The Effect of Mobile Health Intervention on Adherence to a Healthy Lifestyle in Patients with Cardiac Syndrome X (CSX)

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Abstract

Background:

Cardiac syndrome X (CSX) is regarded as a form of ischemic heart disease with functional coronary microvascular abnormalities. This abnormal functioning of coronary microvasculature, often associated with endothelial dysfunction, results in a reduced coronary blood flow reserve. The incidence of CSX in patients undergoing invasive diagnostics for coronary heart disease was approximately 20–30%. Moreover, about 60–70% of CSX patients are female. The CSX symptoms are often debilitating and sufferers have a poor quality of life, with costly demand for healthcare services.

METHODS

The quasi-experimental survey was conducted in a teaching hospital. In this study, 100 Iranian outpatients who were referred to the heart clinic were recruited by randomized sampling. CSX patients were asked to fill out the demographic characteristics form and questionnaires in pre-test then after the period of intervention has been performed the post-test.

Results:

The independent t-test for continuous variable and chi - square test for categorical variables were used. There was no significant difference between two groups for all demographic of intervention and control groups, and RM-Manova was done for main research variables. The result revealed that score of knowledge on CSX risk factors was significantly higher in the experimental group (mean = 20.96) & (SD = 1.77), compared with the control group (mean = 16.32) & (SD = 3.12).

Conclusion

The mobile health messaging intervention significantly is useful for CSX Patients. The educational programs and Lifestyle modification represent a highly effective and low-cost intervention in order to improve the adherence to a healthy lifestyle among cardiac patients.

Background

Cardiac syndrome X (CSX) is regarded as a form of ischemic heart disease (1). Functional coronary microvascular abnormalities, often associated with endothelial dysfunction, results in a reduced coronary blood flow reserve (2, 3, 4). Besides, the formation of atherosclerotic plaque inside the wall of the coronary arteries is a hallmark of coronary artery disease (CAD) which leads to narrowing of the vessels and subsequently into the clinical demonstrations of the acute coronary syndrome including angina and myocardial infarction (4, 5). It happens due to the abnormal functioning of coronary microvasculature (7, 8). In addition, CSX is highly prevalent all around the world as well as in Iran (6, 8). A large patient cohort study

by American Heart Association stated that among participants suspected to have myocardial ischemia and referred for coronary artery disease (CAD), 41% of the females and only 8% of the males showed non-significant epicardial CAD. Approximately 18.2 million adults (> 20 years old) have CAD (about 6.7%). Likewise, it is estimated that 2 out of 10 deaths due to CAD occur in adults (< 65 years old) (9, 10, 11).

Likewise, CSX incidence in patients undergoing invasive diagnostics for coronary heart disease was estimated at approximately 20–30%. About 60–70% of patients with CS X are female, often of menopausal age (12, 13). According to the WHO report in a local setting, CAD is the number one killer among Iranian people which contributes to around 46% of all deaths (14). While, although CSX is not associated with an increased risk of death, it has a sign in a patient's functioning and quality of life. However, CSX symptoms are often debilitating and due to which most of its patients have a poor quality of life and frequently demand costly healthcare services. (15, 16, 17). CSX attributes are comprised of female predominance, typical and atypical features of chest pain, high prevalence of psychological disorders, and recurrent hospital admissions (20, 21, 22). Many patients remain symptomatic despite reassurance, with significant limitations in their daily life activities usually due to persistent chest pain. Functional disability affects approximately 75% of patients with syndrome X, and the majority of these patients usually receive treatment with multiple drug combinations (23, 24, 25). Therefore, this apparent and short-term condition seems to affect negatively the quality of life (25). Compelling evidence indicates that in such societies besides drug treatment and targeting risk factors, a healthy lifestyle is an effective and important approach for the primary prevention of CSX diseases (26, 27). Researchers have suggested that Knowledge of the patient's individual risk factors can play a useful role in clinical decision-making regarding the intensity of preventive interventions and in guiding individualized management and control of these factors (26, 28). The pursuit of lifestyle changes using health education strategies is a necessary step in reducing cardiovascular events (29, 30, 31). Hence, educational programs and Lifestyle modification represent a highly effective and low-cost intervention that can reduce the incidence, progression, and morbidity associated with CSX (27, 32, 33, 34). One of the most effective strategies is to emphasize the improvement of knowledge regarding risk factors of heart diseases and attitude towards CS X risk factors and adherence to a healthy lifestyle (35,36,37 38, 39, 40).

