Optimizing the Application of Mobile Health as a Prevention of Recurrence in Patients with Cardiovascular Disease: A Literature Review

1st Anna Rosdiana R Samsuddin
School of Nursing, Faculty of Medicine and Health Sciences
Universitas Muhammadiyah Yogyakarta
Yogyakarta, Indonesia
annarrsy@gmail.com

2nd Elsye Maria Rosa
Hospital Management
Universitas Muhammadiyah Yogyakarta
Yogyakarta, Indonesia
elsye@umy.ac.id

Abstract—Cardiovascular disease is one of the main health problems and causes of death in the world. M-Health (mobile health) has the potential to improve the prevention of disease recurrence by providing continuous intervention after treatment at a hospital. The purpose of this paper was to review health literature that examines the application of m-health as a preventive measure in cardiovascular disease patients, identify features contained in m-health applications and analyze the factors for implementing mobile health.

The preparation of this literature review used various databases including EBSCO, Google Scholar, Science Direct, PubMed, and Sage Journal which was conducted from December 2018 to January 2019. In total, this paper used 6 journals reviewed with predetermined keywords: four journals with quantitative methods, one journal with qualitative methods, and one journal with mixed-methods feasibility. Then screening was done based on the specified inclusion and exclusion criteria.

M-health can change healthy behavior post-treatment at a hospital and prevent recurrence in patients with cardiovascular disease. With remote health services health workers can easily monitor patients’ health status. The factors that influence the application of m-health are the level of patient knowledge of technology, the level of awareness of prevention of cardiovascular disease, lack of motivation for smartphone use, and poor internet access in a remote area.

Keywords: Mobile Health, app-based smart phone, behaviour change, lifestyle changes, quality of life, cardiovascular disease, cardiac rehabilitation.

I. INTRODUCTION

Cardiovascular disease is a heart and blood vessel disorder including coronary heart disease, cerebrovascular disease, rheumatic heart disease, and other conditions. Four out of five deaths from cardiovascular disease are caused by heart attacks and strokes. Someone at risk of cardiovascular disease can show increased blood pressure, glucose, and lipids as well as being overweight and obese. This condition is an important concern for community, by using existing health facilities in the nearest health service. Identifying someone at risk of cardiovascular disease and ensuring they receive the right treatment can prevent premature death [1].

Cardiovascular disease is the number one cause of death globally more people die each year from cardiovascular disease than from other causes. An estimated 17.9 million people died of cardiovascular disease in 2016, representing 31% of all global deaths. Of these deaths, 85% are caused by heart attacks and strokes. More than three-quarters of deaths from cardiovascular disease occur in low and middle-income countries. Of the 17 million premature deaths (under the age of 70) due to non-communicable disease in 2015, 82% are in low and middle-income countries, and 37% are caused by cardiovascular disease. Most cardiovascular disease can be prevented by overcoming behavioral risk factors such as tobacco use, unhealthy eating patterns and obesity, unhealthy physical activity, and alcohol consumption [1].

The Riset Kesehatan Dasar (RISKESDAS) 2013 showed that the prevalence of coronary heart disease in Indonesia in 2013 was 0.5% or around 883,447 residents, heart failure 0.13% or about 229,696 residents, stroke sufferers were 7.0% or about 1,236,825 residents and people with hypertension 9.4% [2].

M-health is technology-based secondary prevention intended for patients after treatment at a hospital because, according to some research findings, m-health education can affect the healing process or prevention in heart failure patients. M-health is designed to monitor the activities carried out by patients with cardiovascular disease [3] by always reporting their activities such as educating medication schedules, dietary needs, physical activity and habits to stop smoking. M-health has the potential to improve the prevention of primary and secondary disease and provide continuous interventions, improve the ability of patients and nurses in health service [3], monitor patients health in adherence to medication and support for behavior changes during recovery process [4] [5].

M-health is an interesting and developing intervention in the health field at this time that can potentially improve the health care of patients, it is proven that DHI (Digital Health Intervention) for CR (Cardiac Rehabilitation) patients, reduces risk factors after cardiac surgery [6] there is a significant decrease in the number of emergency visits, weight loss, and blood pressure. This proves that the DHI (Digital Health Intervention) program is a strategy to reduce the rate of recurrence in heart failure patients [7]. However, there are some limitations found in the applications of m-health, namely poor internet access in remote areas [8] [4].
II. METHODS

A. Purpose

The purpose of this paper were to review health research articles that examine the application of m-health as a preventative measure in patients with cardiovascular disease and to identify features contained in m-health applications.

B. Search of Strategy

The preparation of this literature review used a variety of journal sites on EBSCO, Google Scholar, Science Direct, PubMed, and Sage Journal that was conducted from December 2018 to January 2019. Searches were limited to documents published from 2017 to 2019 available in English. Several terms or keywords were combined to get the right document as a search strategy as it used “MHealth OR Smartphone app Based OR e Health-Based AND Behaviour Change OR Lifestyle Changes OR Quality of Life AND Cardiovascular Disease OR Cardiac Rehabilitation”.

C. Article Selection Criteria

In the selection process of articles included in the literature review, the articles had to meet the following criteria:

Inclusion Criteria
- Full-text in English
- Research must contain information about the use of m-health, smartphone applications in heart failure patients, post-treatment for heart failure patients or cardiac rehabilitation.
- Research published in 2017 until 2019.

Exclusion Criteria

Publication articles are not in the form of non-original publications.

The articles obtained were read in full text and determined if they met the inclusion and exclusion criteria, followed by analysis whether the articles to be reviewed contained the application of m-health as an effort to prevent cardiovascular diseases.
### TABLE II. CHARACTERISTIC STUDY

| No | Author (year) | Design of research | Name of journal | Sample | Aim of Research | Result |
|----|---------------|---------------------|-----------------|--------|-----------------|--------|
| 1. | Widmer et al. (2017) | Eksperimental study design | American Heart Journal (2017) | 80 respondent | The aim of this study was to determine whether DHI-administered during cardiac rehabilitation (CR) would reduce CV-related emergency department (ED) visits and rehospitalizations in patients after percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS) [7]. | Baseline demographics were similar between the groups. The DHI+CR group had improved weight loss compared to the control group (-5.1±6.5 kg vs. -0.8±3.8 kg, respectively, p=0.02). Those in the DHI + CR group also showed a non-significant reduction in CV-related rehospitalizations plus ED visits compared to those in the control group at 180 days (8.1% vs. 26.6%; RR 0.30, 95% CI 0.08 to 1.10, p=0.054) [7]. |
| 2. | Walsh et al. (2018) | Qualitative Research | Journal of Medical Internet Research | 33 Respondent | The purpose of this study was to (1) know the personal, social, and physical factors that enhance the ability to carry out physical activities (2) discuss technological competencies, needs, and desires in fulfilling the health [10]. | Key recommendations included a collection of patient data and use of measurements, harnessing hospital-based social connections, and advice to utilize a patient-centered approach with personalization and tailoring to facilitate optimal engagement (10). |
| 3. | Eyles et al. (2017) | Eksperimental study design | European Journal of preventive cardiology 0(0001-10 2017 | 66 respondent | This aim of study was to determine the effectiveness of SaltSwitch to support people with cardiovascular disease to make lower-salt food choices [11]. | Thirty-three participants with cardiovascular disease were allocated to the SaltSwitch intervention, and 33 to the control group. A significant reduction in mean household purchases of salt was observed (mean difference (95% confidence interval), _0.30 (_0.58 to _0.03) g/MJ), equating to a reduction of 0.7 g of salt per person per day during the 4-week intervention phase. There were no significant between-group differences in any secondary outcomes (all P>0.05) [11]. |
| 4. | Salvi et al. (2017) | Eksperimental study design | Journal of Telemedicine and Telecare 0(0) 1-14 The Author(s) 2017 | 118 respondent | This health system program is designed to motivate patients who are programmed to cardiac rehabilitation, with content that contains monitoring exercise, motivation and health education [12]. | Some technical issues related to connectivity, usability and exercise sessions interrupted by safety algorithms affected the trial. For those who completed the rehabilitation (19 of 55), the results showed high levels of both user acceptance and perceived usefulness. Adherence in terms of started exercise sessions was high, but not in terms of the total time of performed exercise or drop-outs. Educational level about heart-related health improved more in the intervention group than the control group. Exercise habits at 6 months follow-up also improved, although without statistical significance [12]. |
| 5. | Ni et al. (2018) | Eksperimental study design | International Journal of Nursing Sciences 6 September 2018 | 36 respondent | This study, aimed to develop a mobile technology (mHealth) intervention to improve medication adherence among patients with coronary heart disease (CHD) [13]. | In Phase 1, an m-health intervention was developed by integrating two mobile apps. In Phase 2 medication adherence increased at 30-day follow-up in both groups compared to baseline. At the 30-day follow-up, the mean of the decrease in medication non-adherence score in the experimental group (M=-1.35, SD= 2.18, n=36) was more than the decrease in the control group (M=-0.69, SD=1.58, n=36) (Table 3), which means the medication adherence improved more in the experimental group [13]. |
| 6. | Chen et al. (2018) | Mixed-Methods Feasibility Study | JMR MHEALTH AND UHEALTH 2018 Vol 6 | 190 respondent | This study aimed to evaluate the feasibility, specifically the usability and acceptability, and estimate the preliminary effectiveness of a mobile health (mHealth) intervention targeting both physicians and patients to improve adherence to evidence-based medications and lifestyle modifications [15]. | The results of interviews and surveys showed patients the use and acceptance of interventions. 190 patients were included in the interventions with a significance of 95%. The study also showed a decrease in the percentage of smokers (-5%, P = 0.05), an increase in daily vegetable consumption frequency (+ 0 3/ day, P = 0.01), and frequency of visits by public health service centers (+3 in 3 months, P = 0.04). Here are specific sites valued different: Considered an increase in Hainan (OR 14,68, 95% CI 5.20 – 41.45 ) but not in Shanghai (OR 0.61, 95% CI 0.33-1.12) [15]. |
III. RESULT

M-health Features

Eight articles meet the inclusion criteria that discuss the role of m-health as an effort to prevent the recurrence in cardiovascular disease, all the articles are written in English. In these articles, there are several features contained in m-health to prevent the recurrence in cardiovascular disease.

A. Health Education

In this study, the researchers developed a health system designed to motivate patients so the data would meet the recovery process in the rehabilitation program. The features developed in the m-health applications are exercise monitoring, patient consultation, motivation, and health education content. The method used in this study was a randomized controlled trial to compare the m-health rehabilitation program (55 patients) and standard care (63 patients) which showed increased health education related to the heart in the intervention group compared to the control group, as well as an increase in exercise habits. The results showed that this application can help improve the level of health education and exercise habits [14].

B. Compliance with Medication

In this study, the researchers examined the effectiveness of m-health in terms of adherence and lifestyle modification. The method used was a mixed-methods feasibility study intervention conducted 12 weeks in two locations, namely in Shanghai and Hainan China. Interviews were conducted with 10 doctors and 24 patients in the two locations regarding treatment compliance, usefulness, and acceptance. The results showed that there was a significant increase in 95% compliance with medication, a decrease in the percentage of smoker (P = 0.05), an increase in daily consumption of vegetables (P = 0.01), and an increase in the number of visits to health services in 3 months (P = 0.04). This intervention can improve medication adherence, and lifestyle modification in coronary heart disease patients [15].

Cellular technology interventions improve adherence in coronary heart disease patients. Method I in this study was Phase 1: To test the integration of two applications, namely “We Chat” and “BB Reminder” as m-health interventions. All participants received the same educational material through We Chat every two days, while group participants received a BB Reminder for drug dosages. The duration of Phase 1 was 30 days. Phase 2: Material on health education was given every five days and reminders to take medicine were given every day. The results showed that there was an increase in medication adherence of the participants [13].

C. Diet

The SaltSwitch smartphone app contains reminders for patients on a low salt diet because it can increase blood pressure. This study involved 33 patients with cardiovascular disease with SaltSwitch Intervention and 33 participants in the control group, showing no significant difference as evidenced by the statistical results (P > 0.05) [15]. In contrast to a research conducted by Chen S, 2018 [13].

D. Physical Activity

Individual interviews with 33 cardiovascular disease patients were conducted. The interviews with these patients showed that they were unsure of their ability to perform physical activity at home. Some patients were worried about training sessions and using PATHway. “I did experience difficulties when I ran, my hips began to hurt” (Participants 11, 65-year-old man, Low use of technology, Leuven) [10]. From the intervention group after discharge from the hospital, monitoring of physical activity reported that there was an increase in exercise sessions and exercise habits after 3 months compared to the control group without monitoring [14]. Other research articles also showed an increase in compliance with physical activity by SMS monitoring [16]. Changes in lifestyle behavior were demonstrated by DHI-based CR groups [17].

E. Smoker

The result regarding lifestyle modification to stop smoking was also supported by a research conducted by Chen et al. showing a significant percentage of smokers (P = 0.05) between the intervention group and the control group [15].

Factors for Implementing M-health

Important factors in the application of m-health in health services include the level of patient knowledge of technology, the level of patient awareness of cardiovascular disease prevention, lack of motivation for smartphone use, high drop-out counts [15], and poor internet access in remote areas [8] [4].

IV. DISCUSSION

Cardiovascular disease generally occurs when there is narrowing or blockage of blood vessels or accumulation of fat in blood vessels that can cause sudden cardiac arrest, chest pain (angina) or stroke. Heart disease must be dealt with quickly and appropriately unless it will cause stroke or death. Cardiac rehabilitation is an important part of a cardiovascular health program which has been proven to be effective in patients who experience health events such as stroke or heart failure. The role of technology in health is also very important in this case, technology plays a role in the heart rehabilitation program in patients after treatment in hospital [17].

The role of technology greatly helps the field of health, especially in hospital nursing services with the latest innovations in the m-health technology of health workers to monitor patient health [3] so more optimal health is achieved [17]. Also, the widespread use of cellular devices and equipment (such as smartphones, tablets, etc) makes it easy for doctors to monitor patients remotely and it is cost-saving for patients. M-health is a solution for cardiovascular disease patients [18] designed with a variety of interesting features [17], to be able to assist patients in modifying lifestyle, nursing planning [19] in the prevention of cardiovascular disease [20].

Mobile health (m-health) is a smartphone-based application designed to help patients and healthcare teams remotely, reduce patient costs and facilitate engagement. In this context, the application presents an educational design approach and motivation and results in the HeartCycle project in which a cellular-based cardiac rehabilitation system called “Guided Exercise” (GEX) was created. GEx is designed to
guide patients through a rehabilitation process through physical training and education to start healthy lifestyle [14]. Medication compliance is a form of taking medication which is an agreement between of patients and doctors during recovery process. M-health provides some content about indications or contraindications of the drugs taken, the schedule of taking the medication and the schedule of visits [13]. The SaltSwitch smartphone application is effective in supporting people suffering from cardiovascular disease in purchasing low-salt foods to prevent increase blood pressure [14].

The physical activity report shows the feasibility of applying m-health into clinical practice to increase functional capacity which, in this case, is for patients after hospital care. Adherence to physical activity programs or mild exercise is one of the most effective treatments strategies to prevent recurrence and maintain optimal quality of life. These findings are very significant and clinically relevant. This application of m-health shows the feasibility of using it as an alternative technology-based intervention, where patient’s physical training is always monitored remotely by health team [12].

V. CONCLUSION
Cardiovascular disease is a non-communicable disease. This disease is the number one disease in increased morbidity and mortality in Indonesia. In the era of technological development, innovations are created by health workers in improving health services and increasing the degree of human health. M-health is one of the programs designed to prevent the recurrence in patients after treatment. M-health, also known as distance education, which uses a smartphone application can improve patient’s health status but does not leave the family function as effective support, in addition to remote monitoring by health workers to patients who are at home, facilitating long-distance patients and cost-saving.

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