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EFFECTIVENESS OF M-HEALTH INTERVENTIONS ON PATIENT RESPONSE TO HYPERTENSION AND CORONARY HEART DISEASE: SYSTEMATIC REVIEW

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ABSTRACT

Background*: mHealth strongly supports chronic disease care and the most promising health improvement activities.* ***Objective****: A systematic review was conducted to assess the effectiveness of mHealth interventions on the response of hypertensive patients and coronary heart disease.* ***Method****: Search articles using five search engines published from January 2015 to December 2020 on PubMed, Medline/CHINAL, ProQuest, Scopus and Mendeley. Focus on searching for articles to determine the effectiveness of smart mobile on the response of patients with hypertension and coronary heart disease.* ***Results****: The 16 articles reviewed were divided into two topics, eight discussing the effect of smart mobile with coronary heart disease and eight articles discussing the effect with hypertension. It was found that there were three forms of responses in the systematic review. The patient's response was physiological response (Blood Pressure 11 articles, Cholesterol and LDL 5 articles, Body Mass Index and Weight 5 articles, Pulse 1 article), psychological response (Self-Confidence 2 articles, Attitude 1 article, Self-Awareness 1 article, Stress 1 article, Depression 1 article, QOL (quality of life) 2 articles and Cognitive and Behavioural Responses (Knowledge 2 articles, Adherence 10 articles, Lifestyle Modification : Diet 2 articles, Smoking 4 articles, Physical Activity 6 articles, Alcohol 1 article).* ***Conclusion****: Smart mobile for CHD and Hypertension patients is effective against patient responses such as physiological responses, psychological responses, and cognitive and behavioural responses.*

Keywords/Keywords *Smart Mobile; Hypertension; Coronary Heart Disease; Physiological Response; Psychological Response; Cognitive and Behavioural Responses*

INTRODUCTION

Hypertension and Coronary Heart Disease are part of cardiovascular diseases and non-communicable diseases as well as chronic diseases. Hypertension or high blood pressure is an increase in Systolic Blood Pressure (SBP) of more than 140 mmHg and Diastolic Blood Pressure (DBP) of more than 90 mmHg at two measurements with an interval of five minutes in a state of adequate rest/calm (Kemenkes, 2019). The global prevalence of hypertension shows around 1.13 billion, meaning that 1 in 3 people in the world is diagnosed with hypertension. The overall prevalence of hypertension in adults is around 30-45%, with global standards of 24% prevalence in men and 20% in women respectively (WHO, 2013).

Patients with hypertension are 2-5 times more likely to experience Coronary Heart Disease (CHD) than those who are not hypertensive (Monica et al., 2019; Amisi et al., 2018). The longer patients have hypertension, the more likely they are to get CHD. The number of CHD patients with a history of hypertension is greater than CHD patients with a history of diabetes mellitus (Monica et al., 2019 ; Yulsam et al., 2015). WHO data in 2020 shows that 74% of deaths in the world are caused by Non-Communicable Diseases (41 million people each year) (GBD Compare, 2019). Greater mortality in CHD patients with low socioeconomic status is due to lack of awareness of symptoms in patients and primary care, unreached facilities and infrastructure, lack of drug availability. Strategies implemented by sharing the duties of existing health workers in the community, utilizing new strategies for risk factor control are also needed. Education on medical management by doctors, nurses, and health workers should be strengthened (Gupta & Yusuf, 2019).

Facing the era of digitalization, *mobile health* can improve self-management of chronic disease patients. mHealth is still considered a stage in developing applications for information and communication technology in the field of healthcare. The intensive development of mHealth results from close universal access to mobile devices, especially smartphones, and devices using sensory technology. mHealth strongly supports chronic disease care and the most promising health improvement activities. The increasing interest in mHealth is evidenced by the many publications that present a synthesis of various research results (Duplaga & Tubek, 2018). Innovation in the field of nursing about mHealth has also been widely researched called telenursing. The results of literature studies show that telenursing helps improve access to comprehensive health services such as patients easily provide news about their health condition after the recovery process or when they start getting sick to nurses, who have been trusted but can also provide health education interventions easily (Boro & Haryati, 2020). The literature study on the effectiveness of telehealth used in mental patients also explains that the application of telehealth can help patients to gain well-being in mental health for patients with *posttraumatic stress disorder* and is an appropriate method in improving the social skills of schizophrenic patients (Fadllah et al., 2019; Hasibuan et al., 2019).

Given that hypertension and heart disease are chronic diseases, a systematic review needs to be assessed on the effectiveness of comprehensive use of mHealth. Currently, a systematic review of the use of mHealth for hypertension and CHD is still separated between physical responses, psychological responses as well as cognitive and behavioural responses. Therefore, the purpose of this systematic review is to conduct a *systematic review* that assesses the effectiveness of mHealth interventions on patient responses comprehensively including physical, psychological, cognitive and behavioural responses in hypertension and CHD.

METHODS

Systematic review in the first stage identifies and defines questions correctly and precisely, and is one of several aspects in systematic review (Ham-Baloyi & Jordan, 2016). The format used to answer the research question is PICO (*Population, Intervention, Comparation, Outcome*) and uses PRISMA (Fig. 1). **The population** includes patients with hypertension and coronary heart disease; **Interventions** using *smart mobile*; **Comparison** uses a control group comparator using usual care; and **Outcome** uses patient response (Table 1). The question in this study is: Is *smart mobile* effective for response in hypertensive and CHD patients compared to usual disease management?

