REVIEW ARTICLE

Mobile Health Technology for Hypertension Management: A Systematic Review

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Received: 14 Jan. 2020; Accepted: 04 Jun. 2020

Abstract- Hypertension is a chronic condition, and a major risk factor for other chronic conditions requires management. Considering the growth and extensive use of mobile health (mHealth) technologies and their capabilities, it is essential to examine the effects of these technologies on hypertension control and self-management. The present systematic review examined the effect of using mHealth technologies in controlling blood pressure and investigated the functionalities of mHealth technology on self-management aspects of patients with hypertension. A systematic search was conducted on PubMed, Web of Science, Embase, and Scopus databases. Clinical trials in English investigating the use of mHealth technologies for blood pressure control published from 2005 to 2018 were included in this study. The functionalities of these technologies were also investigated. These functionalities were divided into five categories of monitoring, alarms, feedbacks, education, and communication. The most frequently used technology for hypertension control was smartphones in the 15 articles examined. Moreover, the most frequent functionalities used for self-management of hypertension were communications and reminders, education, monitoring, and feedback, respectively. In the majority of the studies, these functionalities were employed in combination with mHealth technologies, a feature that affects hypertension control and self-management. The use of mHealth technologies, such as smartphones, positively affects hypertension self-management and reduces blood pressure. Functionalities such as communication and reminders, education, monitoring, and feedback are effective in hypertension self-management programs. The simultaneous use of these functionalities combined will be more effective in hypertension self-management programs.

Acta Med Iran 2020;58(6):249-259.

Keywords: Hypertension; Self-management; Mobile health; Mobile technology

Introduction

Hypertension is a chronic disease and a major risk factor for chronic conditions such as kidney failure, cardiovascular diseases, and myocardial infarction. Based on the guidelines available for hypertension management, systolic and diastolic blood pressure equal to or above 140.90 is regarded as hypertension (1,2). Based on a report by the World Health Organization (WHO), 1.13 billion people suffer from hypertension, the majority of whom live in moderate- and low-income countries (3). Thus, preventive care and daily management are vital for controlling hypertension (4). Hypertension management can prevent and control the cardiovascular disease before the emergence of consequences and mortality (5). Although there are various methods for hypertension control, those with hypertension still have little control over this disease and its management (6,7).

Self-management refers to measures taken by a person to control and manage his/her disease and also include the support received from healthcare providers and the healthcare systems (8,9). Based on the definition of the US Institute of Medicine, self-management is regular support for patients by healthcare providers through education and support interventions to enhance their skills and self-confidence, determine the objectives, and support problem-solving for the management of health-related problems (10).

Self-management demonstrates one’s capability for managing his/her signs and symptoms, adherence to treatment, behavioral, psychological, and physiological outcomes, lifestyle changes, and establishment of

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effective communication with healthcare providers and their families and friends in chronic conditions (9,11). It is one of the six essential elements in the care model for chronic conditions (12) and can affect various outcomes, including clinical outcomes, quality of life, and healthcare costs (13). Self-management requires active participation on the part of the patients in managing their signs and symptoms and changing their behaviors and lifestyle (11,14,15). Results of a systematic review performed on the effects of self-management on hypertension control showed that self-management improves hypertension control (16).

Mobile technologies are important tools for facilitating and promoting self-management in patients (17-19). Mobile health (mHealth) is defined as the use of mobile technology (telephones, personal digital assistants, smartphones, and sensors) for supporting and providing healthcare (20,21). Mobile technologies are employed for measurement, diagnosis, prevention, monitoring, and treatment at the personal and community level. They are also employed as a method for collecting environmental, behavioral, and biological data (22,23). These technologies include cell phones, personal digital assistants (PDAs), assistant-like cell phones (*e.g.*, Blackberry, Palm Pilot), smartphones (*e.g.*, iPhone), enterprise digital assistants (EDAs), portable media players (*e.g.*, Mp3 players, iPod, mp4 players), game consoles and handheld and ultra-portable computers (*e.g.*, PlayStation Portable, Nintendo), and portable computers (*e.g.*, Tablets and smart-books). These technologies have a wide spectrum of functionalities, including communications, text messaging, as well as pictures, videos, Internet access, multimedia playing, and application (app) support (24).

