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Effectiveness of an Educational Program through Mobile Health Application on Knowledge and Adherence to a Healthy Lifestyle in Cardiac Syndrome X Patients

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Abstract

Background: Cardiac syndrome X (CSX) is a form of ischemic heart disease with functional coronary microvascular abnormalities. The symptoms are often debilitating and sufferers have a poor quality of life, with costly demand for healthcare services. Therefore, an educational intervention contributes to the increase of knowledge about CSX risk factors and adherence to a healthy lifestyle.
Objectives: This study aimed to investigate the effectiveness of educational interventions on knowledge and adherence to a healthy lifestyle in CSX Patients.
Methods: A simple, two-arm, parallel, randomized control trial was conducted in the Tehran Heart Centre Hospital, (IRAN) on 100 CSX outpatients who were selected through randomized sampling and divided into experimental (n=50) and control (n=50) groups. This study assessed an educational program that has been provided through the Mobile Health application (mHealth app) to the experimental group. The data were collected using the Heart Disease Fact Questionnaire (HDFQ) and Adherence to a Healthy lifestyle questionnaire (AHLQ).
Results: In the intervention group, the difference between the pre-test and post-test mean scores of knowledge on CSX risk factors was statistically significant (SD=1.77; P<0.05). However, there was no significant difference between pre-test and post-test means scores in the control group (SD=3.12; P>0.05).
Conclusion: Patients with CSX have high morbidity and health care expenditure; therefore, the provision of an educational program through the mHealth app as well as lifestyle modification can be considered a highly effective and low-cost intervention contributing to an increase of knowledge about CSX risk factors in patients and adoption of a healthy lifestyle.

Keywords: Adherence to a healthy lifestyle, Cardiac syndrome X, Educational intervention

1. Background

Cardiac syndrome X (CSX) is a form of ischemic heart disease (1). Functional coronary microvascular abnormalities are often associated with endothelial dysfunction, resulting in a reduced coronary flow reserve (2, 3, 4). Moreover, the formation of atherosclerotic plaque inside the wall of the coronary arteries is a hallmark of coronary artery disease (CAD) which leads to the narrowing of the vessels and the clinical manifestations of the acute coronary syndrome, including angina and myocardial infarction (4, 5,6). In addition, CSX is highly prevalent in Iran and all around the world (7, 8). In a large cohort study of patients that guessed to have myocardial ischemia, 41% of women versus only 8% of men had normal or near-normal coronary arteries in coronary angiography (3). Approximately 18.2 million adults age 20 and older have CAD (about 6.7%) and about 2 in 10 deaths from CAD happen in adults less than 65 years old worldwide (9, 10, 11).

There is no clear evidence of CSX prevalence in Iran; however, the results of a study by Masoudkabir in a heart center hospital demonstrated that more than 40% of the total 809 women with typical angina and a positive exercise tolerance test who underwent coronary angiography had CSX. Moreover, Najafipour reported that dyslipidemia, low physical activity (37.9%), and metabolic syndrome (27.7%) were major combined CAD risk factors (1, 6, 12). Furthermore, CSX incidence in patients undergoing invasive diagnostics of coronary heart disease was estimated to be approximately 20-30%. Based on the evidence, the majority (60-70%) of patients with CSX are female, often in menopause age (2, 3, 13). According to the World Health Organization (WHO) report in a local setting, CAD is the first cause of death in Iran and accounts for around 46% of all deaths (14). However, although CSX is not associated with an increased risk of death, it can affect patients' functioning and quality of life (15, 16, 17).