One of the revolutionary technology in the 21st century is mobile technology which has created a large revolution in the field of science and transfer of knowledge and technology. Mobile health (mHealth) is an alternative approach that is being used due to its low cost and wide accessibility. Hence, mHealth could advance health care for patients, providers, and policymakers (41, 442, 43,) Mobile devices have created a new communication channel between healthcare service providers and patients. However, the benefits of mobile devices in healthcare exceed beyond the communication channels. They enable better coordination, improve diagnostic accuracy, and build a bridge of trust (43, 44, 45). Besides, technological innovations have already been used to bridge health disparities and consumer health, empowering patients to take control and play an active role in managing their health as well as enhance the knowledge of the patients (27, 46, 47). Hence, there is developing evidence that mHealth interventions are an effective and acceptable means of improving quality of life and adherence to a healthy lifestyle (27, 43).

Meanwhile, mobile phones can deliver health-improving facilities via short messaging service (SMS), smartphone applications (apps), or video messaging (47, 48, 49). Through the research team of electronic

databases CINAHL (Cumulative Index of Nursing and Allied Health Literature), identified key findings regarding mHealth interventions and health information considered suitable to the study setting and they have suggested that mHealth can be useful tools for health instructional intervention (45, 46). Due to a high prevalence and a large rise in cardiovascular diseases in recent years, more attention is necessary by the Ministry of Health and Education of Iran to give priority to research exploring strategies for the reduction of cardiovascular morbidity and mortality (2, 6). Alternately, it could reduce health care costs and also reduce the waste of medical resources (29, 30). Therefore, mobile health applications pose a great potential in health promotion and increasing knowledge about a healthy lifestyle while reducing costs affect health care (44, 45, 48). Considering that, yet there is no definitive treatment for CSX disease and also there is a lack of guidelines outlining the best course of therapy for modification of their lifestyle (1, 3). Hence, healthcare providers and the health care systems may discover this study to be helpful in creating a new protocol or policies that can improve cardiac patients' knowledge and quality of life (49, 50). The mobile health messaging apps (as a mandatory healthcare intervention) assist in the knowledge transfer between healthcare providers and patients. More knowledge and items can be provided to patients through this platform to improve adherence to a healthy lifestyle and their quality of life. So far in Iran, there have been few studies regarding this subject. To date, there has been no study related to the effect of mobile messaging apps on CSX patients in Iran. In sum, the researcher has suggested that the mHealth Messages App is useful and cost-effective for promoting health education.

Methods

The quasi-experimental survey was conducted in a Teaching Hospital- Clinic of the Heart centre. One Hundred (100) CSX outpatients who have the specified eligibility criteria, were recruited, and divided into experimental ($n = 50$) and control groups ($n = 50$). The intervention group has received an educational program update via mHealth messaging (WhatsApp) for 14 weeks.

Subjects and Settings

One hundred (100) CSX outpatients that were referred to the Clinic of teaching Hospital for visit and treatment with evidence of CSX disease as diagnosed by a cardiologist via the coronary angiography and physical activity test also blood test and symptoms were selected by randomized sampling. The participants who met the specified eligibility criteria were recruited and divided into experimental ($n = 50$) and control groups ($n = 50$). Figure 1 shows the procedure of enrolling participants in this study. The intervention group has received the routine education and educational intervention program for Self-Care. However, the control group has received routine education. Meanwhile, selective criteria in this study were patients that having microvascular dysfunction with typical chest pain (1, 2).