Various studies have been conducted on the effect of using mobile technologies on the self-management activities of patients with hypertension, including monitoring activities, sending alarms and feedback, and patient education (25,26). Considering the ever-increasing expansion of mobile technologies and their positive effect on self-management in chronic diseases (27,28), the present study aimed to examine the effects of mobile technologies on reducing blood pressure and investigate the functionalities of mobile technologies on self-management aspects of patients with hypertension.

Materials and Methods

This systematic review was designed based on the guidelines of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

Data sources and search strategy

Four scientific databases (PubMed, Web of Science, Embase, and Scopus) were searched to find research articles in English published from 2005 to 2019. The search was focused on English articles in journals and conferences. The search strategy consisted of a combination of MeSH terms, Emtree, and keywords related to hypertension and mobile technology. These keywords were combined using Boolean AND/OR operators to retrieve articles from the mentioned databases. Published articles were identified and retrieved using the search strategy developed by the authors (Table 1).

Table 1. Search strategy

No.	Concept	Search strategy
1	Mobile health technology	Telephone OR Computers, Handheld OR Mobile Applications OR mobile health OR mobile applications OR mobile phone OR telephone OR mobile OR personal digital assistant* OR smartphone OR smartphone OR m-health OR mhealth OR m health OR iPad OR iPod OR tablet device OR portable media players OR *phone OR "Cell Phone" OR mobile technology* OR tablet* OR apps OR Smart-books OR app OR PDA OR enterprise digital assistants OR tablet computer
2	Hypertension	Hypertension OR Hypertension OR hypertensive OR hypertension* OR escalated blood pressure OR elevated blood pressure OR Blood Pressure OR blood pressure OR high blood pressure OR abnormal blood pressure
3	1 and 2	--

Inclusion criteria

The inclusion criteria were based on PICOS (29).

Population

The target population in the examined articles comprised all patients with hypertension belonging to all age groups (children and adults), without any restriction as to age, sex, and demographic information.

Intervention

Studies included mobile technologies as an intervention tool for hypertension self-management; intervention tools included all mobile-based technologies such as cell phones, personal digital assistants (PDAs), assistant-like cell phones (*e.g.,* Blackberry, Palm Pilot), smartphones (*e.g.,* iPhone), enterprise digital assistants (EDAs), portable media players (*e.g.,* Mp3 players, iPod, mp4 players), game consoles and handheld and ultra-portable computers (*e.g.,* PlayStation Portable, Nintendo), and portable computers (*e.g.,* Tablets and smart-books).

Comparator

In clinical trials, no intervention was offered to the control group via mobile technologies.

Outcomes

The primary outcomes of the intervention included reduced blood pressure (systolic and diastolic) and the effects of the intervention on self-management of patients with hypertension (symptom management, adherence to treatment, lifestyle changes, physical and physiological changes, and communication), and patients' satisfaction with the type of intervention.

Study designs

All clinical trials were conducted with a control and an intervention group using mobile technologies for self-management of patients with hypertension.

Exclusion criteria

Articles in languages other than English, protocol studies, pre-post studies, systematic reviews, and studies whose full text was not available.

Studies in which the intervention included Windows- or Web-based apps, Websites, and email.

Studies whose main objective was not blood pressure control and blood pressure control were examined in addition to other chronic diseases such as cardiovascular disease and diabetes.

Study selection

All studies examining the status of hypertension and investigated the effects of using mobile technologies on blood pressure (systolic and diastolic) were included in this study. First, the title and abstract of the articles were examined by two authors. After eliminating irrelevant articles, the full text of the articles was examined. Cases of disagreement were resolved upon discussion.

Data extraction

For each article included in this study, the name of the first author, year of publication, location, number of participants, type of technology, duration of intervention, type of intervention, and intervention outcome and effect were extracted (Table 2). The functionalities used in mobile technologies for self-management of patients with hypertension were also extracted (Table 3).

