



Systematic Review

**Effectiveness of Mobile-Based Health Interventions for the Management of Hypertensive Patients: A Systematic Review**

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**ABSTRACT**

**Introduction:** Cardiovascular disease is one of the biggest causes of death in the world. Hypertension is known as a major risk factor for morbidity and mortality in cardiovascular disease. Adherence to treatment is very important to overcome the problem, prevent complications, and prevent prolonged hospitalization in hypertensive patients. With the ever increasing technological development and the popularity of the use of internet-connected cellphones among the public, mobile-based and internet-based health interventions can be the right choice for the management of hypertensive patients. This study aimed to conduct a systematic review of the effectiveness of health interventions based on mobile health interventions for the management of hypertensive patients.

**Methods:** This systematic review used the related elements to content chosen by the PRISMA statement and using specific keywords in the database; Ebscho, ScienceDirect, Elsevier, Sage Journals, Scopus, and ProQuest, limited to the last five years, 2016 to 2020, obtained 13 articles.

**Results:** There were 13 articles that matched the inclusion criteria. There are various forms of intervention: from Short Message Services (SMS), smartphone applications, WeChat, and a combination of SMS with smartphone applications.

**Conclusion:** Most studies report the value of customer satisfaction and high acceptance of each of the interventions provided. Mobile-based health interventions are effective in controlling blood pressure and can improve adherence to treatment in hypertensive patients.

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**INTRODUCTION**

Cardiovascular disease is the leading cause of death due to non-communicable diseases (WHO, 2017). Hypertension is one of the main risk factors for cardiovascular disease (WHO, 2017). At present, it is estimated that >1.5 billion people worldwide suffer from hypertension (Ma et al., 2015). Hypertension is defined as systolic blood pressure greater than 140mmHg and diastolic blood pressure greater than 90mmHg. The prevalence of hypertension in Indonesia in 2018 reached 34.1%, based on measurements of the adult population (≥18 years). Furthermore, 45.6% of these patients do not take their medication regularly. Most of them (59.8%) do

not feel any symptoms while some others often forget (Kemenkes RI, 2018).

Adherence to therapy by providing antihypertensive agents is very important to control symptoms, prevent complications of hypertension, and prevent prolonged hospitalization. However, non-compliance with long-term therapy is a barrier to the effectiveness of therapy and is still a global problem today. It is known that up to 50% of patients with cardiovascular disease have poor therapeutic compliance (Omboni, 2019). Reducing the patient's blood pressure level can reduce the incidence of stroke and cardiovascular events, significantly improve the quality of life of patients, and effectively reduce the burden of disease (Andre, Wibawanti, & Siswanto, 2019).

Complex interventions often take a lot of time and require a lot of effort and high costs. Therefore, it is necessary to develop interventions that are easy, and can be applied in daily practice. One example of an easy and simple intervention is to improve patient response to therapy by remote monitoring. Telenursing / telehealth as part of telemonitoring is a way to provide nursing care using telecommunications and mobile-based information technology. With the increasing technological development, the popularity of the use of internet-based cellular phones has spread widely among the people; therefore, new models of health approaches through cellphones and information technology are increasingly being used in blood pressure management and become the right choice for overcoming non-compliance with drug use by providing medication reminder applications, providing healthy lifestyle education, measuring vital signs, consulting nutrition and keeping records of biometric measurements.

Continuing health interventions for patients returning from mobile cell-based hospitals and using internet networks solve the problem of long space distances in big cities and uncomfortable transportation between urban and rural areas and the community, which causes difficulties for patients seeking medical care, and this method of education is more flexible and diverse. Therefore, the aim of this study is to conduct a systematic review of the effectiveness of health interventions based on mobile health interventions for the management of hypertensive patients.

**MATERIALS AND METHODS**

A systematic review consists of five steps: (1) identification of instruments in the literature (database search); (2) identification of relevant literature based on title and abstract; (3) inclusion and exclusion criteria; (4) get the full text of the literature; (5) the assessment is based on the literature component and analysis of the chosen instrument. This systematic review used the related

elements to content chosen by the PRISMA statement in the database Ebsco, ScienceDirect, Elsevier, Sage Journals, Scopus, and ProQuest and is limited to the last five years, 2016 to 2020, obtaining 13 articles. Next, the search results are narrowed down through the selection process illustrated by Figure 1. Two main research areas are considered to design the search strategy as follows: (1) Diseases and conditions; like hypertension and blood pressure, (2) Mobile-based health intervention areas; such as applications, cellular programs, car applications, and mHealth.