However, CSX symptoms are often debilitating (18,19), and most of these patients have a poor quality of life and frequently demand costly healthcare services with recurrent hospital admissions (20, 21, 22). Functional disability affects about 75% of patients with syndrome X, and the majority of these patients usually receive treatment with multiple-drug combinations (22, 23). Compelling evidence indicates that along with drug treatment and targeting risk factors in the mentioned societies, the adoption of a healthy lifestyle program can be an effective and important approach for the early prevention of CSX disease (24, 25). According to the

previous studies, lifestyle modification through health education strategies is a necessary step in reducing cardiovascular incidences. Accordingly, educational programs and lifestyle modification can be regarded as highly effective and low-cost interventions that reduce the incidence and progression of CSX and the risk of morbidity associated with it (6,8). Therefore, improvement of the general knowledge and attitudes toward risk factors of heart disease and CSX and adherence to a healthy lifestyle can be considered an effective strategy in this regard (4, 16). Moreover, mobile technology in the 21st century has revolutionized the field of science in terms of the transfer of knowledge and technology. The mobile health application (mHealth app) is an alternative approach that is being used due to its low cost and wide accessibility (26, 27). There is developing evidence that mHealth app interventions are effective and acceptable means that can improve quality of life and the chance of adherence to a healthy lifestyle. Moreover, mobile phones can deliver health-improving facilities through short messaging services, smartphone applications, or video messaging. The research team of the electronic databases (Cumulative Index of Nursing and Allied Health Literature) identified key findings related to mHealth app interventions and health information suitable for the study setting. They suggested that the mHealth app could be a useful tool for health instructional interventions (27, 28).

Moreover, technological innovations have already been used to bridge the health disparities and consumer health and empower patients to manage their health and enhance their knowledge (28, 29).

Regarding the lack of definitive treatment for CSX disease and guidelines to outline the best course of therapy for modification of the patients' lifestyle (1, 3) this study may help healthcare providers and the healthcare systems to implement new protocols or policies that improve cardiac patients' knowledge and provide them with a healthy lifestyle. To date, few studies on this subject have been conducted in Iran. As a result, the educational programs and lifestyle modification through the mHealth app represent a highly effective and low-cost intervention to improve the knowledge of patients about CSX risk factors and increase the chance of adherence to a healthy lifestyle.

2. Objectives

This study aimed to investigate the effectiveness of educational interventions on knowledge and adherence to a healthy lifestyle in CSX Patients.

3. Methods

3.1. Study Design

This study is a simple two-arm, parallel, randomized control trial with a pre-test and post-test design that assesses the effectiveness of an educational intervention on knowledge about CSX risk factors and adherence to a healthy lifestyle in CSX patients. This experimental study was conducted in the Tehran Heart Center Hospital, Thran, Iran. The data were collected using the Heart Disease Fact Questionnaire (HDFQ) and the Adherence to a Healthy Lifestyle Questionnaire (AHLQ). The HDFQ consisted of 24 items that could be answered by three options: "True", "False", and "I don't know". The total scale score was calculated by summing the total number of the correct answers and ranged from 0 to 24, with higher scores indicating a higher level of knowledge (30). The AHLQ included 41 items, of which three items had been dropped. According to the 10 specialised viewpoints on the cut-off point, these 3 items were not valid. The remaining 38 items were scored based on a Likert scale ranging from one to five, with higher scores indicating a higher level of adherence to a healthy lifestyle (31). Both questionnaires were translated from English into Farsi. Therefore, the translation process of instruments was done based on the (WHO 2016) recommendation (32).

The Confirmatory Factor Analysis and Composite Reliability (CR) established that convergent validity (AVE) and (CR) exist for the constructs of this study. Based on the results it can be concluded all items had an acceptable value for loading, therefore all were kept in the model. The result shows that the instruments are valid and acceptable to use to measure the outcome of these participants in Iran.

3.2. Participants and Setting

A total of 100 CSX outpatients had been referred to the Clinic of Tehran Heart Centre Hospital (Iran), for visit and given treatment was selected by blinded randomized sampling. Simple random sampling was conducted based on a computer-generated list. The sample size was determinant regarding the significance level of 0.05 (α=0.05) with a two-sided test and a power of 80%. The sample size was increased by 10% to compensate for the drop-outs. The participants in this study included patients with evidence of CSX who were diagnosed by a cardiologist through coronary angiography, physical activity test, blood test, and symptoms of CSX. The participants who met the eligibility criteria were recruited and randomly assigned to experimental (n=50) and control (n=50) groups (Figure 1). The data (from the intervention and control groups) were collected for the pre-and post-tests from March to August 2019. The inclusion criteria were: 1) ≥18 years of age, 2) ability to read and understand the Persian language, 3) identification of the CSX case for more than the last six months, 4) any referral to the Tehran Heart Centre Hospital for a check-up or treatment as an outpatient, 5) stable health condition, 6) lack of hospitalization in the three last months, 7)