Data Collection

The Data Collection process of this study was conducted in May – Aug 2019 for the pre-test and post-tests of the intervention and control groups.

Demographic and Clinical Data

Patient demographic and clinical data were collected from the Clinic of Heart Centre. Demographic details included age, marital status, sex, and education, family history, clinical data included angiography, and EKG result and symptoms. The data was collected via the questionnaires including Disease Fact Questionnaire (HDFQ) & Adherence to a Healthy Lifestyle Questionnaire (AHLQ) that were translated into the Persian version according to the World Health Organization recommendation (51). The process of validity and reliability of the questionnaire has been performed. A pilot study was conducted to examine the feasibility of the questionnaires. The questionnaires were suitable for the local setting.

Educational intervention

The researcher recruited 100 CSX outpatients from the clinic of the heart centre. Then participants have divided into the intervention and control groups. The intervention group received the routine education and educational intervention program for Self-Care. According to the Social Cognitive Theory (SCT) that focuses on behaviour modification and self-care (52). The duration of education intervention was 14 weeks, and the outcome measures were evaluated after educational intervention programs. On the other hand, the control group has received routine education. The educational program has consisted of information related to anatomy and physiology of the heart, CSX risk factors, symptoms and diagnosis of CSX disease, healthy diet, fruit, vegetables, oils, and regular exercise, and advantages of self-care through the management of a healthy lifestyle, blood pressure, blood sugar, and cholesterol monitoring and control of weight(BMI) and stress. This education program was produced based on the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines (53, 10) and European guidelines. These educational contents were developed through the literature review panel and its content validity were confirmed by experts (including three nursing faculty members and two heart clinical nurse and one Heart Specialist Cardiologist). The educational intervention was given to the experimental group which consisted of a day workshop via using PowerPoint slides, images, and WhatsApp application through the mHealth messages and health education booklet. The duration of educational intervention was 14 weeks, and the outcomes were evaluated after education programs. The control group has received routine education. While, after the data collection of this study, also the content of the self-care educational program was presented to the participants in the control group.

Statistical analysis

In this study collected data based on the questionnaires were analysed using the Statistical Package for Social Sciences (SPSS) version 23 for Windows. All demographic variables were studied using descriptive statistics separately in each group (control and intervention) and were compared between control and intervention groups using independent t-test for continuous variable and chi-square test for categorical variables. From the results in (**Table:2 & 3**) there was no significant difference between the two groups for all demographic between intervention and control groups, therefore these variables showed the same pattern across the two groups. two ways. To assess the homogeneity of the research variables for both intervention and control groups, an independent sample t-test was used separately for knowledge on CSX risk factors, and adherence to a healthy lifestyle. The results of comparing two groups indicated that there were no significant differences between the two groups for knowledge on CSX risk factors and adherence to a healthy lifestyle at pre-test. Two-Way RM-MANCOVA & RM-ANCOVA followed by Bonferroni post hoc test, was used in order to test research hypotheses and comparing the knowledge on CSX risk factors between pre and post-intervention between two groups.

Results

Study Population

The participants' demographic data, which includes age, gender, educational level, marital status, and job status, were collected and classified. Most of the participants were female 58% ($n = 58$), and 86% of them were a widow and their mean age was 55.79. In terms of education level, most of the participants had attained a diploma of ($n = 46$). The university certified was ($n = 17$) and those with primary educational level were ($n = 10$). The participants ($n = 22$) had low incomes. The demographic distribution of the participants is shown in Table 1. No significant differences were found between the experimental and control groups for different categories in all demographic variables (p values > 0.05).