Table 2. Characteristics of included studies

Author (publication year)	Study location	Age Group and Sample Size	Technology used	Duration of intervention	Intervention	Results
Meurer et al (2019)(30).	USA	IG:(mean=49 years) CG:(mean=50 years) IG:(n = 28) CG:(n = 27)	Smartphone	4 months	The text message was used once a week for the experimental group. The text message included guidance on lifestyle, physical activities, nutrition, and the type of medication to be taken.	IG: a mean drop of 9.1 mmHg (95% CI 1.1 to 17.6) CG: 6.6 mm Hg (95% CI -2.4 to 15.6) Effect: positive
Márquez Contreras et al (2019)(31).	Spain	IG:(mean= 57,7 years) CG:(mean= 57,08 years) IG:(n = 77) CG:(n = 77)	Smartphone	12 months	The intervention included installing the app on patients' mobile phones and having the doctors teach them how to use it. This application included modules for recording personal information, recording doctor's notes on medications, setting alarms, setting appointments, recording the results of blood pressure measurement, sending alarms to patients in case of high blood pressure, and education.	The mean BP at the beginning (134,7±14 mmHg in IG v.s. 134,47±8 mmHg in CG) and the final (BP: 132,2±12, p<0.05 in IG v.s. (134,4±11 mmHg in CG) Effect: positive
Chandler *et al.*, (2019)(32).	USA	IG:(mean= 44.4 years) CG:(mean= 46.8 years) IG:(n = 26) CG:(n =28)	Smartphone	9 months	The intervention included sending a text message to patients once every three days for measurement of blood pressure in the morning and evening. Then, the data were sent to healthcare providers.	SBP averages were significantly lower in IG versus CG groups (month 1: 125.3 vs. 140.6; month 3: 120.4 vs. 137.5, month 6: 121.2 vs. 145.7 mmHg; month 9: 121.8 vs. 145.7, respectively; all *p*-values <0.01) Effect: positive

Cont. Table 2

Scala *et al.*, (2018)(33).	Italy	IG:(mean= 57.5 years) CG:(mean= 57.7 years) IG:(n = 84) CG:(n =80)	Telephone	12 months	The intervention included counseling/educational sessions depending on patients' needs, about once every two months by pharmacists.	Significant reduction in BP values in IG (p < 0.001) Effect: positive
Morawski *et al.*, (2018)(34).	USA	IG:(mean= 51.7 years) CG:(mean 52.4 years) IG:(n = 209) CG:(n =202)	Smartphone	4 months	The app used in this study allowed for manually entering the names of all medications, setting a reminder for taking them, tracking the measured blood pressure and other biometrics, alarms when taking a wrong dose, access to the history of taking drugs, and communication with other patients.	The mean systolic blood pressure at the beginning 151.4 (9.0) mm Hg in IG v.s 151.3 (9.4) mm Hg, in control participants) and the final (SD) systolic blood pressure decreased by 10.6 (16.0) mm Hg among intervention participants and 10.1 (15.4) mm Hg among controls (between-group difference: -0.5; 95% CI, -3.7 to 2.7; P = .78). Effect: not different
Lee *et al.*, (2018)(35).	Vietnam	IG:(mean= 55.1 years) CG:(mean 48.2 years) IG:(n = 10) CG:(n =36)	Smartphone	3 months	The app allowed for entering demographic information first, followed by entering the blood pressure every week and sending alarms to patients if they failed to do so, online communicating with healthcare providers for counseling, history of medications, and displaying blood pressures in the form of charts and graphic tables.	mean a change of systolic blood pressure in the monitoring group and the non-monitoring group (-16.0 vs. -5.7, p = 0.008) Effect: positive
Ciemins *et al.*, (2018)(36).	USA	IG:(mean= 48 years) CG:(mean 21 years) IG:(n = 131) CG:(n =353)	smartphone	9 months	The patients measured their blood pressure 3-7 times per week and sent their data to the healthcare centers via the mobile app. Then, if the healthcare providers viewed abnormal patient data, they called the patients and offered reminders and education on taking the medications.	Mean BP control rates improved for patients who received HBPM from 42% to 67% compared with matched control patients who improved from 59% to 67% (p < 0.01) Effect: positive
Varleta *et al.*, (2017)(37).	USA	IG:(mean= 60.7 years) CG:(mean 59.9 years) IG:(n =163) CG:(n =151)	smartphone	6 months	The intervention included sending a text message once every 12-14 days. The content of the text messages included educational information on healthy diets, salt consumption, scheduling the consumption of hypertension medication, the importance of consumption of medication, and adherence to treatment.	Baseline mean BP was 142.7/81.1 mm Hg and 140/78.4 mm Hg in the SMS and non-SMS groups, respectively. In final mean BP was 134.6/77.5 mm Hg in the SMS group and 136.8/78.3 mm Hg in the non-SMS group. Effect: positive
Rubinstein *et al.*, (2016)(38).	Argentina	IG:(mean= 43·6 years) CG:(mean 43.2 years) IG:(n = 266) CG:(n =267)	smartphone	12 months	Sending a text message daily on diet and physical activities to the experimental group	The intervention did not affect change in systolic blood pressure (mean net change -0·37 mm Hg [95% CI -2·15 to 1·40]; p=0·43) or diastolic blood pressure (0·01 mm Hg [-1·29 to 1·32]; p=0·99) compared with usual care Effect: not different
Petrella *et al.*, (2014)(39).	Canada	IG:(mean= 55.7years) CG:(mean 57.8 years) IG:(n = 67) CG:(n =60)	smartphone	3 months	Smartphones equipped with a database including patient information were used for tracking and monitoring patients. Tools for the measurement of blood pressure and glucose as well as a pedometer were used, which transferred the data to the smartphones and then to the database via Bluetooth. In emergencies, alarms were sent to doctors' phones for follow-up.	mean change in SBP was greater in the active control group compared to the intervention group (-5.68 mmHg; 95% CI -10.86 to -0.50 mmHg; p = 0.03) Effect: not different
Moore *et al.*, (2014)(40).	USA	IG:(mean= 48.3 years) CG:(mean 51.9 years) IG:(n = 20) CG:(n =22)	Personal digital assistant	3 months	The CollaboRhythm software which can be installed on tablets and mobile phones was used. The features of this software included: sending daily alarms for taking the medication and blood pressure measurement as well as simultaneous transfer of patient data to healthcare providers, and the use of data display tools for better understanding of the data.	Intervention subjects achieved a greater decrease in systolic BP at 12 weeks than control subjects (26.3 mm Hg vs. 16.0 mm Hg, P = 0.009) Effect: positive
Margolis *et al.*, (2013)(41).	USA	IG:(mean= 62.0years) CG:(mean 60.2 years) IG:(n =228) CG:(n =222)	Telephone	18 months	The intervention included the use of a Web site for storing and transferring the data on blood pressure to the pharmacist. In the first six months of the intervention, the pharmacist and patient communicated on the phone once every two weeks until the blood pressure reached a specified level of stability. Then, this communication was limited to once a month, and from Month 7 to 12, to once every two months. During the telephone call, pharmacists emphasized a change in lifestyle and adherence to medication. Based on an algorithm, they evaluated and specified hypertension medications.	Systolic BP decreased from baseline more among telemonitoring Intervention than Usual Care patients by 10.7 mm Hg at six months, 9.7 mm Hg at 12 months, and 6.6 mm Hg at 18 months, all *P*<0.001. Diastolic BP decreased from baseline more among telemonitoring Intervention than Usual Care patients by 6.0 mm Hg at six months, 5.1 mm Hg at 12 months, and 3.0 mm Hg at 18 months Effect: positive