access to the internet through a smartphone and using the WhatsApp application, 8) any follow-up record as a CSX patient in the cardiac clinic. However, the participants diagnosed with different heart diseases, such as valve problems, arrhythmia, acute pulmonary edema, and cardiac infection, and patients with other comorbidities, such as renal failure, respiratory problems, and heart failure, were excluded from the study.

3.3. Study Intervention

The intervention program of lifestyle modification and self-care for CSX patients was conducted in the Clinic of the Tehran Heart Centre Hospital for the experimental group. The experimental group received the educational program for self-care. At the baseline, the educational program and self-care materials were developed to prevent or decrease the CSX risk factors among CSX patients. The educational program plan highlighted the background, learning outcomes, and workshops related to educational materials, and relevant activities including WhatsApp messages. The materials of the educational program were approved, including the concept, definition, advantages, benefits, and self-care strategies. The educational program consisted of information about the anatomy and physiology of the heart, CSX risk factors, CSX symptoms and diagnosis, healthy diet (including fruits, vegetables, oils, and foods), regular exercise, and the advantages of self-care items, such as management of a healthy lifestyle, blood pressure monitoring, blood sugar monitoring, cholesterol monitoring, weight control, and stress control. This educational program was developed based on the American College of Cardiology, American Heart Association (10, 33), and European guidelines. The educational contents were developed through the literature review panel and its content validity as a guideline was confirmed by experts, including three nursing faculty members, two heart clinical nurses, one specialist cardiologist, and three lecturer nurses. The educational program was provided to the experimental group through a one-day workshop using PowerPoint slides, images, and a health education booklet, as well as a WhatsApp application by sending biweekly mHealth messages for 14 weeks. Technology was adopted to facilitate learning, and a face-to-face workshop was held to reinforce teaching, support the intervention group participants, and encourage them to ask questions (if any) from the researchers or experts. The workshop was implemented by the researchers. The control group did not receive any information regarding knowledge of CSX risk factors and a healthy lifestyle. Those participants in the control group received only the standard of care provided by the specialist and the clinical nurses during the visit and consultation. The researcher first collected data from the control group which was followed by data collection from the intervention group to avoid any possibility of interaction between the participants. The baseline data were collected before intervention. The outcome was assessed two weeks after the educational programs, which lasted for 14 weeks. Afterward, post-test data were collected from both the intervention and control groups. Blinding was done to limit the contamination. The educational program was also provided to the control group through a one-day workshop and a booklet after the post-test data collection.

4. Results

4.1. Population Characteristics

The majority of participants (n=58, 58%) were female (86% of whom were widows) with a mean age of 55.79±12.54. In terms of educational level, 43 (43%), 34 (34%), and 22 (22%) participants had a diploma, were university certified, and had a primary educational level, respectively. In addition, 49 (49%) participants had low incomes. The demographic distribution of the participants is presented in Table 1. No significant differences were found between the experimental and control groups in terms of different categories in all demographic variables (P>0.05). The researcher conducted the homogeneity test and found both the control and intervention groups were homogenous, hence it could be assumed that the true effect of the intervention on the outcome was measured (Table 1).

4.2. Effect of educational intervention on knowledge of CSX patient

Table 2 presents the descriptive statistics (mean and standard deviation) of knowledge of CSX risk factors in pre-and post-tests. The study results indicated a significant difference between the intervention and control groups in terms of the knowledge of CSX risk factors in the post-test. The mean±SD score of knowledge was significantly higher in the experimental group (20.96±1.77) compared to the control group (16.32±3.12). According to the results, the difference between pre-test and post-test means scores of knowledge of CSX risk factors were statistically significant in the intervention group (P<0.05), while there was no significant difference between pre-test and post-test scores in the control group (P>0.05) (Table 2).

