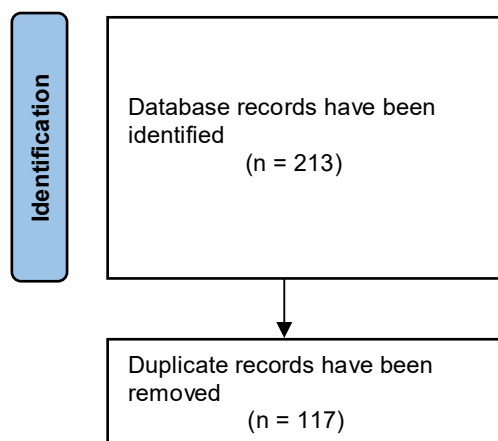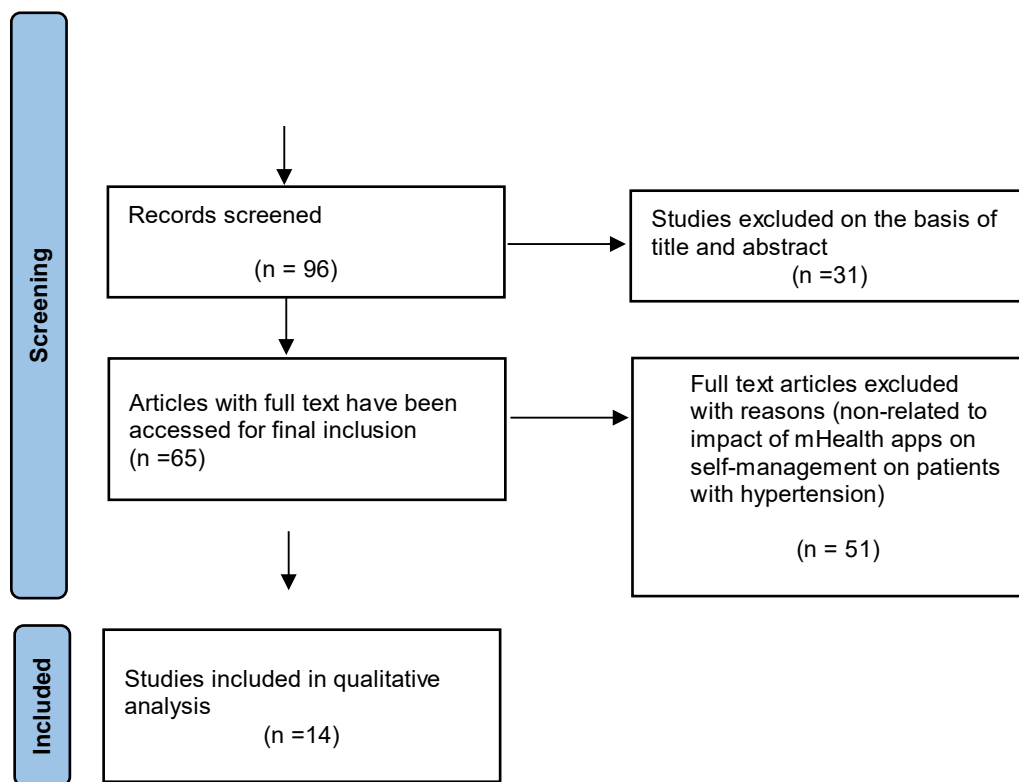
Fig 1. Prisma chart for the investigation

## 2.1 Inclusion Criteria: -

- The population group in all articles evaluated was 18-79 years.

- The studies were conducted between 2015 to 2022.

## 2.2 Exclusion Criteria: -

- The studies were carried out on less than 18 years and more than 80 years of age.

- The studies were carried out on chronic diseases other than hypertension.

- The studies published in languages other than English were excluded, which likely missed the relevant research.

## 3. RESULTS AND DISCUSSION:

TABLE 1: DETAILS OF ARTICLES INVESTIGATING THE IMPACTS OF MOBILE HEALTH APPLICATIONS ON SELF-MANAGEMENT IN PATIENTS WITH HYPERTENSION BETWEEN 2015 AND 2022.