Article Search Strategy

A comprehensive study was conducted to determine the effectiveness of using *smart mobile* on patient response to hypertension and coronary heart disease. Research articles are research originating from all countries and published in English. The study used six data-based PubMed, CINAHL, MEDLINE, ProQuest, Scopus, Mendeley from 2015-2020 to find relevant publications. Search terms are included with "smart mobile", "mobile app", "smartphone", "cell phone", "mobile phone", "portable app", "mobile technolog*", "app", "mobile healthcare", "mHealth", "hypertension", "myocardial ischemia", "heart muscle ischemia", "Coronary Heart Disease*", "Ischemic Heart Disease*". Aspect analysis is applied in terms of more focused searches (table. 2). Terms related to research questions are combined using Boolean operators (OR, AND). The Boolean operator 'OR' brings together all identified terms to improve the sensitivity of the findings. In contrast, the Boolean operator 'AND' is used to increase the specificity of findings by narrowing the search and identifying articles that discuss PICO elements. Truncation (*) if appropriate to improve search.

Table 1. PICO

P (Population)	I (Intervention)	C (Comparison)	O (Outcome)
Hypertensive patients and coronary heart disease	*Smart mobile*	Usual care	Patient response in the form of physiological responses, psychological responses, and changes in lifestyle behaviour

Eligibility Criteria

The articles searched have inclusion and exclusion criteria (table 1). Focus on searching for articles to determine the effectiveness of *smart mobile* on the response of patients with hypertension and coronary heart disease. Female and male adult patients aged 18-60 years using *smart mobile* can be in the form of *mobile applications, smartphones*, *mobile technology*, *mobile health* which contains short messages, structured education, motivation and notifications. The patient's response was physiological (Blood Pressure, Cholesterol and LDL, Body Mass Index, Weight, Pulse), psychological response (Self-Confidence, Attitude, Self-Awareness, Stress, Depression, QOL (quality of life) and Cognitive and Behavioural Responses, Knowledge, Adherence, Lifestyle Modification: Diet, Smoking, Physical Activity, Alcohol).

Study Type

The studies used in *the systematic review* were all *randomised controlled trials* (RCTs) to evaluate the effectiveness of *smart mobile* on the response of hypertensive patients and coronary heart disease. The reason for using RTCs is considered the "*gold standard*" for evaluating the effectiveness or failure of selected interventions (Ann, 2014); therefore resources, feasibility and ethical considerations are taken into consideration, RCT is the best method to address the questions in this *systematic review*.

Article Search Strategy

Table 2. Search strategy (a), article selection inclusion and exclusion criteria (b)

a		
Population		**Intervention**
Hypertension	AND	Smart Mobile (MeSH term)
OR		OR
Myocardial ischemia		Mobile app
OR		OR
Heart muscle ischemia		Smartphone
OR		OR
Coronary Heart Disease*		Cell phone
OR		OR
Ischemic Heart Disease*		Mobile phone
		OR
		Portable app
		OR
		Mobile technolog*
		OR
		App
		OR
		Mobile healthcare
		OR
		mHealth

b	
Inclusion	Exlusion
Original article	Research whose patients have complications or additional comorbidities
Randomized controlled trials	Studies in children
English	Studies that have multiple modalities
Minimum publication 5-10 years (2015-2020)	
Male or female patients 18-60 years	
Using *smartphone web*, SMS, other applications	
Research using control groups	

RESULT

Search Results

Total articles found in databased amounted to 758 articles, PubMed (n = 105), CINAHL/MEDLINE (n = 175), ProQuest (n = 392), Scopus (n = 70), Mendeley (n = 16). Articles that had been identified as duplicates using Mendeley desktop were 250 articles then combined. Articles after being filtered and excluded through the article title and reading the article abstract (n=130) entered the inclusion and exclusion criteria (n=120). The total number of full text articles issued (n = 104) and the number of articles investigated was 16. Study selection is shown in Figure 1 using the PRISMA flowchart

Article Characteristics

The characteristics of the article are reviewed from the origin of the country, the number of samples involved in the research, the duration of the study. There were 16 articles selected, including 8 articles (50%) related to *smart mobile* in Coronary Heart Disease (Chow et al., 2015; Johnston et al., 2016; Redfern et al., 2020; Santo et al., 2018; Shariful Islam et al., 2019; Tongpeth et al., 2020; Zhang et al., 2017; Zheng et al., 2019) and 8 articles (50%) discussing *Smart Mobile* in hypertension (Chandler et al., 2019; Gong et al., 2020; Jahan et al., 2020; Kim et al., 2016; Morawski et al., 2018; Persell et al., 2020; Rehman et al., 2019; Varleta et al., 2017).

Based on country origin, articles discussing CHD have four countries including Australia occupying the most frequency, namely five articles (62.5%), followed by Sweden, Singapore, and China (12.5%, 12.5%, 12.5%) while articles discussing hypertension have five countries, including the United States there are four articles (50%), followed by each of China, Bangladesh, Pakistan and the United Kingdom (12.5%, 12.5%).