4.3. Effect of the educational program on adherence to a healthy lifestyle in CSX patients

In this study, the mean±SD scores of adherence to a healthy lifestyle were obtained at 3.20±0.68 for the control group and 3.26±0.76 for the intervention group. In addition, post-test mean±SD scores of adherence to a healthy lifestyle were estimated to be 3.29±0.37 for the control group and 3.45±0.28 for the intervention group (Table 3).

Repeated measures multivariate analysis of covariance showed significant differences between the two study groups (control and intervention) across the time in terms of patients' adherence to healthy lifestyle subscales at a significance level of 0.05 (F [5,90]=23.446, P<0.001, Wilk's Λ=0.434, η2=0.566). According to these results, the overall effect of time was also significant in all dependent variables (F [5, 90]=5.826, P<0.001, Wilk's Λ=0.755, η2=0.245). This result showed that the interaction between group and time was statistically significant (F [5,90]=36.311, P<0.001, Wilk's Λ=0.331, η2=0.669), indicating that both groups had a significantly different pattern over the time for all subscales of patient's adherence to a healthy lifestyle. Based on these results, among two covariates, only age was significant (F [5, 90]=3.957, P=0.003, Wilk's Λ=0.820, η2=0.180) while income was not statistically significant (F [5,90]=1.434, P=0.220, Wilk's Λ=0.926, η2=0.074) (Table 4).

Table 1. Descriptive statistics for demographic variables of intervention and control groups (N=100)

Variable	Level	Control n (%)	Intervention n (%)	P-value
Gender	Female	28 (56)	30 (60)	0.685[a]
	Male	22 (44)	20 (40)	
Marital Status	Married	3 (6)	3 (6)	1[a]
	Widow	43 (86)	43 (86)	
	Single	4 (8)	4 (8)	
Educational Degree	Diploma	21 (42)	23 (46)	0.873[a]
	University certified	17 (34)	17 (34)	
	Literate	12 (24)	10 (20)	
Income	Good	5 (10)	7 (14)	0.584[a]
	Middle	18 (36)	21 (42)	
	Low	27 (54)	22 (44)	
Family History	No	20 (40)	23 (46)	0.386[a]
	Father	11 (22)	6 (12)	
	Mother	15 (30)	18 (36)	
	Sister	2 (4)	3 (6)	
	Brother	2 (4)	0 (0)	
Age	Mean (SD)	54.26 (12.54)	57.38 (11.55)	0.204[b]
Height	Mean (SD)	165.44 (9.85)	164.8 (9.51)	0.742[b]
weight	Mean (SD)	71.78 (16.13)	73.34 (12.71)	0.592[b]

a: Pearson chi square test, b: Independent t test. Significance level <0.05

Table 2. Pairwise comparison of knowledge of CSX risk factors across time for the study groups

Group	Pre-test				Post-test				Comparison between tests
	N	Mean	SD	Comparison between groups	N	Mean	SD	Comparison between groups	
				P-value				P-value	P-value
Control Group	50	15.48	2.82	0.099	108	16.32	3.12	<0.001*	0.074
Intervention Group	50	14.46	3.29		108	20.96	1.77		<0.001*

* The mean difference is significant at p<0.001

Table 3. Results of the mean total score of knowledge and adherence to a healthy lifestyle

Group	Control		Intervention	
	Mean	SD	Mean	SD
HDFQ[I] Pre-test	15.48	2.82	14.46	3.29
HDFQ Post-test	16.32	3.12	20.96	1.77
AHLQ[II] Pre-test	3.20	0.68	3.26	0.76
AHLQ Post-test	3.29	0.37	3.45	0.28

I: Heart disease fact questionnaire
II: Adherence to a healthy lifestyle questionnaire

Table 4. Summary of RM-MANCOVA* results for comparison between groups across the time

Effect	Wilks' Lambda	F	Hypothesis Df	Error Df	P-value	η^2_p
Group	0.434	23.466	5	90	<0.001*	0.566
Time	0.755	5.826	5	90	<0.001*	0.245
Time* Group	0.331	36.311	5	90	<0.001*	0.669
Age	0.820	3.957	5	90	0.003*	0.180
Income	0.926	1.434	5	90	0.220	0.074