Based on the determination of keywords according to the topics contained in the PRISMA statement, and complemented by the Boolean Logic method (ScienceDirect, Sage Journal, Scopus, ProQuest, PubMed) then the English keywords used are "hypertension", "pressure blood, "AND" mobile applications, "AND" mobile health,, "AND" randomized controlled trials "AND" cellular health".

The inclusion criteria for this study were randomized controlled trials using telephone-based health interventions and reminders with cellphones (SMS, telephone), e-mail, android applications for remote health interventions for blood pressure management in hypertensive patients; all research subjects met the criteria diagnostic for hypertension, that is, systolic blood pressure  $\geq 140$  and / or diastolic blood pressure  $\geq 90$  mmHg (1 mmHg = 0.133 kPa); the study was a randomized controlled trial, clear outcome indicators were included; and the patient's age, sex, source of cases, course of disease, and types of hypertension are unlimited. Type of experimental group intervention (distance health intervention); control group (traditional nursing intervention). Main outcomes measured in the study: systolic blood pressure (mmHg) and diastolic blood pressure (mmHg), secondary outcome: medication adherence; and regular blood pressure measurement; reasonable diet; smoking cessation and restriction alcohol, heavy control, adhering to proper exercise, knowledge about prevention and treatment of hypertension and its dangers. Exclusion criteria are articles about providing interventions other than telephone-based

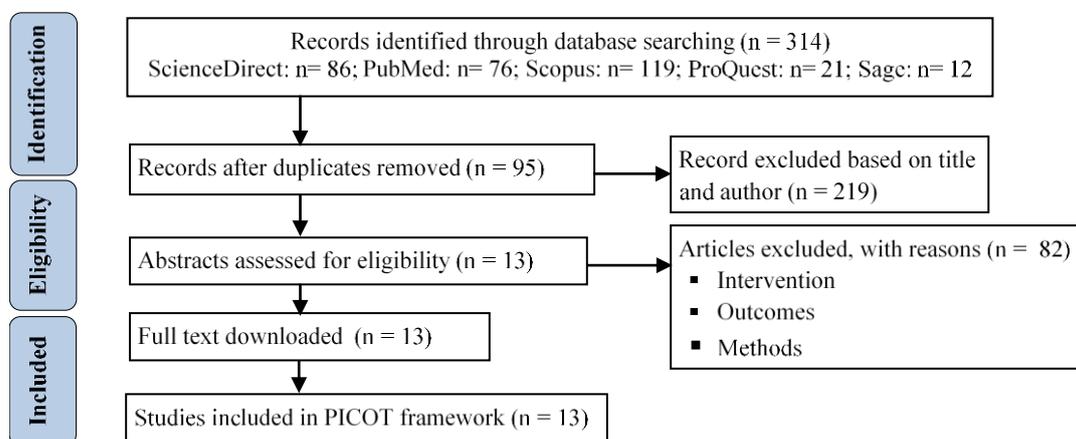


Figure 1 – Flow chart of the study identification process (Liberati, 2009) (A. Liberati et al, 2009)