Table 1
Descriptive statistics for demographic variables in both groups

Variable	Level	Control n (%)	Intervention n (%)	t / χ^2	p value
Sex	Female	28(56)	30(60)	0.164	0.685
	Male	22(44)	20(40)		
Marriage	Married	3(6)	3(6)	0.000	1
	Widow	43(86)	43(86)		
	Single	4(8)	4(8)		
Education	Diploma	21(42)	23(46)	0.273	0.873
	University	17(34)	17(34)		
	literacy	12(24)	10(20)		
Income	Good	5(10)	7(14)	1.074	0.584
	Middle	18(36)	21(42)		
	Low	27(54)	22(44)		
Family. History	No	20(40)	23(46)	4.153	0.386
	Father	11(22)	6(12)		
	Mother	15(30)	18(36)		
	Sister	2(4)	3(6)		
	Brother	2(4)	0(0)		
Unrelated. History	Yes	20(41.7)	20(40)	0.028	0.867
	No	28(58.3)	30(60)		
Pre-BP	1	29(58)	25(50)	0.644	0.422
	2	21(42)	25(50)		
Pre-FBS	1	12(24)	18(36)	1.714	0.19
	2	38(76)	32(64)		
Age	Mean (SD)	54.26(12.54)	57.38(11.55)	-1.278a	0.204
Hight	Mean (SD)	165.44(9.85)	164.8(9.51)	0.33a	0.742
weight	Mean (SD)	71.78(16.13)	73.34(12.71)	-0.537a	0.592
Child	Mean (SD)	2.66(1.99)	2.76(1.52)	-0.267a	0.79

a: Independent t test

Effect of the mobile messaging apps on Cardiac Syndrome X patients' knowledge on risk factors

According to the results, there was no significant difference between the intervention and control groups for knowledge on CSX risk factors at pre-test (mean = 15.48) & (SD = 3.29), while in the post-test the mean score of knowledge on CSX risk factors was significantly higher in the experimental group (mean = 20.96) & (SD = 1.77), compared with the control group (mean = 16.32) & (SD = 3.12).

Table 2

Pairwise comparison of knowledge on CSX risk factors across time for both control and intervention

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

Effect of the mobile messaging apps on CSX patients' and adherence to a healthy lifestyle

This research objective was related to evaluating the differences in the mean score of patient adherence to a healthy lifestyle before and after the intervention. According to the results, it was found that five subscales of adherence to a healthy lifestyle including lifestyle change, barriers, motivation, results, and satisfaction were correlated, therefore, a two way repeated measure MANCOVA followed by two way repeated measure ANCOVA was applied to exclude the probable effect of two covariates (age and income) from the results and Bonferroni post hoc test also was applied for pairwise comparisons among test and groups for a lifestyle change, barriers, motivation, results, and satisfaction across the time. Repeated measure MANCOVA test for both groups across the time showed that there were significant differences between two groups (control and intervention) on patient adherence to healthy lifestyle subscales at 0.05 level of significance. ($F(5,90) = 23.446$, $p < 0.001$; Wilk's $\Lambda = 0.434$, $\eta^2 = 0.566$). According to these results, the overall effect of time also was significant on all dependent variables ($F(5, 90) = 5.826$, $p < 0.001$; Wilk's $\Lambda = 0.755$, $\eta^2 = 0.245$). This result also revealed that the interaction between group and time was statistically significant ($F(5,90) = 36.311$, $p < 0.001$; Wilk's $\Lambda = 0.331$, $\eta^2 = 0.669$) which means groups had a significantly different pattern over the time for all subscales of patient adherence to a healthy lifestyle. The differences between experimental and control were significant for all dependent variables in post-test ($p < 0.05$).