| Study (year) | Study title | Aim | Study design |
|---|---|---|---|
| [14] | The Effectiveness of Self-Management of Hypertension in Adults Using Mobile Health. | The goal of this systematic review was to find out how well mHealth helps adults better manage their own hypertension. Blood pressure (BP), blood pressure control, medication management, self-management behaviour, and costs were used to measure the results. | Systematic Review and Meta-Analysis |
| [15] | Evaluation of the Effectiveness of the Mobile Application on Adherence of Patients with Arterial Hypertension. | The purpose of the study was to evaluate the impact of a mobile application on medication adherence in individuals with documented arterial hypertension. | A multi-centre randomized controlled |
| [16] | Smartphone Apps to Support Self-Management of Hypertension, | The study's goal is to evaluate and describe all existing applications that aid in self-management of hypertension, as well as to analyses their functionalities. | Review and Content Analysis |
| [17] | Apps on Google Play Store to assist in self-management of hypertension in Indian context. | The purpose of this research was to examine the analytical and practical features of hypertension self-management apps found in the Google Play Store. | Features analysis study |

| [18] | Comparing the Acceptance of Mobile Hypertension Apps for Disease Management Among Patients Versus Clinical Use Among Physicians. | The goal of this study is to find out what makes people in German-speaking countries accept mobile hypertension apps for personal use and what makes doctors accept them for clinical use. | Cross-sectional Survey |
|------|------|------|------|
| [19] | Mobile health applications for the management of primary hypertension. | The objective was to evaluate the impact of mobile Health applications on blood pressure control and medication adherence. | A multicenter, randomized, controlled trial |
| [20] | Chinese Mobile Health APPs for Hypertension Management. | The goals of this study are (a) to provide recommendations for developers in industry and (b) to aid hypertensive patients in selecting suitable APPs by comparing and contrasting the efficacy of hypertension management APPs released in the Chinese market; (c) to gain an understanding of the general circumstances, characteristics, issues, and trends in hypertension management mHealth APPs; and (d) to determine the gaps between products from mainland China and those from outside of mainland China. | A Systematic Evaluation of Usefulness |
| [21] | Effects of using a mobile health application on the health conditions of patients with arterial hypertension. | To verify the mobile intervention and effects of using a health application on patients with hypertension. | A pilot trial in the context of Brazil's Family Health Strategy |
| [22] | A content analysis of smartphone-based applications for hypertension management. | This study aims to determine the content of mobile hypertension applications available on Google Play and Apple iTunes. | cross–sectional study |
| [23] | Impact of a mobile phone app on adherence to treatment regimens among hypertensive patients. | The aim of this study is to investigate the impacts of mobile applications and medication adherence among hypertensive patients. | A randomized clinical trial study |
| [24] | Effect of an Integrative Mobile Health Intervention in Patients with Hypertension and Diabetes. | The object of this study is to evaluate the use of an integrated mobile application for hypertension, obesity, and blood pressure. | Crossover Study |
| [25] | The effect of the mobile "blood pressure management application" on hypertension self-management enhancement. | This study assessed the impact of a self-management application on patient adherence to hypertension therapy in context of the increasing use of mobile health in healthcare. | a randomized controlled trial |
| [26] | The Emerging Role of Mobile-Health Applications in the Management of Hypertension | This study examined the current research on m-health systems and how m-health might impact the management of hypertension. | Study review |
| [27] | Mobile Health Applications and Medication Adherence of Patients with Hypertension. | The goal of this study is to figure out how health apps impact how people with hypertension take their medicine and what causes those effects. | A systematic Review and Meta-Analysis |

### 3.1 Positive impacts of mobile health applications on self-management in patients with hypertension

The information monitoring feature for self-care and the app's display, notes and reminders, information access, and information sharing features support the fundamental self-care tactics [3]. Because hypertension patients need to regularly assess their lifestyle, they have found the reminder feature on mobile health applications to be quite beneficial [11, 28]. To remind themselves to take their medications, exersise, check blood pressure, the patients set alarms and reminders. Numerous medications are used to manage hypertension, and not all patients can keep track of when they should take each one. The utilisation of the reminder feature to notify patients when their next appointment is coming is due to the fact that patients occasionally need to see a doctor [28]. Therefore, Reminders have a very positive impact on medication, notification pop up on smartphone screens either to check blood pressure or to take medicines.

Goal setting feature on the mobile application is also helpful because hypertension patients need to check on their weight and food intake daily. By setting a goal of reducing weight and watching their diet on the mobile applications they will be able to achieve their set targets. Moreover, setting goals is a powerful tool for encouraging physical exercise. The goal setting feature allows the patients to set a target and observe their improvements towards achieving their goals. A sedentary lifestyle is closely linked to hypertension. Exercise has been demonstrated to delay the onset of hypertension [29]. Effective blood pressure reduction has been shown to occur with both aerobic and resistance training hence the need for hypertension patients to set a goal of exercising daily. The hypertensive patient can set goals using medical health applications. He can generate a checklist or can use a default list of common goals that have to be achieved or recommended by the physician. Through these applications, hypertensive patients record the achieved goal in progress goals. Mobile health applications can also populate these goals and show overall progress. Achieved or progressed goals can also be linked with calendars and deadlines. Mobile health applications provide tips on one base of these achieved goals [30].