Table 1. Summarize of selected studies

Author (year)	Design	Sample Size	Intervention Group	Control Group	Outcome
Meurer, W. J. et al., (2019)	RCT	104	Type: SMS Frequency : 1 day / week Duration : 3 months	The control group was instructed to follow up with their primary care doctor for treatment.	The intervention group had significant BP reduction over time with a mean drop of 9.1mm Hg (95% confidence interval = 1.1 to 17.6)
Chandler, et al., (2019)	RCT	54	Type: Smartphone applications (SMASH ) combined with SMS Frequency : every 3 days in the morning and evening. Duration : 9 months	The enhanced standard care (ESC) participants received text messages, including links to PDFs and brief video clips containing healthy lifestyle tips for attention control.	The SMASH group reported significantly greater increases in medication adherence at each evaluation.
Rehman, et al., (2019)	RCT	120	Type: SMS Frequency : during their clinical checkup visits Duration : 3 months	The control group relied only on medication therapy to control hypertension	The intervention group showed better hypertension control, with systolic blood pressure (SBP) declining by 8mmHg to 141.15 ± 5.73mmHg, and diastolic blood pressure (DBP) declining by 6mmHg to 88 ± 3.97mmHg. The control group showed a 2mmHg and 3mmHg decline in SBP and DBP, respectively.
Marquez Contreas, et al., (2019)	RCT	154	Type: Smartphone applications (ALERHTA) Frequency : - Duration : 12 months	Control group with usual intervention (Control every 6 months of blood pressure, annual control of therapeutic adherence, annual analysis and biannual electrocardiogram)	1. The intervention group had a higher level of adherence to take daily dose intake. (p<0,001) 2. The intervention group had a higher control of high blood pressure at 12 months (p<0.05).
Tobe, S. et al., (2019)	RCT	243	Type: Active text messaging Frequency : - Duration : 2 months	Passive text messaging (described healthy lifestyle and behavior changes )	Blood pressure results overall showed a fall throughout the study in both groups, but there was no difference between the groups. The main study hypothesis that active text messages would lead to more BP lowering than the passive messages alone was not proven.
Li, T., Ding, et al., (2019)	RCT	492	Type: WeChat Frequency : - Duration : 6 months	Usual care	The intervention group had a higher control blood pressure
Bobrow, et al., (2016)	RCT	1372	Type: SMS text-messages Frequency : - Duration : 12 months	Usual care	There was no significant differences in blood pressure control between all groups There was no evidence that an interactive intervention increased this effect
Varleta, P. et al., (2017)	RCT	314	Type: SMS Frequency : - Duration : 6 months	Usual care	Adherence to hypertensive drugs improved significantly in the intervention group from 49% to 62.3% (p= 0.01) BP reduction was higher in the intervention group
Monroe, V. D. (2018)	RCT	67	Type: Mobile applications combine with SMS - OnTimeRx® application Frequency : - Duration : 3 months	Only used mobile applications	1. The use of software applications that have a reminder service could significantly and positively impact medication adherence

Author (year)	Design	Sample Size	Intervention Group	Control Group	Outcome
Zha, P. et al, (2020)	RCT	30	Type: Smartphone applications Frequency : - Duration : 6 months	Standard care	<ol style="list-style-type: none"> <li>1. There was no statistically significant difference in systolic and diastolic BP between the two groups at baseline, 3 months, and 6 months.</li> <li>2. The mHealth group demonstrated higher BP monitoring adherence across the study period compared with the standard group.</li> <li>3. mHealth group was more likely to have greater adherence in taking prescribed antihypertensive medications and consequently experienced better hypertension control.</li> </ol>
Movahedi, et al., (2019)	RCT	188	Type: SMS Frequency : 1 time/day Duration : 2 months	Usual care	<ol style="list-style-type: none"> <li>1. BP reduction was higher in the intervention group</li> <li>2. SMS training would be an effective method to control hypertension.</li> </ol>
Morawski, K. et al., (2017)	RCT	413	Type: Smartphone applications- Medisafe Frequency : Duration : 3 months	Usual care	<ol style="list-style-type: none"> <li>1. After 12 weeks, those in the intervention arm decreased their blood pressure by 10mmHg more than the control group.</li> <li>2. statistically significant increase in self-reported medication adherence after 4 weeks</li> </ol>
Li, X. et al., (2019)	RCT	253	Type: WeChat- Frequency : Duration : 6 months	Usual care	<ol style="list-style-type: none"> <li>1. Individuals who participated in the intervention program had better BP monitoring, improved their hypertension self-management as well as parts of their disease knowledge and self-efficacy.</li> <li>2. The WeChat-based self-management intervention may be a feasible and efficient program to help Chinese community middle-aged and elderly hypertensive patients lower BP and improve self-management.</li> </ol>

health interventions, non-randomized controlled trial literature (RCT); inconsistent baseline data; no specific intervention time; treatment measures do not meet the selection criteria.