Table 3
Results of the mean total score of knowledge,
adherence to the healthy lifestyle

Group	Control		Intervention	
	Mean	SD	Mean	SD
PRE.HDFQ	15.48	2.82	14.46	3.29
POST.HDFQ	16.32	3.12	20.96	1.77
AHLQ. pre	3.20	0.68	3.26	0.76
AHLQ. post	3.29	0.37	3.45	0.28

Discussion

The current study was conducted to investigate the effectiveness of an educational intervention via Mobile Health Massaging App on the health knowledge of participants and adherence to a healthy lifestyle among CSX patients. In this regard, results revealed that educational intervention and mHealth intervention can increase knowledge in the experimental group compared with the control group. This finding was supported by some studies that used health education and counselling as health education interventions (9,26,32, 33). In addition, the total score of adherence to a healthy lifestyle and its subscales have been improved in the experimental group after the intervention, (Table 3) compared with the score at the baseline. Moreover, the result of the current study shows that the self-care educational program via mHealth application can develop the individual's abilities and awareness about the risk factors and encourage the people to follow a healthy diet and regular exercise which is consistent with a study conducted in Minnesota (18). Outcomes of the latest investigation revealed that educational apps via mobile phones can be extremely useful for people with existing heart disease. These apps can encourage lifestyle behaviour modifications and also promote adherence to medication (41, 46). Besides, a study in Iran demonstrated that health intervention successfully changed participant's lifestyle patterns, moreover, they stated that health promotion is an essential strategy for the reduction of health inequalities (50). In this study, the extreme development in adherence to a healthy lifestyle contributed to the supportive atmosphere of the WhatsApp group (27,32). In addition, the results of the current study revealed positive feedback for the acceptability and usefulness of mHealth intervention to promote cardiovascular diseases in the Iranian setting. This is consistent with the findings from a systematic review which identified that mHealth interventions must be flexible as well as culturally and socially appropriate to the desires and needs of the patients (43, 44). Anderson (38) found that the knowledge of pathophysiological mechanisms of CSX is still limited for physicians. However, many researchers suggested that lifestyle modification has a beneficial effect on improving coronary microvascular dysfunction and quality of life (30, 34, 37). Meanwhile, according to previous studies, cardiovascular diseases especially CSX, are known to be associated with impaired health-related quality of life (HRQOL) (4, 5, 16, 25). Therefore, mobile apps as a health intervention method had been confirmed by many studies to significantly improve participant knowledge and decrease readmission to hospitals due to an improvement in awareness of heart disease risk factors and their quality of life (26, 27,38).

Appropriate to our study Yu-Mi Lee, et al (26) also found that educational interventions can increase heart symptoms management, self-care, psychological condition, and the QOL in the intervention group compared with the control group (16, 17, 19). Moreover, a similar study demonstrated that health educational intervention is very useful in health system divisions where fund and information penetration are always an issue faced by typical health education methods. In this study, it is concluded that WhatsApp (as a health intervention method) manages to increase patients' knowledge and subsequently enhances their adherence to a healthy lifestyle (27, 43) and empowers the patients to take control and play an active role in managing their health (44, 45). In this regard, the result of a similar study has reported that TextMe2 will generate reliable data about the effectiveness of an entire text message-based intervention as a potential primary prevention solution to control multiple cardiovascular risk factors among those at moderate to high cardiovascular risk (42). Meanwhile, Khonsari, et al find out that the mHealth intervention had the desired effect on cardiovascular risk factors management and can lead to adherence to medication among Iranian CHD patients (43). The mHealth intervention was well accepted and feasible with early evidence of effectiveness that needs to be confirmed in an entirely influenced future randomized clinical trial. Thus, increasing the effective knowledge about a healthy lifestyle while reducing healthcare costs. These findings are consistent with the results of previous studies involving patients with established CVD (47,48). For instance, Abbott, et al (15) has reported cardiovascular health promotion intervention among Rural African Americans, significantly improved cardiovascular health knowledge and was associated with advancements in the stages of change toward the action and maintenance phases. The educational program can also help patients with CHF to manage their symptoms, increase self-confidence, reduce hospitalization, and improve their QOL (16, 21, 22, 39). Moreover, research has shown that regular physical activity, and healthy diet, and participation in cardiac rehabilitation (CR) can improve risk factors and decrease morbidity and mortality, and hospital readmission (30, 35, 38). Altogether, adherence to a healthy lifestyle is associated with substantially lower risks of morbidity from all sources of cardiovascular diseases. Hence, population-wide primary prevention targeted for reducing exposure of risk factors should be the global overarching priority for the response to this crisis.