Some applications for mobile health have an educational component that gives more details about the patient's illness and how they may manage it at home. Patients may comprehend the data they input into mobile applications, such as their blood pressure and salt intake, with the aid of the teaching component. The educational function will enable patients to determine whether their condition is improving or declining. There are apps that can give you the contents, including the calories, fat, and sugar, of any specific restaurant item [29]. You may make an informed choice that supports you by rapidly comparing the nutrition facts to your daily objectives. Hypertensive patients also use the educational features of mobile health applications in which applications suggest them food intake, weight management as well as physical activities. These applications are also used to ask a question from a physician or to seek his opinion. The motivational feature of mobile health applications is also very important as it helps people to continue the medication and adherence and finally, they get rid of the disease.

### 3.2 Barriers to using mobile health applications on self-management for hypertension patients

Lack of privacy is one of the major barriers to adoption of mobile health applications. The mobile applications contain patients' crucial information such as their email address, phone number and home address which when a breach occurs the information can be used by cyber criminals for malicious reasons [11, 31].

In addition, usability is a crucial concern for mobile health application systems because it contributes significantly to their success. However, Poor usability is a major obstacle to the widespread use of mobile applications [32]. Therefore, M-health could have unforeseen, detrimental effects if usability is not taken into account, including an increase in medical errors and issues with provider communication [31]. Some applications are very tedious and the data entry process is annoying. Even patients who are familiar with technology found it difficult which is one of the reasons for not using mobile health applications. Numerous mobile health applications are not regulated, which means they may provide consumers inaccurate information and seriously harm their health [29].

Another barrier is the prescription of mobile applications, patients think that only those applications can be beneficial and are recommended by their doctor. Finding an appropriate application is also a barrier to the frequent use of mobile applications. Lack of evidence about the effectiveness of medical health applications is also a barrier, patients demand evidence of whether either application feature is beneficial for hypertension or not. [33].

### 3.3 Examining the effects of using mobile health apps for hypertension self-management by patients in table 1

This study aimed to review the impacts of mobile applications on self-management among patients with hypertension. In this review, 14 studies have been reviewed that were conducted recently between 2015 to 2022. There may be differences in study design however the main crux of these studies was to evaluate the impacts of mobile health applications on self-management in patients with hypertension.

These studies have appraised the applications with a combination of functionalities and features, as some were designed for self-monitoring of blood pressure, some to measure blood pressure and other was helpful in log and record updating of a patient. In most studies, participants accepted the applications for blood pressure and self-monitoring. Due to varying places, study designs, and quality of results, it is inconclusive to define the most evident impacts of mobile applications, and which is more effective in lowering blood pressure worldwide. However, it is finalized that applications with more comprehensive functionalities and features were more effective in self-management.

There are different study designs evaluated in this paper, (4/14) studies are randomized control trials, (3/14) are systematic reviews and meta-analysis, (2/14) are cross-sectional surveys and (2/14) are reviews and content analysis whereas other study designs are included in this paper are, features analysis study, pilot trial in the context of Brazil's

family health strategy, crossover study. All these studies were on the effectiveness of mobile health applications in patients with hypertension, and many have also assessed the experience and satisfaction with these applications. As these are conducted in different environments for different purposes, so there is no standard duration as well as the number of participants.

A systematic review conducted in China to determine the effectiveness of self-management of hypertension patients who use mobile health indicated that mHealth self-management treatments successfully lower blood pressure [14]. Patients with hypertension require self-management regularly. Maintaining blood pressure with medication and avoiding problems are the fundamental therapies for hypertension. Because hypertension is seen as a chronic condition, self-management should be a regular part of the patient's routine. Improvements in self-management behaviour and medication adherence were seen as a result of this review. The mHealth intervention that was the most effective combined personalized messaging with interactive communication and diverse features. With the prevalence of hypertension increasing internationally, mHealth presents a potentially efficient approach for hypertension self-management and control. It is simple to incorporate mHealth into current healthcare systems [14]. Therefore, according to this study, self-management education

can increase patients' understanding of hypertension and enable early diagnosis of excessive blood pressure.

A study conducted in the UK to evaluate various mobile applications that support the self-management of hypertension patients and their functions concluded that many mobile health applications but only a few could be considered effective [16]. According to the study, many applications are ineffective because they do not have security measures and do not provide evidence of their effectiveness and usability making it difficult for hypertension patients to determine which mobile health applications are effective [16]. In Brazil, a study was conducted to verify the effects of mHealth applications on arterial hypertension patients. The study indicated that technology use with health information is a development that can benefit hypertension patients' therapeutic plans by promoting better treatment compliance, healthier lifestyle choices, and better health outcomes [21]. mHealth systems help patients manage hypertension in the following ways: setting alarms and reminders for patients to take their medications, linking patients' blood pressure reports to their electronic medical records so that their doctors can check them, providing patients with feedback on their blood pressure tendencies, and acting as point-of-care blood pressure sensors [21]. mHealth apps with alarms and reminders can increase medication

compliance, while apps that share ambulatory blood pressure records with patients' doctors can advance patient-health professional communication.