* The mean difference is significant at p<0.001
* Repeated measures-multivariate analysis of covariance

5. Discussion

This study was conducted to assess the effectiveness of an educational intervention through the mHealth app on participants' knowledge of CSX risk factors and their adherence to a healthy lifestyle. The obtained results revealed that educational intervention through the mHealth app intervention could increase knowledge in the experimental group compared to that in the control group. This finding was in line with the results of some studies in which health education and counseling were adopted as health educational interventions (34, 35,36). In addition, the total score of adherence to a healthy lifestyle and its subscales improved in the experimental group after the intervention (Table 5), compared to the baseline scores.

Table 5. Descriptive statistics of adherence to a healthy lifestyle for the study groups

Variable	Group	Pre-test		Post-test	
		Mean	SD	Mean	SD
AHLQI.MOTII	Control	3.64	0.98	3.70	0.77
	Intervention	3.58	1.09	4.21	0.60
AHLQ.BARIII	Control	2.94	0.83	4.04	0.85
	Intervention	3.29	0.99	1.76	0.54
AHLQ.RESIV	Control	3.17	1.15	2.95	0.46
	Intervention	3.27	1.07	3.87	0.53
AHLQ.SATV	Control	2.77	0.72	2.56	0.76
	Intervention	2.82	0.96	3.29	0.41
AHLQ.LCVI	Control	3.49	1.06	3.24	1.04
	Intervention	3.48	1.15	4.15	0.54
AHLQ	Control	3.20	0.68	3.29	0.37
	Intervention	3.26	0.76	3.45	0.28

I: Adherence to a Healthy Lifestyle Questionnaire
II: motivation
III: barriers
IV: results
V: satisfaction
IV: lifestyle change

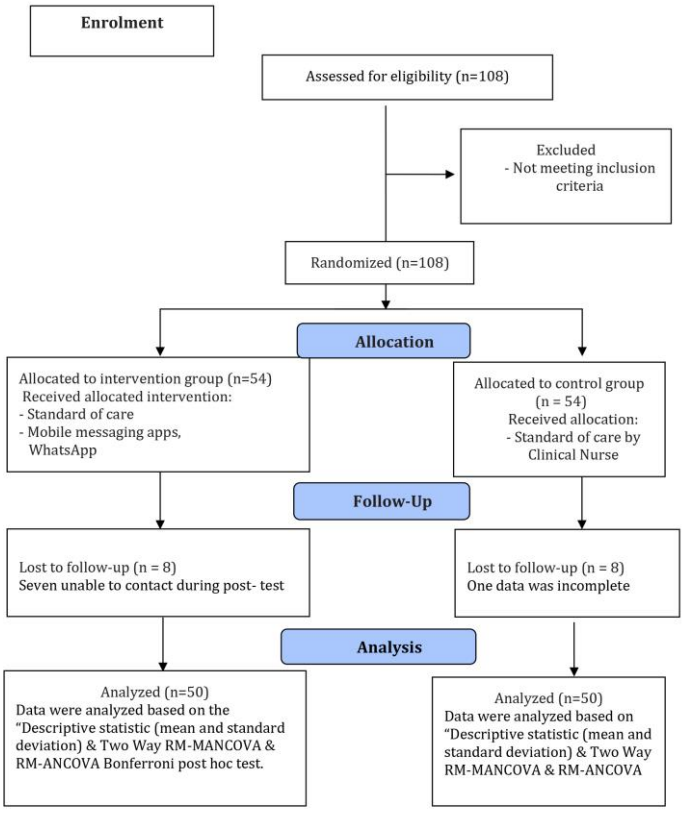

Figure 1. CONSORT flow diagram of the study
I: short messaging service
II: repeated measures-multivariate analysis of covariance
III: repeated measures-analysis of covariance

Based on the study results, the self-care educational program provided through the mHealth app can improve individuals' abilities and awareness about the risk factors and encourage people to follow a healthy diet and regular exercise, which was consistent with the results of a study conducted in Minnesota (18). Furthermore, the result of the current study can be used to improve and support educational programs for CSX patients. Outcomes of the latest investigation showed that educational applications in mobile phones can be extremely useful for people with heart disease. These applications can encourage lifestyle behavior modifications and promote adherence to medication (24,29). A study conducted in Iran demonstrated that health intervention successfully changed the lifestyle patterns of participants who likewise stated that health promotion was an essential strategy for the reduction of health inequalities (36). In the same line, Yu-Mi Lee et al. (23) also found that educational interventions could improve heart symptoms management, self-care, psychological condition, and the quality of life in the intervention group compared to the control group (16, 20, 24). Moreover, a similar study demonstrated that health educational intervention was very useful in health system divisions where fund and information penetration have always been an issue in typical health educational methods. In the current study, it was found that the adoption of the WhatsApp application (as a health intervention method) led to an increase in patients' knowledge and their adherence to a healthy lifestyle (34, 35). Similarly, the mHealth app could increase knowledge about a healthy lifestyle and reduce healthcare costs at the same time. These findings were consistent with those obtained in the previous studies involving patients with established cardiovascular disease (28, 38). For instance, Abbott, et al (15) has reported that cardiovascular health promotion intervention among Rural African Americans, significantly improved cardiovascular health knowledge, and it was associated with advancements in the stages of change behaviour. Based on the evidence, regular physical activity, a healthy diet, and participation in cardiac rehabilitation programs can improve the knowledge of risk factors and decrease morbidity, mortality, and hospital readmission (20,37,38,39). The mHealth app maintains a live dialogue between nurses and healthcare providers with patients. Therefore, nurses involved in the dialogue should have the professional knowledge to present factual information. Moreover, the mHealth app can help nurses and healthcare providers to share information with other healthcare providers including specialist cardiology doctors and other members of the health system team. Therefore, the health systems, especially hospitals, are recommended to develop or reshape the related guidelines to include the use of mHealth apps as effective health interventions.

5.1. Strengths of the Study

Regarding the strengths of this study, one can refer to the fact that the questionnaires used in the study were validated psychometrically by the developer of the instrument and were found to be satisfactory. Moreover, there was homogeneity between the participants in this study and a high survival rate in the intervention (100%) and control (100%) groups. Furthermore, the participants were selected through a randomized sampling method. Eventually, this was the first study on the effects of educational interventions for CSX patients on patients' lifestyles which might be useful for the treatment of these types of patients in the future. Moreover, the results of this study can be presented as a guide for nursing care.

5.2. Limitations of the Study

This study was conducted at one hospital in one city, therefore, the findings should not be generalized. This was the first study in Iran to examine the association among the CSX patients' socio-demographic information, their knowledge of CSX risk factors, and their lifestyle, which explains the limitation of evidence on CSX and its associated risk factors from Iran and all around the world.

6. Conclusion

The results of this study indicated that modification of the lifestyle with appropriate exercise programs along with a healthy diet was essential for CSX patients and could improve adherence to a healthy lifestyle. The mHealth app is an alternative approach with low cost and wide accessibility and can be used to help patients, health care providers, and health policymakers. The benefits of using mobile devices in health care go beyond the communication channels. They enable better coordination and can improve diagnostic accuracy and build trust between health care service providers and patients to increase the knowledge of patients and adherence to a healthy lifestyle. Technological innovations and WhatsApp health applications can be used to bridge the gap between health disparities and consumer health and empower patients to manage their self-care, enhance their knowledge, and adhere to a healthy lifestyle. The authors believe that dissemination of the findings of this study, as a primary effort to evaluate the lifestyle of patients with CSX and atherosclerosis, would increase the nursing knowledge and they can plan the educational interventions as a treatment approach and encourage adherence to a healthy lifestyle.

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Footnotes

Conflicts of Interest: The authors declare that they had no conflicts of interest.

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Ethical Considerations

This study was approved by the University of Malaya and Tehran Heart Center Hospital under the Ethics Codes: 201839-6110 and MEDICINE.REC.1398.901. Informed written consent was obtained from the participants at the start of the study.

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