The number of CHD patients studied in the entire article was 4183 people divided into two groups, namely the intervention group of 2060 people and the control group of 2123 people while the total number of hypertensive patients in the article was 2157 people where the control group was 1063 people and the intervention was 1094 people. The duration of the study in both CHD and hypertensive patients in the range of 1-12 months (Table 3).

The characteristics of *smart mobile* used in the article are classified into two forms, namely applications both on smartphones and websites and in the form of short messages or SMS. Content from the Application and short messages such as providing education, motivation, lifestyle modification, blood pressure monitoring, medication orders, and prevention procedures.

Outcome Article

Physiological Response

Blood pressure

The sixteen articles reviewed consisted of eight discussing coronary heart disease articles and eight discussing hypertension articles. Three out of eight (37.5%) found results related to blood pressure (Redfern et al., 2020; Santo et al., 2018; Zheng et al., 2019). Eight articles of hypertension found that there were seven out of eight articles whose outcomes were related to blood pressure (Chandler et al., 2019; Gong et al., 2020; Jahan et al., 2020; Kim et al., 2016; Morawski et al., 2018; Persell et al., 2020; Rehman et al., 2019).

In smart mobile CHD patients, there was no significant difference between the intervention and control groups mean systolic blood pressure (136.3 vs. 136.4 mmHg, mean difference 0.12 mmHg, 95% CI −2.21 to 2.45, p = 0.92) after 12 months (Redfern et al, 2020), Although there was no statistically significant difference, the intervention group's systolic blood pressure was lower than the control group after six months of intervention (Zheng et al., 2019). In contrast to research Chow et al., (2015) There was a significant difference in systolic blood pressure between the control and intervention groups, namely the intervention group 128.2 mmHg and the control group 135.8 mmHg p< 0.001.