Cont. Table 2

Bove *et al.*, (2013)(42).	USA	IG:(mean= 61.0years) CG:(mean 58.2 years) IG:(n = 120) CG:(n =121)	Telephone	6 months	The system used consisted of a Web site on which patients entered the blood pressure data using their phones. These data were then transferred to healthcare providers. The data were recorded by patients twice per week, and in case of abnormal blood pressure, a text or audio message would be sent to patients and healthcare providers. Then, the healthcare providers gave orders over the phone to control patients' blood pressure.	Intervention subjects demonstrated a greater reduction in systolic BP (Intervention: -19 ± 20 mm Hg, Control: -12 ± 19 mm Hg; P = .037) Effect: positive
Piette *et al.*, (2012)(43).	USA	IG:(mean= 58 years) CG:(mean 57.1 years) IG:(n = 89) CG=(n =92)	Telephone	2 months	The intervention included the use of an automatic call system using a tree-structured algorithm for collecting data on patients' blood pressure, self-monitoring the blood pressure, adherence to medication and diet, and offering to counsel based on patients' response. During the call, patients regularly examined their blood pressure, and questions were asked on recent blood pressure values, higher or lower than the normal level, as well as adherence to medication and salt consumption. Over the call, patients received additional information on self-care with regard to alternative medications in case of increased blood pressure. In case of abnormal blood pressure, an email would be sent to healthcare providers.	intervention patients' average SBPs decreased 8.8 mm Hg (-14.2, -3.4, p=0.002) Effect: positive
Brennan *et al.*, (2010)(44).	USA	IG:(mean= 55.3 years) CG:(mean 56.1 years) IG:(n = 318) CG:(n =320)	Telephone	12 months	The intervention comprised telephone calls by nurses, including education on lifestyle, physical activities, and diet.	systolic BP was lower in the intervention group (adjusted means 123.6 vs. 126.7 mm Hg, P = 0.03) there was no difference for diastolic BP Effect: positive

IG: Intervention group
CG: Control group
BP: Blood pressure
SBP: Systolic blood pressure
HBPM: Home blood pressure monitoring
SMS: Short message system

Table 3. Functionalities of mobile technologies

Authors	Functionalities: Self-monitoring	Reminder and alert component	Automatic feedback	Educational information	Communication with a healthcare provider
Meurer *et al.*, (30).	✓	✓		✓	✓
Márquez Contreras *et al* ., (31).	✓	✓	✓	✓	✓
Chandler *et al.*, (32).	✓	✓	✓		✓
Scala *et al.*, (33).				✓	✓
Morawski *et al.*, (34).	✓	✓	✓		
Lee *et al.*, (35).	✓	✓	✓	✓	✓
Ciemins *et al.*, (36).	✓	✓		✓	✓
Varleta *et al.*, (37).		✓	✓	✓	✓
Rubinstein *et al.*, (38).		✓		✓	✓
Petrella *et al.*, (39).	✓	✓	✓		
Moore *et al.*, (40).	✓	✓	✓	✓	✓
Margolis *et al.*, (41).	✓	✓		✓	✓
Bove *et al.*, (42).	✓	✓	✓	✓	✓
Piette *et al.*, (43).	✓	✓	✓	✓	✓
Brennan *et al.*, (44).				✓	✓
Total(%)	11 (73%)	13 (86%)	9 (60%)	12 (80%)	13 (86%)

Results

Based on the results of the search strategy, 3686 articles were retrieved. The results for each database are given in the PRISMA diagram. All search results were inputted into EndNote. The results of each stage are presented in the PRISMA diagram. In the next phase, 954 duplicates were automatically identified and removed by the software, and 2732 articles remained for final analysis. In the next step, the title and abstract of the remaining articles were examined by the authors. In this stage, 2637 articles were removed, and 95 cases remained. Based on the inclusion and exclusion criteria, irrelevant articles were eliminated. A number of articles were removed at this stage: 21 articles were removed since they were not suitable for clinical trials; 31 articles because they did not measure blood pressure as the primary goal and lacked self-management goals; three articles because they were duplicates; two articles because they provided intervention for healthcare providers; 15 articles because they examined other conditions such as stroke, diabetes, and pregnancy; four articles because they were protocols; three articles because they did not use mobile technology, and one article because its full text was not available. Finally, 15 articles that were compatible with the objectives and inclusion criteria of the present study remained for review (Figure 1).

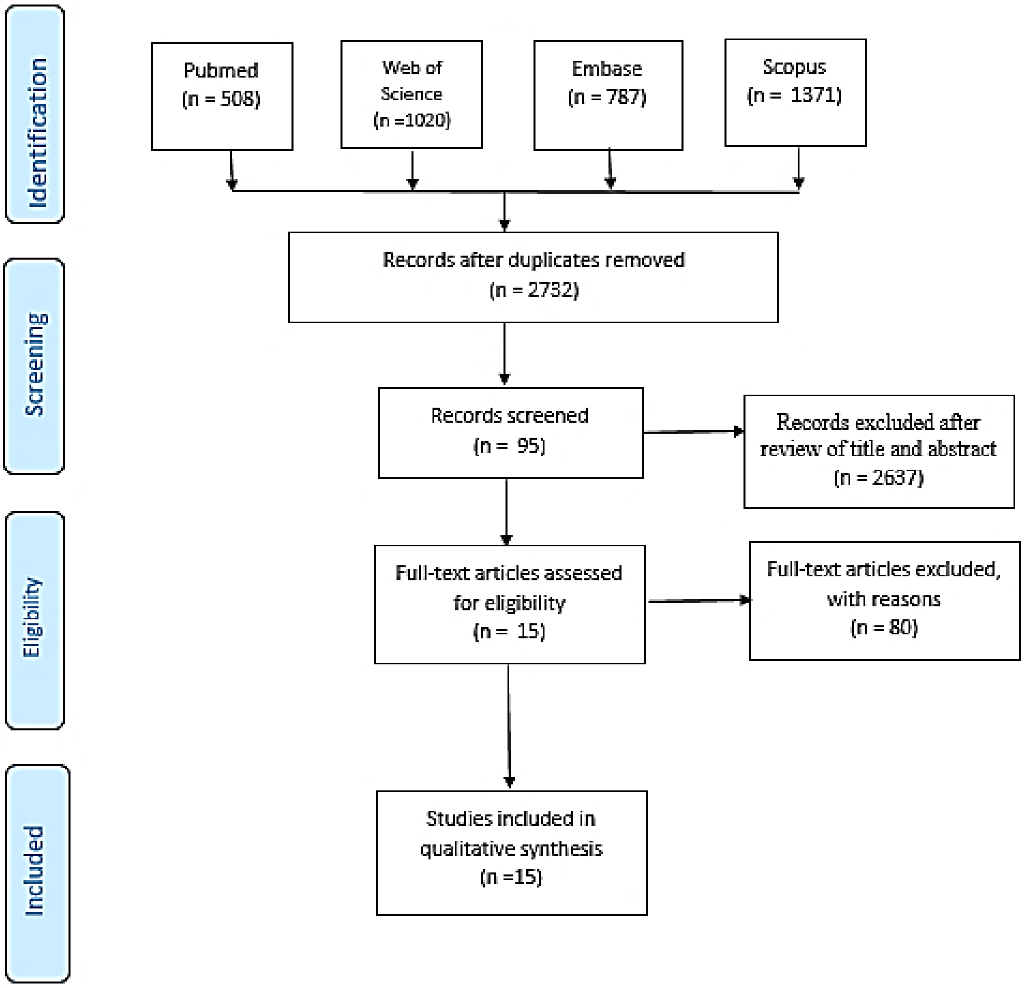

Figure 1. PRISMA flow diagram of literature search and selection

Characteristics of the included studies

The majority of articles (n=10) (30,32,34,36,37,40-44) were conducted in the US, and one study in Spain (31), Italy (33), Vietnam (35), Argentina (38), and Canada (39). The number of patients in the experimental group and control group equaled 1936 and 2058, respectively. Participants aged from 21 to 62 years. The most frequently used mobile technology was smartphones in nine articles (30-32,34-39), followed by telephone in five articles (33,41-44) and PDA in one article (40). The duration of the intervention varied from 2 to 18 months.

Functionalities of mobile technology

The functionalities of mobile technologies for self-management of patients with hypertension were divided into five categories (monitoring the patients, providing alarms, providing feedback, education, and communication with healthcare providers). The same classification was adopted in other studies for conditions such as cancer (45) and pain management (46).

Functionalities used in mobile technologies

Most functionalities used in mobile technologies for self-management of hypertension were communications and alarms, education, monitoring, and feedback, in that order. The majority of combination functions used by the studies was the simultaneous use of monitoring, alarm, education, and communication in eight studies (30,31,35,36,40-43).

The modules used in alarms and feedback included setting alarms for taking medications, alarms in the case of taking the wrong dose, sending encouraging messages in the case of taking the right dose, and sending messages in case of incomplete information and reminding time of visits (30-32,34-36,41,43).

The data collected on healthcare providers were delivered to the patients and included additional self-care information on alternative medications in case of increased blood pressure, questions on recent values of blood pressure higher or lower than the normal level, adherence to medications, amount of salt consumed, and lifestyle (30-32,35,36,43).

Education was provided to the patients through telephone calls or text messages. The content of the text messages included educational information on healthy diets, salt consumption, scheduling the consumption of hypertension medication, the importance of consumption of medication, and adherence to treatment (30,31,40-44).

In terms of monitoring, the intervention included installing the app on patients' smartphones and having doctors teach them how to use it. This application included modules for recording personal information, recording doctor's notes on medications, setting alarms, setting appointments, recording the results of blood pressure measurement, sending alarms to patients in case of high blood pressure, and education. Patients sent the measured value of blood pressure through the mobile app to healthcare centers. Then, if healthcare providers viewed abnormal blood pressure in patients' data, they would call the patients and remind them to take the medications or provide the necessary education (30-32,34-36,41,43).

Intervention outcomes

Measurement and control of hypertension was the primary objective of all the reviewed articles. The results of using mobile technologies revealed that the majority of articles (n=12) noted the positive effect of using these technologies in controlling hypertension in the experimental group compared to the control group (30-33,35-37,40-44). The mean reduction in blood pressure was in the 2-26 mmHg range in the experimental groups (30-32,35,37,40-42).

In these studies, smartphones were the most frequently used technology (30-32,35-37). The most frequently used functions for the effective control of hypertension in mobile technologies was the simultaneous use of monitoring, alarms and reminders, education, and communication with healthcare providers (30,31,35,36,40-43). On the other hand, the results of three articles indicated that the use of mobile technologies in comparison with routine methods had no effect on controlling and lowering blood pressure (34,38,39).

Discussion

The present systematic review examined the effects of using mobile technologies on hypertension reduction as well as self-management aspects of this disease. Based on the findings, mobile technologies decrease blood pressure in comparison with routine treatment methods in the experimental group compared to the control group. The majority of the examined articles reported that mobile technologies decrease blood pressure. A review study was conducted by McLean *et al*., to examine the effect of digital interventions on supporting self-management in patients with hypertension and the reduction of blood pressure. Results demonstrated the positive effects of digital interventions on supporting self-management and reducing systolic and diastolic blood pressure (47). Moreover, Alessa *et al*., explored the effects of using mobile apps on self-management of patients with hypertension and reduction of blood pressure level. Based on the results, most apps effectively decreased blood pressure (25). Other studies have also reported the positive effect of using a tablet- and mobile-based interventions on controlling chronic conditions, including hypertension. These results reveal that mobile technologies have high potentials for use in self-management of chronic conditions (48-50). From among the mobile technologies examined, smartphones had the most effect on control and self-management of hypertension, and significantly reduced blood pressure and enhanced the self-management aspects of the disease. Mobile technologies are a beneficial and accessible solution for promoting the self-management aspects of chronic conditions (49,51). The literature shows that the growth and expansion of smartphones and their different functionalities can greatly contribute to self-management in hypertension (52,53). In this study, mobile technologies employed various functionalities combined with controlling blood pressure. All studies used more than one functionality in these technologies. The majority of functionalities with the highest effect on hypertension control were monitoring, alarms, education, and communication with healthcare providers. Using smartphones, patients send their measured blood pressure values to healthcare providers who sent alarms or educational content to patients based on their information. Smartphones can support apps and thus employed for monitoring hypertension. By sending text messages, they improve and facilitate communications, alarms, and education (35-37). In similar studies, the use of combined functionalities of mobile apps has enhanced hypertension control (25). Moreover, the use of text messaging as reminders and for monitoring blood pressure using mobile apps greatly affect hypertension control (54,55). The review study by Abu Dagga *et al*., showed that the use of distant monitoring is effective for hypertension control, and patients actively participated in the process. Moreover, this distance monitoring provided patients with valuable information on hypertension management and control from healthcare providers (56). The use of distant monitoring establishes effective communication between patients and healthcare providers, and thus provide more rapid access to healthcare providers and offer timely educational information to patients to better control their blood pressure. It also controls costs and enhances adherence to the treatment plan (57). Mobile technologies have a wide spectrum of functionalities, including text messaging, pictures, videos, Internet access, multimedia playing, and app support (24). Various studies have evaluated the use of mobile technologies to be positive in supporting self-management of hypertension (58,59).

Strong points and limitations of the study

This systematic review examined the effect of mobile technologies on blood pressure and the self-management aspects of hypertension. Four databases were searched using a comprehensive search strategy, and relevant articles were retrieved. The functionalities used in mobile technologies for self-management of hypertension were also classified and introduced. The first limitation of this study was the exclusion of articles in languages other than English, which limited the sample size. The second limitation was the unavailability of the full text of some articles. The third limitation was restricting the search to clinical trials and excluding articles that had assessed co-morbidities (such as stroke, diabetes, and pregnancy). This study aimed to investigate the effect of mobile technologies on self-management in hypertension and the reduction of blood pressure. The results of this systematic review revealed that self-management supported by using mobile technologies positively affect blood pressure control. The use of mobile technologies for blood pressure control can help in different ways: setting reminders and alarms for taking the medication at the right time which enhances patients' adherence to the treatment plan; establishing effective communication between patients and healthcare providers for receiving guidance on medications or education on lifestyle, nutrition, and behavior changes for reducing blood pressure; and the use of sensors for monitoring the trend of vital signs and physiological conditions for distance monitoring and receiving feedback.

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