Strengths and limitations of the study

Strengths of this study are:

- It is the first study conducted about educational intervention for CSX patients and their healthy lifestyle could be useful for the treatment of these patients
- The questionnaires that were used in this study have been validated psychometrically by the developer of the instrument and it is found satisfactory. Through a pilot study, the questionnaires demonstrated adequate validity and reliability tests.
- Two groups of CSX patients who participated in this research are homogeneity at the beginning of the study, and this emphasizes the requirements for the comparison of the two groups.
- This study can develop the efficiency of knowledge attraction, hereby the information share to patients through this platform is easy to absorb and comprehend, thus increasing the efficiency of knowledge transfer via the mHealth to improve their quality of life and consequently adherence to a healthy lifestyle.

- **The first limitation**, it is unique in being a quasi-experimental assessment compared with routine care management-based interventions for handling multiple CSX risk factors in a primary prevention setting, hence the evidence was limited.
- The second limitation of the study was a lack of generalization. The study was conducted at one hospital in one city. This had restricted the sample size participating in this study, so the sample size is relatively small.
- Thirdly, the sample size was limited because the diagnosis of Cardiac Syndrome X by a cardiologist still is a big challenge and complicated

Conclusion

The mobile health messaging apps intervention significantly is useful for Cardiac Syndrome X Patients. Besides, the educational programs and lifestyle modification represent a highly effective and low-cost intervention in order to improve the adherence to a healthy lifestyle among cardiac patients. In this study, is concluded that for CSX patients' treatment, WhatsApp and Mobil massaging as a health intervention method manages can increase patients' knowledge and subsequently increase their adherence to a healthy lifestyle.

Abbreviations

CSX: Cardiac Syndrome X

AHLQ: Adherence to a Healthy lifestyle questionnaire

CINAHL: Cumulative Index of Nursing

CVD: Cardiovascular Diseases

mHealth: Mobil Health

CR: Cardiac Rehabilitation

QoL: quality of life

Declarations

Ethical considerations

Data was collected from the Tehran Heart Centre Hospital. This study was approved by the University of Malaya medical centre in 2018. The approval number was 201839-6110 and the protocol was accepted by the Ethics Committee of the Tehran University of Medical Science (IR.TUMS.MEDICINE.REC.1398.901).

Moreover, informed written consent was received from the participants.

Consent for publication

The authors of this article declare that they have no conflicts of interest.

Availability of data and materials

Data supporting our findings can be made available upon request.

Competing interests: Not Competing interests

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Authors' contributions

Malekzadeh, S designed and developed the project including the concepts of investigation; data collection, and the acquisition of data; also analysis of data and interpreted data, Chong, & Tang has checked all the processes by guidance, Omid helped me with sample size selection in the heart clinic. All authors read and approved the final manuscript.

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References

1. Masoudkabar, F, Vasheghani-Farahani, A, Hakki, E. (2018), Novel Scoring System for Prediction of Cardiac Syndrome X in Women with Typical Angina and a Positive Exercise Tolerance Test. *Tex Heart Inst J*. 2018 Feb; 45(1): 5–10.. doi: 10.14503/THIJ-16-5906
2. Vasheghani-Farahani A, Nouri N, Seifirad S, Sheikh Fathollahi M, Hakki E.(2013). Comparison of cardiovascular risk factors and biochemical profile in patients with cardiac syndrome X and obstructive coronary artery disease: A propensity score-matched study. *ARYA Atheroscler*. 9(5),269-73.
3. Saadat, M. Masoudkabar, F. Afarideh, M, Ghodsi, S.(2019). Discrimination between Obstructive Coronary Artery Disease and Cardiac Syndrome X in Women with Typical Angina and Positive Exercise Test; Utility of Cardiovascular Risk Calculators. *Medicina (Kaunas)*. 2019 Jan; 55(1): 12.. doi: 10.3390/medicina55010012
4. Radico, F, Cicchitti, V, Zimarino, M, De Caterina, R. (2014). Angina Pectoris and Myocardial Ischemia in the Absence of Obstructive Coronary Artery Disease: Practical Considerations for Diagnostic Tests. *JACC: Cardiovascular Interventions* Volume 7, Issue 5, May 2014DOI: 10.1016/j.jcin.2014.01.157