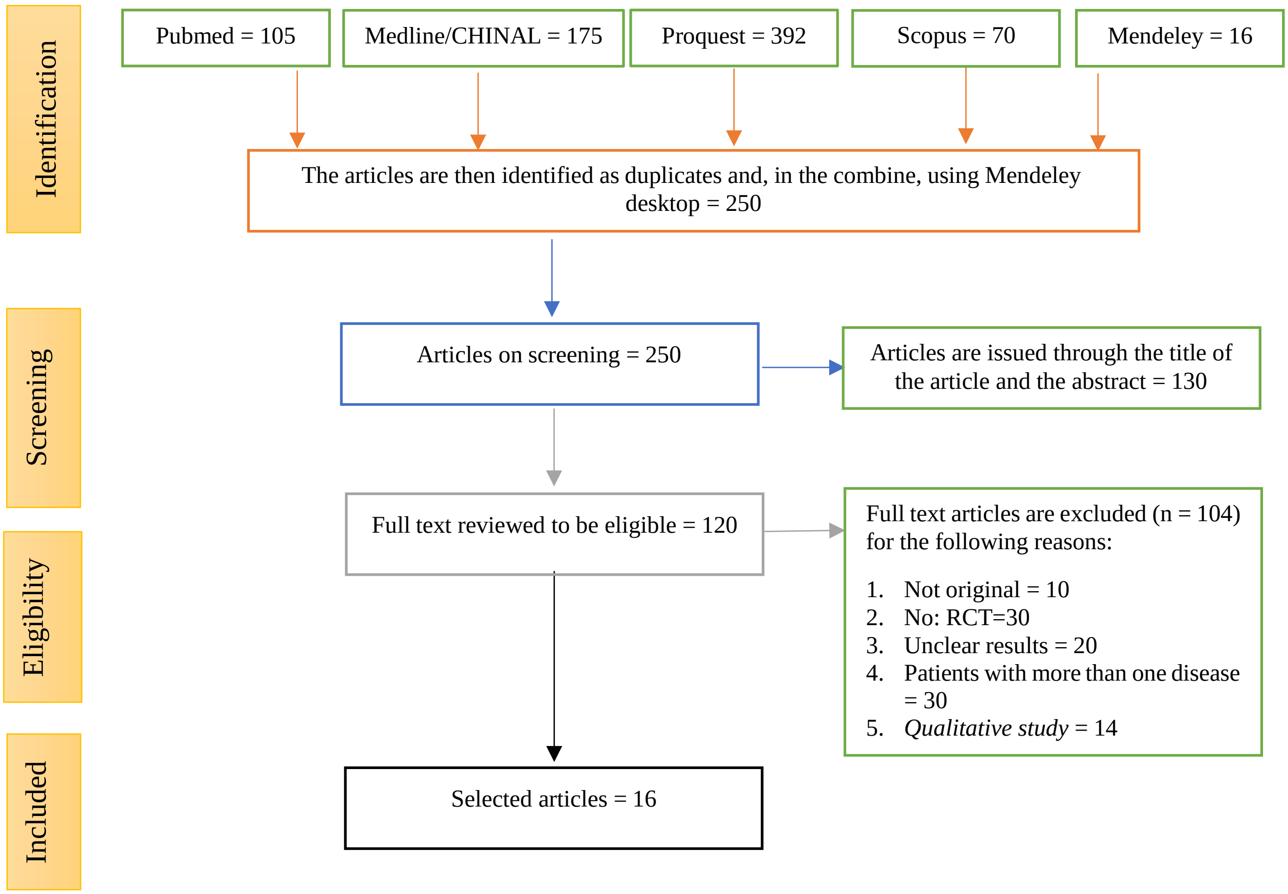

Figure 1. Prisma Diagram

The article hypertensive patients found that there was a significant difference in systolic and diastolic blood pressure in the control group and the intervention group averaging SBP between the intervention groups (p = 0.00)) (Chandler et al., 2019; Jahan et al., 2020; Persell et al., 2020). Significant differences were also observed in the mean decrease in DBP between the intervention group and the control group (p =.00). The intervention group had a larger percentage of participants with controlled blood pressure than the control group at the end (p =.011) (Gong et al., 2020). Systolic and diastolic blood pressure significantly decreased in both groups (systolic TD, p = 0.04; TD diastolic p = 0.02) (Jahan et al., 2020). In the intervention group blood pressure control was better in the control group, systolic blood pressure in the intervention group decreased by 8 mmHg and diastolic blood pressure decreased by 6 mmHg, while in the control group Systolic and diastolic blood pressure decreased by 2 mmHg and 3 mmHg (Rehman et al., 2019). There were differences in systolic and diastolic blood pressure reductions (p = 0.02 and p = 0.007) in both groups (Kim et al., 2016). Other studies also showed no statistical difference but there was a decrease in systolic blood pressure in both groups after two weeks (p = 0.16; p = 0.53; p = 0.78) (Chandler et al., 2019; Morawski et al., 2018; Persell et al., 2018).

Cholesterol and LDL

The outcome of the article that examines LDL is only found in the CHD article and is not discussed in the hypertension article. In the article on CHD, five out of eight articles found research output related to cholesterol and LDL. There were four articles with significant differences in LDL (Redfern et al., 2020; Santo et al., 2018; Zhang et al., 2017; Chow et al., 2015) While one article found no significant difference between the control and intervention groups (Zheng et al., 2019)

Body Mass Index (BMI) and Weight Loss

Articles that discuss body mass index are only found in CHD, not in hypertension. There was no difference in body mass index in the control and intervention groups (Zheng et al., 2019), different from research Chow et al (2015) mentions there are differences in BMI between the control group and the intervention group and Santo et al (2018) Body mass index (BMI) at six months of follow-up there was a significant difference between the control and intervention groups ($p = 0,005$).

The weight loss article is discussed in the hypertension article and not in the CHD article. Weight monitoring status increased from baseline to 1 month but decreased thereafter ($P<.001$) (Jahan et al., 2020) but different from Persell et al (2020) which mentions that there is no significant difference in body weight between the two groups

Heart Rate

Heart rate was only discussed by CHD articles and it was found that there was a significant difference in the number of pulses of the intervention group and the control group on the pulse rate of CHD patients after follow-up (Chow et al., 2015)

Psychological Response

Self-efficacy

Self-efficacy was proven to be able to control blood pressure to a greater extent in the intervention group than in the control group, and there was a significant difference between the two groups ($p<0.001$) (Persell et al., 2020) Similarly, confidence in CHD patients also had significant differences between the control and intervention groups for 6 months (Tongpeth et al., 2020).

Attitude

The attitude of CHD patients after the intervention was found to be a significant difference between the control group and the intervention group ($p = 0.009$), Attitudes about recognizing the signs and symptoms of a heart attack, getting help during a heart attack, distinguishing and recognizing the signs and symptoms of a heart attack (Tongpeth et al., 2020).

Self-Awareness

The intervention group had better self-awareness of CHD than the control group after being given the smartphone-based coronary heart disease prevention (SBCHDP) programme ($X2 = 6.486$, $p = 0,039$) (Zhang et al., 2017).

Stress

Comparison of perceived stress between the intervention and control groups in CHD patients did not show significant differences between the two groups (Zhang et al., 2017).

Depression

CHD patients' depression scores at 6 months were lower in the intervention group compared to the control group, averaging a difference of 1.9 (95% CI 1.5 to 2.4, $p<0.0001$).

Table 3. Article Characteristics

Article Characteristics	CHD	Hypertension
Country		
Australia	5	
Swedish	1	
Singapura	1	
China	1	1
Bangladesh		1
Pakistan		1
United States		4
United Kingdom		1
Smart mobile		
Smartphone/Web Application	3	6
Short Message	5	2
Intervention		
1 month	1	
3 months		2
6 months	6	4
9 months		1
12 months	1	1
Group		
Control Group	2123	1063
Intervention Group	2060	1094
Total	4183	2157

QOL (Quality of life)

Every CHD and hypertension article discusses quality of life. QOL of hypertensive patients in both groups showed significant improvement during the study period (P<.001) (Jahan et al., 2020) and there was a change in the quality of life of CHD patients between the two groups but did not reach statistical significance (Johnston et al., 2016).

Cognitive and Behavioural Responses

Knowledge

There are two articles that discuss the knowledge of CHD patients. The intervention group had a significant increase in knowledge of CHD symptoms (Tongpeth et al., 2020) and better overall CHD knowledge levels (t = 3.171, p = 0.002) (Zhang et al., 2017).