## RESULTS

In this review, we examine the effectiveness of mobile-based interventions in controlling blood pressure in hypertensive patients and treatment

compliance for hypertensive patients. We analyzed 13 articles from various publicly publicized countries that fit the inclusion criteria that we had set. Overall, 10 of the 13 studies showed that using telephone-based health interventions was effective in controlling blood pressure in hypertensive patients. This systematic review includes research with a randomized control trial design. Some interventions used in this research study include SMS, WeChat, smartphone applications and SMS combined with

smartphone applications. The majority of studies (6 of 13) used SMS as interventions (Meurer et al., 2019), (Rehman, Naeem, Abbas, Ashfaq, & Hassali, 2019), (Tobe et al., 2019), (Bobrow et al., 2016), (Movahedi, Khadivi, Rouzbahani, & Tavakoli-Fard, 2019), (Varleta et al., 2017), three studies used smartphone applications (Márquez Contreras et al., 2019), (Zha et al., 2020), (Morawski et al., 2018), two studies used chat applications namely WeChat (T. Li, Ding, Li, & Lin, 2019), (X. Li et al., 2019) and two studies used SMS combined with smartphone applications (Chandler et al., 2019), (Monroe, 2018). The interventions given in each article mentioned the average intervention for two to 12 months. Overall, 10 of the 13 studies showed that the use of telephone-based health interventions was effective in controlling blood pressure and increasing adherence to treatment therapy. Most studies report the value of customer satisfaction and high acceptance of each of the interventions provided.

The advantages that can be observed in the intervention by using smartphone related applications are interesting features, easily accessed anytime and anywhere because smartphones are always carried everywhere.

### **SMS**

Most studies (6 of 13) used SMS as an intervention. Interventions were by sending text messages explaining health education about hypertension (definitions, signs and symptoms, complications, control methods), reminders to measure blood pressure, discuss healthy lifestyle to reduce blood pressure such as reducing salt consumption, increasing fruit and vegetable intake, smoking rehabilitation, anxiety reduction, selection of the right oil, appropriate body weight and regular physical activity. In addition, short messages also discussed the importance of compliance in using drugs. Text messages are sent routinely according to a schedule determined by the researcher. In studies using text messaging interventions, almost all have shown significant results in increasing adherence to antihypertensive drugs and improving blood pressure control. Text messaging offers attractive choices for behavioral interventions, given its popularity in underserved populations, low costs, ease of adoption, scalability, and the ability to reach people in real time while remaining flexible and comfortable (Meurer et al., 2019)

### **Smartphone Applications**

There are three studies using smartphone applications as interventions. Several studies using smartphone application interventions use a blood pressure measuring device whose results are sent to a smartphone via Bluetooth that is connected directly to the server, which can be accessed by health workers, so they can provide feedback related to health conditions or the results of blood pressure measurements of patients. Other features provided

through the smartphone application are health education about hypertension, reminders to measure blood pressure regularly and reminders to take medication. The average results from all studies using the smartphone application as an intervention show effective results in lowering blood pressure and increasing adherence in the treatment of hypertension. Research conducted by (Márquez Contreras et al., 2019) with a total sample of 144 patients undergoing antihypertensive treatment showed the results that the intervention group had a higher level of adherence to taking hypertension medication every day compared to the control group.

### **WECHAT**

WeChat-based research interventions containing health education, health promotion, group chat, and blood pressure monitoring (BP) are used as a combination of modalities. Research conducted by (T. Li et al., 2019) consists of four types, namely health education about hypertension, health promotion about healthy lifestyles, how to avoid hypertension, how to control weight, group chat about the third two weeks containing individual experiences in disease management, and reporting on their physical condition and current life status, most recent active tracking of participants' blood pressure about patients reporting blood pressure measured by patients at home and researchers providing feedback on patients' monthly blood pressure reports. The difference between the WeChat intervention and the others is that there is a chat feature that can be used as a sharing between members of the intervention group.

### **Smartphone Applications combined with SMS**

The research intervention by combining sending SMS and smartphone applications was used by two studies in this systematic review. One in this study is that participants measure blood pressure every three days in the morning and evening using a Bluetooth monitor that is paired with a smartphone application (SMASH), while SMS messages were sent to remind participants to measure blood pressure and remind them to take hypertension medication regularly

### **DISCUSSION**

Adherence to medication and blood pressure control is very important to control symptoms, delay development, and prevent the recurrence of hypertension (Alessa, Abdi, Hawley, & Witte, 2018). In this industrial era 4.0, the use of mobile-based health interventions will optimize the provision of nursing care which is not limited by distance and time (Wu et al., 2019). In addition, the use of smartphone applications offers new strategies for patients and their families to be more actively involved in the care of hypertensive patients (Márquez Contreras et al., 2019). Overall results show increased treatment adherence in hypertensive patients and increased blood pressure control. Although the types of

interventions differed in each study, the results in line with all of them had a positive effect. Health interventions for hypertension patients based on cell phones obtained from the results of a literature review study of 13 articles can be divided into four types: text messaging, WeChat chat application, smartphone application and SMS combination with smartphone application. All have the role of giving reminders of drug intake, reminders of independent blood pressure monitoring, or reminders of routine clinic visits. This is very important considering that it is not uncommon to encounter hypertension patients who use drugs and only visit the clinic when there are complaints, making the antihypertensive prevention role inefficient. Noting blood pressure fluctuations is also very important for hypertensive patients and healthy patients, to prevent recurrent hypertension. Mobile-based health interventions using smartphone applications as interventions have been proven effective in controlling blood pressure in hypertensive patients (Andre et al., 2019), (Alessa et al., 2018). As in the study conducted by (Zha et al., 2020), which conducted a 6-month mHealth application trial of underserved urban communities with high numbers of hypertensive patients, and showed a significant increase in adherence to blood pressure monitoring controls themselves.

The use of mHealth to motivate and facilitate adherence to treatment regimens can be significant for self-management of chronic hypertension and preventing complications (Andre et al., 2019), (Lakshminarayan et al., 2018). Text messaging interventions offer attractive options for behavioral interventions, given their popularity in underserved populations, low costs, ease of adoption, scalability, and the ability to reach people in real time while remaining flexible and comfortable (Movahedi et al., 2019)(Chandler et al., 2019). Text messages contain health education about hypertension, motivation to take medication regularly, and reminders when there are schedules for clinic visits (Movahedi et al., 2019), (Varleta et al., 2017). Research conducted in Pakistan (Rehman et al., 2019) for three months showed good results in increasing adherence to non-pharmacological treatment of hypertension. Interventions with SMS generally contain personal data about the indications and motivations of patients and the appropriate barriers and information relating to health education / related diseases. Based on the results of research, the use of SMS can support monitoring of adherence to specific intervention treatments in patients with hypertension (Kim, Wineinger, & Steinhubl, 2016). The third intervention of the WeChat application is not much different from the cellular and SMS applications, the difference in WeChat being that there is a group chat room for hypertension sufferers to discuss with each other related to the disease. Group chats create a positive group environment for patients by sharing personal self-management experiences, and personal chats provide personalized advice for patients, which will

increase their confidence in disease control (T. Li et al., 2019). Participants in the intervention group did indeed receive social support from other patients in the same chat group and from health workers during the six-month intervention(X. Li et al., 2019).

The overall results of this study indicate an increase in the level of adherence in the treatment of hypertension and an increase in blood pressure control. In addition to increasing compliance with hypertension treatment, health interventions using mobile phones also improve healthy lifestyle habits for hypertensive patients (Morawski et al., 2018), (Sarfo et al., 2019). The mechanism of health interventions can influence blood pressure control and improve medication adherence, namely measuring blood pressure itself and reporting the results regularly, will increase patient awareness about the condition of their illness so that it leads to positive behavior to support their condition. Providing health education will increase knowledge related to illness and understanding and confidence to conduct self-management so that it will change the lifestyle that is less good (Andre et al., 2019), (Sarfo et al., 2019), (Midlöv et al., 2019)

## CONCLUSION

Mobile-based health interventions are easy to apply to hypertensive patients and are not limited by distance and time so that they can improve adherence to treatment, and improve blood pressure control well. Technological advances make smartphones a promising alternative, but more evidence-based research is needed for related learning outcomes to be obtained.

## CONFLICT OF INTEREST

No Conflicts of interest have been declared.

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