A study conducted in Kazakhstan was aimed at evaluating the effectiveness of mobile health applications on patients diagnosed with arterial hypertension. The study concluded that the mobile health applications did in fact help with patient adherence. However, more research is needed to allow the wider implementation of mobile health applications in healthcare [15]. A study done in India to identify the mobile applications in the Google play store that support self-management for hypertension patients indicated that the applications mainly focused on recording blood pressure and providing statistics and trends and not self-management techniques, hence the need for improvement [17]. Therefore, Developers of hypertension apps should now focus on including additional self-management features.

According to a study conducted in German speaking countries to determine the acceptance of mobile health applications for patients and physicians of hypertension by observing the modes of service and delivery of health services indicated that the expected performance of the applications was the main factor for the acceptance of the mHealth applications [18]. A systematic review done in China to evaluate the effectiveness and usefulness of mobile health applications for

hypertension patients concluded that the usefulness of the mobile applications was unsatisfactory hence the need for improvement because there is a rise in the need for mHealth applications for hypertension patients [20].

In Palestine (Gaza Strip), a study was conducted to identify the impact of mobile health applications on adherence to medication on hypertension patients indicated that the applications were indeed effective and reduce cardiovascular mobility and morbidity [23]. A study conducted in South Korea to investigate the effect of using integrated mobile health intervention on patients with hypertension and diabetes indicated that even though the apps body fat and glucose levels they failed to indicate clinical improvement on the patients. The medical information and reminder app was also more appealing to patients than a food diary and fitness monitor [24].

A study conducted in Iran to verify the effect of mobile blood pressure management application on self-management for patients with hypertension indicated that the application is helpful for hypertension patients in developing countries [25]. An analysis is done in France to determine the effectiveness of smartphone-based applications on hypertension management showed that the applications were helpful by recording the patient's blood pressure, heart rate and salt intake. Additionally, Medical app development for HTN,

especially medical devices, needs more oversight. [22]. In China a study was conducted to observe the impact of mHealth apps on blood pressure and medical adherence and the results showed that the mHealth apps helped to lower blood pressure, improve blood pressure control, and medication adherence, all of which can assist to minimise the economic and social burden of hypertension in people [19].

A review conducted to identify the role of mobile health applications on the management of hypertension indicated that improvements in blood pressure outcomes might be achieved through the use of smartphone applications that serve as medication reminders, offer patients with individualised feedback, and provide two-way communication with their healthcare professionals [26]. A study conducted to analyze the impacts of mobile health application on medical adherence of hypertension patients and the underlying factors showed that mobile health applications have a positive impact on medical adherence of hypertension patients and helps improve their conditions [27].

All the above-mentioned studies agreed as a whole that smartphone-based has the potential to manage chronic diseases considerably. The results are in accordance with the impacts of mobile health applications in self-management for patients with hypertension. The results of the application with automatic feedback and recommendation features

without involving a physician were more promising in controlling blood pressure. In the same way, the mobile applications in which healthcare products were involved in remotely monitoring the patients with automatic feedback also had a significant impact on blood pressure. It can be assumed that both approaches are effective and beneficiary.

In all the included studies one thing is common hypertensive patients appreciated the features of medical health that have saved their time as compared to traditional ways. They found medical health application valuable if it is simple to use, provide specific and to-the-point recommendations and instructions and share data with their desired individual. Though tracking is the main function, it may distract the patients at the same time.

This study is one of the systematic reviews which explore the impacts of mobile health applications in self-management for patients with hypertension. Lastly, this study might be a roadmap for future studies on this topic.

4. CONCLUSION

This study determined that mobile health applications are acceptable and assist in controlling and lowering the blood pressure of hypertensive patients. It is also concluded that applications with more comprehensive features and functionalities are more effective. This study also demonstrates its positive impacts and barriers which help the

technology giants to design user-friendly applications. In positive impacts, it highlights the most effective impacts, such as reminder, goal setting as well as educational feature of these applications. At the same time, the barrier in patients' perspectives is also highlighted. Implementation of these applications more effectively would help to control the disease which requires self-management and self-monitoring. According to studies, mobile health applications can benefit people with hypertension by keeping track of their diet, salt intake, blood pressure, and heart rate, which can help their condition. The majority of studies showed that mobile health applications had a good effect. To boost the effectiveness of mobile health applications for patients self-managing their hypertension, we advise conducting more research in this area.

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