Adherence

There are four articles that explain the effect of *smart mobile* on CHD patient adherence including adherence to taking medication. The results found that CHD patients who followed the recommendation of > 80% with drugs for 12 months proved to be low and there was no difference between groups of medication adherence rates (32.8% vs. 29.9%; RR 1.07 [95% CI, 0.88–1.20] p = 0.49) (Redfern et al., 2020). Similarly, with greater patient adherence to medication adherence was achieved in the active vs. control group (*nonadherence score*: 16.6 vs.

22.8 [P = .025]) (Johnston et al., 2016). One article discussing dietary adherence found no significant association between the control and intervention groups (Chow et al., 2015). Adherence to the diet via smart mobile showed no significant association between the control group and the intervention (Santo et al., 2018).

There were six articles found related to hypertension patient adherence. Results obtained at the 6th month; drug adherence increased in two groups. The intervention group had more participants adhering to high and moderate category drugs compared to the control group (Gong et al., 2020). There were no significant differences between the 2 groups in drug adherence (Kim et al., 2016; Persell et al., 2020). Adherence rates were significantly higher (9%) among the control group regarding salt intake (p=0.04) (Jahan et al., 2020). There was a significant difference in drug regimen adherence at month 9 between the intervention and control groups (p = 0.001) (Chandler et al., 2019). Through the short messaging system, it was found that there was a difference in adherence to consuming antihypertensive drugs between groups that received SMS and not (p = 0.001) (Varleta et al., 2017).

Lifestyle Modification

Diet

Among 710 CHD patients, 54% adhered to ≥ 4 dietary guideline recommendations (53% intervention vs. 56% control, p = 0.376) at the start of treatment and At six months, the intervention group had a significantly higher proportion of patients adhering to ≥ 4 recommendations (314.93%) compared to the control group (264.75%, RR 1.23, 95% CI 1.15–1.31, p < 0.001) (Santo et al., 2018). In the primary, behaviourally focused results, salt intake of less than 6 g/day, showed significant improvement in both groups (P<.001). Fruit intake behaviour continued to improve in both groups (P<.001). Participants in both groups had a special vegetable intake daily/week (Jahan et al., 2020).

Smoke

Numerically, the intervention group was associated with higher smoking cessation rates in CHD patients but did not achieve statistical significance (Johnston et al., 2016). There was no difference in smoking status between the 2 intervention and control groups in CHD patients (Zheng et al., 2019). At 6 months, a significant reduction in smoking (Chow et al., 2015). Improvements in patient activation were associated with improved smoking (beta=−0.46, P<.001) and blood pressure control (beta=0.04, P=.02). This association was further strengthened in reducing smoking (beta=−0.60, P<.001) (Kim et al., 2016).

Physical Activity

The intervention was associated with increased achievement of physical activity targets, there was a significant difference between the control and intervention groups (87.0% intervention vs 79.7% control, p = 0.02) (Redfern et al., 2020). Numerically there was an increase in physical activity but did not reach statistical significance (Johnston et al., 2016). There was no significant difference in the physical activity of the 2 groups (Zheng et al., 2019). Significant increase in physical activity, and reduction in smoking (Chow et al., 2015). There were significant differences in physical activity behaviour (P<.03) and physical activity increased and continued until the completion of the study (P<.001 in both groups) (Jahan et al., 2020). There was no significant difference between the 2 groups in physical activity. The adjusted difference in self-reported physical activity was 26.7 minutes per week (95% CI, −5.4 minutes per week to 58.8 minutes per week; P = .10) (Persell et al., 2020)

Alcohol

There were significant differences in alcohol consumption in hypertensive patients in the control and intervention groups (beta=−0.26, P=.01) (Kim et al., 2016)

DISCUSSION

The results of the review of 16 articles obtained results categorized in a response from patients when given *smart mobile* consisting of physiological responses, psychological responses, cognitive and behavioural responses and lifestyle modifications. The patient response obtained in *this systematic review* is an integral part of the self-management of hypertensive patients and CHD when smart mobile interventions are carried out. The most results obtained in this *review* were the way patients managed blood pressure, followed by adherence to both medication adherence and lifestyle modifications. (Table.4)

Education about CHD risk factors and lifestyle adoption is very important for the prevention of CHD and its complications. Technology has become important today in everyday life. First, people can receive health information anywhere without space restrictions; secondly, they can access the app anytime instantly without time limitation; third, they may gain more confidence in their own lives, therefore health must also evolve with cellular-based health continuing to evolve worldwide with some evidence supporting that technology is effective in disease prevention and health promotion (Wang et al., 2015). The use of mobile phones has increased tremendously around the world. Smart mobile or mobile Health (mHealth) can efficiently deliver high-quality health care, but the evidence supporting its effectiveness is currently mixed. mHealth is increasingly being used (1) for patient communication, monitoring, and education, (2) to reduce the burden of poverty-related diseases, (3) to improve access to health services, clinical diagnosis, and medication adherence, and (4) for management chronic diseases (Marcolino et al., 2018).

The mHealth app (app) featuring culturally appropriate 3D animated educational videos delivered on mobile tablets aims to improve hypertensive health literacy among participants in resource-constrained settings. In addition, we sought to estimate the relationship between study participants' knowledge of hypertension and sociodemographic variables (Garner et al., 2020). Based on the results of the study that face-to-face health education requires the integration of home health care provision while interactive SMS text messages are more relevant and timelier to increase the effectiveness of interventions. In addition, public awareness can be created to encourage a "low salt culture" and educate family members" (Jahan et al., 2020). Several studies also prove that there is an influence of the use of SMS and websites on patient attitudes in dealing with CHD and hypertension (Sadeghian et al., 2017; Tongpeth et al., 2020)

The efficacy of mHealth is comparable to cardiac rehabilitation for heart patients in order for smartphones to be an effective platform to support behaviour change and self-management of health conditions, smartphones need to be an important and integral aspect of intervention (Hamilton et al., 2018). The interventions set out in *smart mobile* in 16 articles both web and short message are strategies given to patients. Strategies for secondary prevention of cardiovascular disease (hypertension and CHD) are divided into two approaches, namely population-based directed towards tobacco use, salt and fat reduction while individual interventions such as adherence to medications and access to availability of cardiac resynchronization and cardiac rehabilitation include population-based interventions (Prabhakaran et al., 2017).

The adoption of cellular-based technologies to monitor patients' blood pressure could provide practical solutions for managing cardiovascular patients. Patient health education and enhanced application functionality can improve patient adherence and satisfaction while reducing the burden on Health workers (Xiao et al., 2019). This application has been no modified to reduce many factors of non-adherence to hypertension treatment (Ashoorkhani et al., 2016). Several evidence-based drug regimens are effective in the secondary prevention of CHD. These include aspirin, beta-blockers, ACEI and ARBs, statins, and most recently, multidrug combination pill regimens. Drugs will also contribute to having an impact on other physiological changes (Prabhakaran et al., 2017)

Tobacco production is a major risk factor for CHD, yet a large portion of the global population continues to smoke. Forms of tobacco include bidis, kreteks, hookah pipes, smokeless tobacco, and second-hand smoke, all of which are associated with an increase in CHD (Prabhakaran et al., 2017). The use of mobile text messages was shown to reduce smoking cessation measured not through questions but by nicotine in the urine (Huo et al., 2017).

Understanding the key dietary factors effective for preventing noncommunicable diseases, the five dietary contributors to mortality are 1) Low fruiting (4.9 million distributional deaths per year); 2) High sodium (3.1 million); 3) Low nuts and seeds (2.5 million); 4) Low vegetables (1.8 million) 5) Low whole grains (1.7 million) (Prabhakaran et al., 2017). The effectiveness of population-level interventions to improve diet and physical activity to prevent obesity in six domains: nutrition and agriculture policy, food labelling, food advertising, mass media campaigns, school and workplace interventions, and urban planning (Prabhakaran et al., 2017). Another study also mentioned that there was an increase in the average score of dietary compliance assessment before and after the intervention was given so that there was an effect of nutritional messages via SMS on dietary awareness and compliance in hypertensive patients (p value = 0.000) (Merita et al., 2019).

Regular moderate or vigorous intensity physical activity, especially leisure-time physical activity, significantly lowers death from coronary heart disease (CHD). Individuals who engaged in physical activity equivalent to 150 minutes at leisure, with moderate intensity per week had a 14 percent lower risk of CHD than individuals with no leisure-time physical activity (Prabhakaran et al., 2017). Four smartphone-based physical activity coaching interventions significantly increased daily physical activity. These results suggest that digital interventions delivered through mobile apps have the ability to increase short-term physical activity levels (Shcherbina et al., 2019).

Table 4. Study Characteristic and Finding among the 16 Studies

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
Effectiveness of an Avatar application for teaching heart attack recognition and response: A pragmatic randomized control trial Tongpeth et al., (2020), Thailand	*Coronary Heart Diseases* Primary Outcome: knowledge of symptoms; Secondary Outcome: attitudes and beliefs.	*Avatar App* *N = 70* *Control group = 35* *Intervention group = 35*	Control Group: respondents received usual care that included bedside education by cardiac nurses The intervention group receiving education through the Avatar app on handheld tablet computers was divided into four parts: a) a heart attack warning signs quiz; b) signs and symptoms of a heart attack; c) what to do when having a heart attack and d) Heart Attack Action Plan Quiz.
A digital health intervention for cardiovascular disease management in primary care (CONNECT) randomized controlled trial Redfern et al (2020), Australia	*Cardiovascular diseases* Primary Outcome: adherence to recommended drug guidelines (≥ 80% a day followed for blood pressure (BP) and statin drugs). Secondary Outcome: including achievement of risk factor targets and eHealth literacy	*The Consumer Navigation of Electronic Cardiovascular Tools (CONNECT)* *a parallel-design, single-blind randomized clinical trial* N = 934 patients with, or at high risk of CVD Intervention group = 486 Control group = 448	Intervention group: receive an interactive application pre-populated and validated with electronic medical record risk factor data, diagnosis and, medications. Interactive risk calculators, motivational messages, and lifestyle goal tracking are also included. Control group: receiving usual health care follow-up of 12 months
Effects of interactive patient smartphone support app on drug adherence and lifestyle	*Myocardial infarction patients*	*Web-based application [app]* *randomized study*	Intervention Group: actively received a complete interactive patient support tool (web-based application [app]) installed on a smartphone containing an extended

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
changes in myocardial infarction patients: A randomized study Johnston et al (2016), Swedish	Primary Outcome: is a composite nonadherence score that measures patient adherence, Secondary Outcome: secondary include changes in cardiovascular risk factors, quality of life (*European Quality of Life–5 Dimensions*), and Patient Device Satisfaction (*System Usability Scale*).	In total, 174 patients (91 in the active group and 83 in the control group)	medication adherence e-diary education module and a secondary prevention education module. Control group: received a simplified tool containing only a simplified drug adherence e-diary with no secondary preventive education module installed on a smartphone. 6 months
The effects of a lifestyle-focused text- messaging intervention on adherence to dietary guideline recommendations in patients with coronary heart disease: an analysis of the TEXT ME study Santo et al., (2018), Australia	*Coronary Heart Disease* The primary outcome of this analysis was the proportion of patients adhering to the 4 ≥ dietary guideline recommendations simultaneously and each recommendation was assessed individually as a secondary outcome	*The TEXT ME* *parallel-group single-blind, RCT* N = 710 Intervention group = 352 Control group = 358	Intervention group: received four text messages per week, including at least one message per week focused on diet, for six months in addition to standard care. Control group: Patients receiving usual care 6 months
The effect of a smartphone-based coronary heart disease prevention (SBCHDP) programme on awareness and knowledge of CHD, stress, and cardiac-related lifestyle behaviours among the working population in	*Coronary Heart Diseases* Key outcome: awareness and knowledge of CHD Secondary outcomes: including perceived stress levels as well as heart-related lifestyle behaviors	*The smartphone app "Care4Heart"* *A pilot randomised controlled trial.* N = 80 person	Intervention group : SBCHDP program, There are four learning modules in the Care4Heart app for participants to learn in one month. Participants in the control group were provided with the website addresses *of*

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
Singapore: a pilot randomised controlled trial Zhang et al (2017), Singapore		Intervention group n = 40 Control group n = 40	*the Singapore Heart Foundation* (SHF) and *Health Promotion Board* (HPB). 4 weeks
Effect of Text Messaging on Risk Factor Management in Patients With Coronary Heart Disease The CHAT Randomized Clinical Trial (Zheng et al., 2019), China	*Coronary Heart Disease* Primary outcome: systolic TD (TDS) change from baseline to 6 months. Secondary outcomes included changes in LDL-C (*low density lipoprotein*), body mass index (BMI), physical activity, and smoking cessation	*Text messaging intervention* *multicenter, single-blinded randomized controlled trial* N = 822 Patient Control group = 411 Intervention group =411	Intervention Group: designed as a secondary prevention program in which regular text messages are sent to participants according to a predetermined algorithm. Specifically, in addition to usual care, participants in the intervention group received 6 messages per week The control group, usual care and received 2 thank you text messages per month during the 6-month study period 6 months
Effect of Lifestyle-Focused Text Messaging on Risk Factor Modification in Patients With Coronary Heart Disease A Randomized Clinical Trial Chow et al (2015), Australia	*Coronary Heart Disease* The primary outcome of this study was the plasma level of LDL-C Secondary outcomes were systolic blood pressure, BMI, total cholesterol level, waist circumference, heart rate, total physical activity, smoking status, and guideline level of achievement	TheTobacco, Exercise and Diet Messages (TEXTME) *Parallel-design, single-blind, randomized clinical trial* N = 710 Intervention group = 352 Control group = 358	Intervention group: Intervention participants received, in addition to usual care, a 6-month prevention program of approximately 96 messages. Control group: treatment that generally includes community follow-up with the majority is called inpatient cardiac rehabilitation, as prescribed by the physician 6 months

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
	of a proportion of modifiable risk factors		
Effect of text messaging on depression in patients with coronary heart disease: a substudy analysis from the TEXT ME randomised controlled trial Islam et al., (2019), Australia	*Coronary heart disease* Outcome: Depression	The Tobacco, Exercise and dieT MEssages *parallel-group single-blind, RCT* N = 683 Intervention group = 333 Control group = 350	Intervention group: Intervention participants received, in addition to usual care, a 6-month prevention program of approximately 96 messages. Control group: general treatment 6 months
Mobile health applications for the management of primary hypertension A multicenter, randomized, controlled trial Gong et al (2020), China	Hypertensive Primer Outcome: Blood Pressure control, drug adherence	*m-Health apps* *multicenter, randomized, controlled trial* N = 443 Control group : 218 Intervention groups : 225	Intervention: the intervention group downloaded the application "Yan Fu" and the list with real names consisted of Personal notes, Reminder Notes, Consultations, Queries, Emergency contacts, Health evaluation Participant monitoring Control: the control group did not use a hypertension management app but they needed to measure their blood pressure using the same sphygmomanometer and record their blood pressure on paper every day. 6 months