5. Roffi, M & Mukherjee, D, (2018), Treatment-risk paradox in acute coronary syndromes, Eur Heart J 2018 Nov 7;39(42):3807-3809. PMID: 30247536 DOI: 10.1093/eurheartj/ehy577
6. Soleimani A, Pourmoghaddas A, Sadeghi M, Roohafza H, Talaei M, Dianatkah M, Oveisgharan S, Soleimani M, Sarrafzadegan N.(2018). Risk and Age of Cardiovascular Event in Women with Metabolic Syndrome: Menopause Age in Focus. Metab Syndr Relat Disord. 2018 Apr;16(3):127-134. doi: 10.1089/met.2017.0096. Epub 2018 Feb 13.PMID: 29437523
7. Kuruvilla S, Kramer CM. Coronary microvascular dysfunction in women: An overview of diagnostic strategies. Expert Rev Cardiovasc Ther 2013;11:1515–1525 [PMC free article] [PubMed] [Google Scholar]
8. Patel, H, T. Aggarwal, N, Rao, A, Elizabeth Bryant, E, M. Sanghani, R, et al,(2020). Microvascular Disease and Small-Vessel Disease: The Nexus of Multiple Diseases of Women. J Womens Health (Larchmt). June 2020; 29(6): 770–779. PMID: 32074468. doi: 10.1089
9. World Health Organisation (2019). Health statistics 2019: Monitoring world health for the sustainable development goals. Retrieved from https://www.who.int/gho/publications/world_health_statistics/2019/EN_WHS_2019_TOC.pdf?ua=1
10. American Heart Association and American Stroke Association. (2020) Patient Education Resources for Healthcare Professionals. Red Dress DHHS, Go Red AHA; National Wear Red Day is a registered trademark.
11. Nowbar,N,A, Gitto, M, Howard, P, J, Francis, P, D, Al-Lamee, R, (2019). Mortality From Ischemic Heart Disease. Circulation: Cardiovascular Quality and Outcomes. 2019;12:e0053752019<https://doi.org/10.1161/CIRCOUTCOMES.118.005375>.
12. Cekirdekci, E, Bugan, B, (2018). Level of Anxiety and Depression in Cardiac Syndrome X. Med Princ Pract . 2019;28(1):82-86. PMID: 30396178 PMCID: PMC6558324 DOI: 10.1159/000495109
13. Centers for Disease Control and Prevention. Underlying Cause of Death, 1999–2018. CDC WONDER Online Database. Atlanta, GA: Centers for Disease Control and Prevention; 2018. Accessed March 12, 2020.
14. World Health Organization (2014). Cardiovascular diseases (CVDs). Retrieved from <http://www.who.int/mediacentre/factsheets/fs317/en/>
15. Abbott LS, Slate EH, Graven LJ. (2019).Cardiovascular disease risk among rural residents living with diabetes and prediabetes: A cluster randomized trial. Public Health Nurse. 2020 Jan;37(1):16-24. doi: 10.1111/phn.12659. Epub 2019 Sep 5. PMID: 31489717
16. Anchah, L, Hassali, A,M, Han Lim, S, M, Mohamed, I, M, Ibrahim, