Original Article

Effects of Mobile Health on Self-Care in Senior Patients with Myocardial Infarction

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Abstract

Background: *Myocardial infarction is one of the leading causes of death in the world and accounts for 23% of mortalities. Self-care for senior patients with myocardial infarction can reduce complications, multiple hospitalizations, and financial costs.*

Methods: *This clinical trial was performed on 128 older adults with myocardial infarction. Available sampling was done via block random sampling among patients at the Heart Clinic of Booali Hospital, Qazvin, Iran. Data were collected through interviews and demographic and self-care questionnaires regarding heart disease. Data analysis was conducted using R software, version 4.1.0, and via the mixed-effects model method and post hoc and contrast tests.*

Results: *The mean age of the study population was 65.54±4.50 years. Before the intervention, self-care maintenance was not significantly different between the 2 groups. After the intervention, a statistically significant difference was observed between the groups (P=0.001). No statistically meaningful difference concerning self-care monitoring existed between the 2 groups at the beginning of the study (P=0.03); however, a significant difference emerged after the intervention (P=0.001). A difference existed between the groups regarding self-care confidence study commencement in that the self-care confidence level in the control group was higher (P=0.013), but no difference was observed following the intervention. Nonetheless, after 1 month, the groups were significantly statistically different (P=0.003) in that the self-care confidence level in the intervention group increased.*

Conclusion: *Mobile health could improve self-care in older adults with myocardial infarction.*

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Keywords: *Mobile health units; Myocardial Infarction; Self-care; Humans; Attitude to health*

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Introduction

Coronary heart disease and myocardial infarction (MI) are the most common cardiovascular diseases, and despite efforts aimed at primary and secondary prevention, they constitute the leading cause of death in many countries. Heart disease accounts for 23% of the causes of death in Iran.[1] After an MI, patients must adapt to the resultant angina pain or fatigue.[2]

Implementing educational interventions based on self-efficacy strategies could positively affect health-promoting behaviors among patients with heart failure.[3] While self-care is essential to everyone's health, it assumes even greater significance among individuals suffering from chronic diseases. Indeed, self-care is the cornerstone of chronic disease management and enables the patient to be an active partner in the effort.[4]

Discharge education could enhance the quality of life and curtail the hospital readmission rates of patients with congestive heart failure, hence the significance of incorporating self-care training and discharge education into the heart failure management strategy.[5]

Cardiac rehabilitation, albeit an evidence-based clinical standard, has disconcertingly low referral and participation rates.[6] Cardiac rehabilitation is a framework that effectively reduces mortality by 25% and promotes the secondary prevention of coronary heart disease. It also improves physical activity, increases the quality of life, and lessens the rate of hospital readmission.[7] Despite its importance, nevertheless, cardiac rehabilitation is utilized less than other treatments.[7, 8] Only 98 countries in the world have cardiac rehabilitation programs, of which 68% are in high-income countries and 23% in low-income or middle-income ones.[7] Among the reasons why patients do not use cardiac rehabilitation are geographical access and costs.

Cardiac rehabilitation at home via smartphones is one of the proposed models to overcome the obstacles to seeking cardiac rehabilitation.[9] Mobile health (mHealth) comprises a component of healthcare services supported by digital processes, communication, or technology (eHealth) and is a combination of health and medical measures afforded by smartphones, monitoring devices, digital smart assistants, and wireless devices.[10] Programs featuring mHealth provide patients with quick and easy access to health information, assist them in health-related decision-making (eg, seeing a doctor or visiting an emergency department), and improve their clinical outcomes.[11]

Post-discharge interventions for patients with MI are limited and include clinic visits, which sometimes require traveling over long distances. It is in this context that smartphones have become a valuable technology for modern life and can provide therapeutic and educational interventions in patients' houses.[12] mHealth technologies modernizem edicine by enabling greater patient engagement, monitoring, outreach, and healthcare delivery. With the growing prevalence of cardiopulmonary disease, mHealth technologies may become a more essential element of care within and without traditional healthcare settings.[13]

The need to teach older adults health behaviors, self-care, and lifestyle changes is undeniable. Recent rapid changes in the modern era call for new strategies vis-à-vis education, treatment, and healthcare. Innovations in information and communication technologies can play an instrumentalr role in caring for senior adults in their homes and other care settings.[14]

The increasing prevalence of heart disease and self-care challenges requires a simplea nd mechanistic way to support self-care among outpatients and discharged patients. Smartphone applications seem suitable for monitoring and managing various diseases. Many patients today use such phones because of their portability, accessibility, and user-friendliness.[15] Smartphone applications can affect the self-management of chronic diseases, reduce costs, and facilitate access to resources.[16]

In the present study, we sought to assess the effects of mHealth on self-care in senior patients with MI.

Methods

The present prospective, real-world, randomized controlled trial was conducted on 2 parallel groups: intervention and control. An available sample of 128 patients was recruited from the Heart Clinic of Booali Hospital, Qazvin, Iran, from January through April 2021.

Ethical approval was obtained from the Research Ethics Committee of Qazvin University of Medical Sciences (code: IR.QUMS.REC.1400.200). Written informed consent was obtained from the study participants. The study was registered in the Clinical Trials Center (IRCT code: 20210327050782N1).

The inclusion criteria were as follows: age 60 years or older, a confirmed diagnosis of MI at least 6 months earlier, mental capacity to communicate, willingness to participate in the study, ownership of a smartphone (Android), and minimum reading and writing ability. Patients were excluded from the study if they had heart failure; recent cardiac events in the preceding 3 months; cognitive impairment, disabilities, psychiatric conditions, or hearing or speech impairment preventing communication; having debilitating diseases (eg, stroke and neurological diseases); experiencing a severely stressful event in the preceding 3 months; not owning smartphones; and unwillingness to participate in the study.

The permuted block randomization method was used to have 6 equally-sized blocks. Random allocation software was utilized to generate random sequences. Based on the comparison between the 2 groups and considering the

number of covariates (k=8), the total sample size was calculated using the formula n=50 + 8k. This resulted in a total of 114 samples. However, to account for a potential attrition rate of 10%, the sample size was increased to 128, with 64 participants in each group.

Data were collected using questionnaires about sociodemographic characteristics and self-care completed by the study participants online on a mobile app after the intervention and 1 month later. Demographic characteristics (reported by the respondents) and clinical information (obtained from medical records) included age, sex, educational level, occupation, marital status, disease duration, and comorbidities. Self-care was measured at baseline before the intervention and after the intervention. The degree of independence and functional status was measured using the standard Persian Activities of Daily Living (ADL) questionnaire, in which a higher score indicates more independence in daily activities. Self-care was assessed using the Self-care of Coronary Heart Disease Inventory (SC-CHDI). This questionnaire was designed and psychoanalyzed by Wagan et al (2016) based on the theory of chronic disease self-care. The questionnaire has 22 items on 3 scales: self-care maintenance, self-care management, and self-care confidence, and respondents determine the frequency of these behaviors based on a 5-point Likert scale from never (1) to always (5). Each scale is scored separately, with a higher score indicating better self-care. The self-care scale items recommend behaviors for maintaining physical and mental stability: seeing a doctor; taking medication; controlling blood pressure; exercising; eating vegetables, fruits, and low-fat foods; and controlling weight. The self-care monitoring and confidence scales are each composed of 6 items. Convergent validity was assessed by comparing 2 specific adhesion scale tools: the Medical Outcome Study–Social Support Survey (MOS–SAS) and the Decision-Making Competency Inventory (DMCI). Cronbach's α values were 0.78 and 0.86, respectively. For the reliability of this tool, the factor determinacy score (FDS) criteria were used, which were 0.87 and 0.76, respectively. Cronbach's α for the self-care confidence scale was 0.84.[17] The reliability of the Persian version in the pilot study was calculated to be 0.82 based on Cronbach's α coefficients of 0.71, 0.75, and 0.76 on the scales, respectively.

A health smartphone application (Heart Care) was installed on the phones of the intervention group, and they were taught how to use it. Before the intervention, the baseline level of self-care was assessed using the Self-care of Coronary Heart Disease Inventory (SC-CHDI), incorporated in the application. The application consists of monitoring and training. The monitoring section includes monitoring the individual regarding medication use, cardiac symptoms, and nutrition. The interactive and automated capabilities of this software lie in the medication section since it provides reminders for the punctual use of medicines. In the event of cardiac symptoms, the study participants could initially receive a recommendation to go to the emergency department, stop activities, or reduce activity by entering their symptoms into the program. Moreover, if the patients had any issues or questions about the proposed areas in the training program, they could consult the Question and Answer (Q&A) section for responses from care specialists. The training provided in the application was daily for 4 weeks. Educational content was provided via specialized resources after simplifying the multimedia format through Persian animations, texts, and audio files. During this period, the control group received routine care at Booali Hospital. The program consisted of a low-fat diet, an educational brochure (advising the group members to avoid salt and sex for up to 2 weeks), and a follow-up appointment with a doctor 2 weeks after discharge. Immediately after the intervention and 1 month later, the software automatically measured the self-care level and sent the results online to the software server. Data analysis was performed with R software, version 4.1.0. The Kolmogorov-Smirnov test, the mixed-effects model, and post hoc and contrast tests were conducted.

Results

The study population consisted of 128 senior patients with MI divided into an intervention group (n=64) and a control group (n=64). The participants' mean age was 65 years, with a standard deviation of 4.5. Men comprised 46.8% (n=60) and women 53.1% (n=68) of the studied patients. Among the subjects, 37.5% had poor education, 40.6% had elementary literacy, 21% had a high school diploma, and fewer than 1% had university qualifications. Concerning marital status, 91.4% of the patients were married, and 8.5% had lost their spouse. Regarding employment, 35.1% of the cases were unemployed, 63.2% were retired, and 1.5% were employed. Diabetes was reported in 16.4% of the participants, hypertension in 46.8%, thyroid disease in 3.1%, and hyperlipidemia in 25.7% (Table 1, Figure 1).

The t-test results showed no statistically significant differences between the groups in pre-intervention self-care maintenance (P=0.129). Nonetheless, immediately after the intervention and 1 month after, self-care maintenance in the intervention group rose significantly (P=0.001) (Table 2, Figure 2).

The t-test results demonstrated that self-care monitoring before the intervention did not differ significantly between the groups (P=0.062). Nevertheless, immediately after the intervention, self-care monitoring in the intervention group exhibited a statistically meaningful rise (P=0.03), with the increase continuing significantly 1 month after the intervention (P=0.001) (Table 3, Figure 3).

Before the intervention, the t-test results revealed that

self-care confidence was significantly higher in the control group than in the intervention group (*P*=0.013). However, immediately following the intervention, self-care confidence in the intervention group increased, albeit nonsignificantly (*P*=0.468). One month after the intervention, with increasing self-care confidence in the intervention group, a significant difference was observed between the intervention and control groups (*P*=0.003) (Table 4, Figure 4).

As can be seen in Table 1, the χ^2 test showed that none of the contextual variables had a significant effect on self-care. Further, contextual diseases did not impact the study process significantly.

Table 1. Distribution of demographic variables

Category	Intervention Group		Control Group		Total Samples		Chisq.df	P
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage		
Age (y)								
60-64 y	30	46.875	27	42.1875	57	44		
65-69 y	25	39.0625	23	35.9375	48	38		
70-74 y	5	7.8125	10	15.625	15	11		
75-79 y	4	6.25	4	6.25	8	7		
Sex							1.05 (1)	0.304
Male	33	51.5625	27	42.1875	60	46.875		
Female	31	48.4375	37	57.8125	68	53.125		
Education Level							0.89 (3)	0.829
Poor education	25	39.0625	23	35.9375	48	37.5		
Elementary literacy	23	35.9375	29	45.3125	52	40.625		
Diploma	16	25	11	17.1875	27	21.09375		
University Qualifica-tion	0	0	1	1.5625	1	0.78125		
Marital Status							0.18 (1)	0.674
Married	58	90.625	59	92.1875	117	91.40625		
Widowed	6	9.375	5	7.8125	11	8.59375		
Employment Status							4.51 (2)	0.105
Unemployed	9	14.0625	36	56.25	45	35.15625		
Retired	54	86.375	27	42.1875	81	63.28125		
Employed	1	1.5625	1	1.5625	2	1.5625		
Duration of the Dis-ease							0.31 (1)	0.578
0-1 y	53	82.8125	58	90.625	111	86.71875		
1-2 y	8	12.5	5	7.8125	13	10.15625		
> 2 y	3	4.6875	1	1.5625	4	3.125		
Contextual Disease								
Diabetes	12	18.75	9	14.0625	21	16.40625	0.02 (1)	0.890
Hypertension	29	45.3125	31	48.4375	60	46.875	0.75 (1)	0.388
Thyroid	1	1.5625	3	4.6875	4	3.125	0.12 (1)	0.725
Hyperlipidemia	15	23.4375	18	28.125	33	25.78125	1.22 (1)	0.269

Table 2. Comparison of self-care maintenance before and after the intervention*

	Self-Care Maintenance T-test Results		
Study Phase	Intervention Group	Control group	P
Before the intervention	20.28±2.60	19.66±1.96	0.129
Immediately after the intervention	23.80±2.16	20.26±2.15	0.001
1 month after the intervention	24.52±2.17	20.20±2.05	0.001

*Data are presented as mean±SD or n (%).

Table 3. Comparison of self-care monitoring before and after the intervention*

	Self-Care Monitoring T-test Results		
Study Phase	Intervention Group	Control Group	P
Before the intervention	11.70±1.89	12.35±2.03	0.062
Immediately after the intervention	12.95±1.70	12.26±1.88	0.030
1 month after the intervention	13.50±1.77	12.06±1.80	0.001

*Data are presented as mean±SD or n (%).

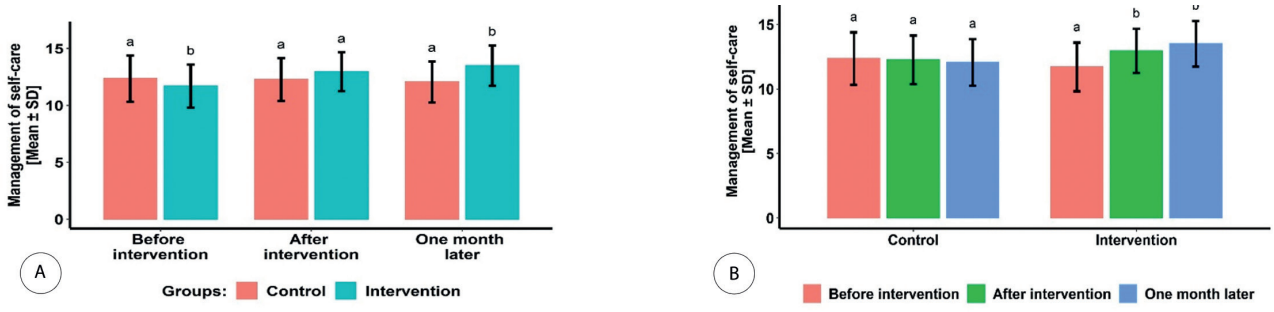

Figure 2. As is evident in the images, during the follow-up period, no significant differences regarding self-care maintenance existed in the results of the control group compared with itself at any time. Additionally, the intervention group had a significant difference in self-care maintenance compared with itself over time after the intervention.

A) Comparison of the control and intervention groups over time

B) Comparison of each group with itself over time

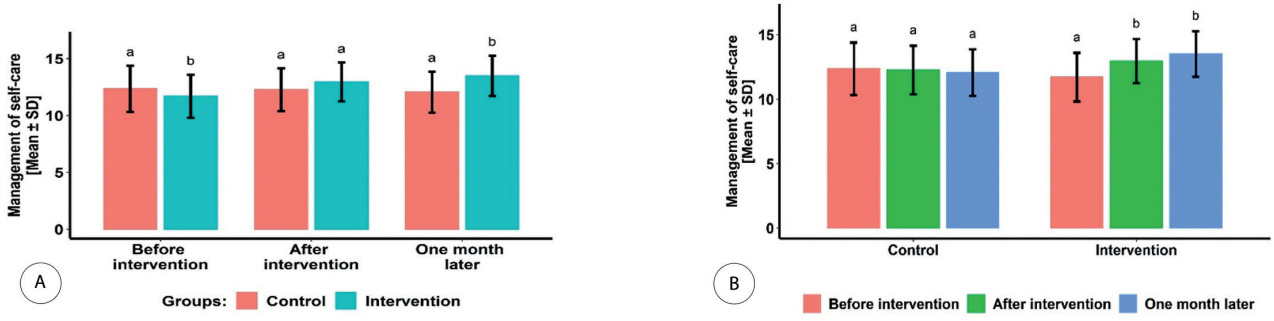

Figure 3. As the images illustrate, during the follow-up period, no significant differences regarding self-care management existed in the results of the control group compared with itself at any time. Furthermore, the intervention group exhibited a significant increase in self-care management compared with itself over time after the intervention. Prior to the intervention, the level of self-care management was lower in the intervention group than in the control group. Following the intervention, there was no difference between the groups. However, 1 month later, the intervention group continued to show the rise in self-care management.

A) Comparison of the control and intervention groups over time

B) Comparison of each group with itself over time

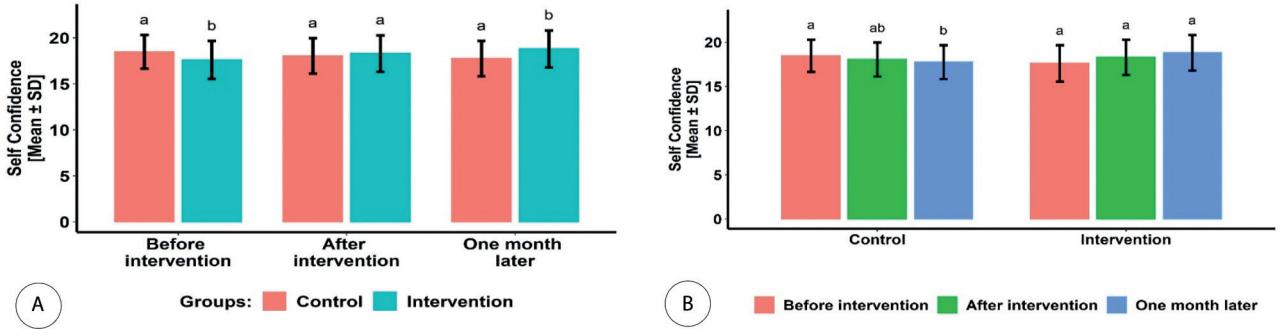

Figure 4. As is evident in the images, during the follow-up period, no significant differences vis-à-vis self-care confidence existed in the results of the control group compared with itself over time, although the trend was downward. In addition, the intervention group exhibited a significant difference concerning self-care confidence in comparison with itself over time after the intervention. Following the intervention, the groups did not differ in terms of self-care confidence. Nevertheless, 1 month afterward, the level of self-care confidence continued to rise in the intervention group.

A) Comparison of the control and intervention groups over time

B) Comparison of each group with itself over time

Table 4. Comparison of self-care confidence before and after the intervention

	Self-Care Confidence t-test Results		
Study phase	Intervention Group	Control Group	P
Before the intervention	17.61±2.05	18.48±1.83	0.013
Immediately after the intervention	18.30±2.00	18.05±1.92	0.468
1 month after intervention	18.81±2.01	17.75±1.91	0.003

Discussion

The mobile application was designed with the aim of creating an educational tool that could be accessed via smartphones. This tool focuses on teaching various aspects of self-care to patients with MI. The features of the application, similar to those found in other studies, include physical activity guidance, medication management, dietary advice, lifestyle training, and a Q&A section.[18] We found that the application was effective in helping senior patients with MI maintain self-care immediately and 1 month post-implementation. Clinical trials on heart failure patients showed that the tablet-based self-care program improved their self-care behavior.[19] Qualitative studies on the experiences and views of heart failure patients regarding the health effects associated with self-care revealed that most participants believed that using this type of program would enhance their self-care activities.[20, 21] Our approach's strengths lie in the innovative use of daily varied content for patient education, facilitated by special algorithms. However, our weaknesses include limited financial support for extended patient follow-up and the potential loss of patients in the long term due to the nature of the disease under study and the age range of the volunteers. With appropriate advertising and a broader age range and disease spectrum, more comprehensive software could be optimally utilized in delivering such services.

One potential drawback of using this technology is the oversimplification of heart symptoms due to self-reporting. There is also a risk that a person may experience heart problems during exercise, making face-to-face rehabilitation potentially more beneficial. While body mass index is used in the diet presentation of this program, it cannot substitute for prescribed face-to-face diets.

Furthermore, the use of this technology could lead patients to believe that face-to-face visits are no longer beneficial, which could complicate their treatment.

Conclusion

This study confirmed the efficacy of mHealth in enhancing self-care among older adults with MI. Improvements were observed in 3 key areas: self-care maintenance, self-care monitoring, and self-care confidence, supporting existing evidence that mHealth can improve self-care significantly.

In addition to its standalone benefits, mHealth can be integrated into MI rehabilitation programs to further enhance self-care outcomes. These programs can be tailored to meet societal needs and reflect cultural contexts. The affordability of these programs, coupled with their goal-oriented content, contributed to their ease of use in this study.

The program's interactive nature and the incorporation of artificial intelligence kept the content engaging and dynamic. The 2-way communication feature and the ability to answer users' questions through the program's messaging system reduced the need for face-to-face visits.

The robust design of the clinical trial is a key strength of this study, providing compelling evidence for the intervention's effectiveness. The application's content was crafted around the core components and dimensions of cardiac rehabilitation. This study also investigated the application's impact over time. Its conceptual framework drew upon contemporary models and concepts in chronic disease self-care. The application was developed using Android programming with the Java language, a leading-edge method for creating mobile software.

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