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
Awareness Development and Usage of Mobile Health Technology Among Individuals With Hypertension in a Rural Community of Bangladesh: Randomized Controlled Trial Jahan et al (2020), Bangladesh	Hypertension Patients The primary outcome: evaluation of self-reported behavior changes (salt intake, fruit and vegetable intake, physical activity, and blood pressure [BP], and weight-monitoring behavior). Secondary outcomes were measurements of actual salt intake and dietary salt excretion, blood glucose levels, BP, and quality of life (QOL)	Mobile HEalth Applications and onLine TeleHealth *Single-center, prospective randomized (1:1), open-label, parallel-group* 420 participants Intervention group = 209 Control group = 211	Intervention group: received 5 months of live health education along with a health education booklet and SMS text messages to raise awareness and knowledge, as well as motivate behavior change, with the same educational material content and SMS text messages. Control group: received the same health education booklet as the intervention group without text messages and followed up every consecutive month for up to 5 months (twice in the first month and once for the rest). The total duration of study is 12 Months.
Effect of Home Blood Pressure Monitoring via a Smartphone Hypertension Coaching Application or Tracking Application on Adults With Uncontrolled Hypertension A Randomized Clinical Trial (Persell et al., 2020), USA	Hypertension Results of the main study: systolic blood pressure at 6 months. Secondary outcomes included self-reported antihypertensive drug adherence, home monitoring and self-management practices, self-efficacy measures associated with blood pressure, weight, and self-reported health behaviors	*Smartphone-Enabled Personal Control Program, or "Smart Hypertension Control Study,"* *randomized study* 150 participants in each group	Intervention group: received a smartphone coaching app to improve monitoring and behavior change associated with hypertension self-management plus home blood pressure monitors. Control participants: received a blood pressure tracking app plus a home blood pressure monitor 6 months

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
Utilization of short message service (SMS) in non-pharmacological management of hypertension. A pilot study in an URBAN public hospital of Multan, Rehman et al (2019), Pakistan	*Hypertension* Non-pharmacological treatment in hypertensive patients.	*Short message service (SMS)* *Randomized control study* N = 120 patients Intervention group = 60 Control group = 60	Control group: drug therapy to control hypertension. Intervention group: in addition to taking medicines to manage hypertension, it is also added by SMS about different lifestyle modifications. 3 months
The Influence of Wireless Self-Monitoring Program on the Relationship Between Patient Activation and Health Behaviors, Medication Adherence, and Blood Pressure Levels in Hypertensive Patients: A Substudy of a Randomized Controlled Trial Kim et al., (2016), United State American	Hypertension Three health behaviors were assessed on baseline and a 6-month follow-up Web-based survey: frequency of alcohol use, smoking, and exercise Blood pressure monitoring Adherence	*Mobile phone* *Randomized controlled trial designed* N = 95 Intervention Group = 52 Control group = 43	Intervention group: received a wireless monitoring program plus disease management Control group: received a standard disease management program. 6 months
Impact of a Culturally Tailored mHealth Medication Regimen Self-Management Program upon Blood Pressure among Hypertensive Hispanic Adults	Hypertension Primer outcome: change in resting systolic blood pressure (SBP) from baseline to period 6 months.	*Smartphone Med Adherence Stops Hypertension* (SMASH) N = 54 SMASH (Speakers) = 26 ESC (Control) = 28	SMASH participants used the SMASH app which interacted with a Bluetooth-enabled TD monitor for self-monitoring of TD and electronic drugs. ESC participants received text messages including links to PDFs and short video

Title, Author, Year and Country	Conditions and outcomes	Mobile apps, Design, Population and Sample	Exposure to intervention and control groups & Duration
Chandler et al., (2019), United State American	Secondary outcome: Diastolic Blood Pressure (DBP) and Adherence	RCT	clips containing healthy lifestyle tips for attention control 9 months
Association of a Smartphone Application With Medication Adherence and Blood Pressure Control The MedISAFE-BP Randomized Clinical Trial Morawski et al(2018), *United Kingdom*	Hypertension Key outcome: change from baseline to 12 weeks in self-reported drug adherence, measured by the Morisky drug adherence scale (MMAS) and systolic blood pressure changes.	*Smartphone applications (apps)* N = 411 Intervention = 209 Control = 202 *Randomized clinical trial*	Intervention group: administered this app aims to help individuals adhere to prescribed therapy and drug adherence smartphone apps The control group did not receive any intervention. 12 weeks
Mobile phone text messaging improves antihypertensive drug adherence in the community (Varleta et al., 2017), United State American	Hypertension The main result: this study was adherence to antihypertensive therapy	*SMS* *N = 274* *Intervention Groups: 163* *Control group: 151* *Randomized*	Intervention group: receiving SMS Control group: not receiving SMS related to medication and healthy lifestyle 6 months

CONCLUSION

The articles that participated in the selection were as many as 16 articles out of 250 articles filtered in the search process. The article consists of 8 articles discussing hypertension and 8 other articles discussing CHD. From the results of a general systematic review based on usability, *Smart mobile* for CHD and Hypertension patients is effective in-patient response, although some of the 16 articles say the results are no difference, but other articles prove a significant difference between the two groups statistically. The weakness of various articles is that there are short and long intervention times so that the effectiveness of *smart mobile* still varies. Of the 16 articles above, most have not directed to nursing science so it is necessary to develop a *smart mobile* through a nursing approach.

CONFLICT OF INTEREST

No Conflict of Interest

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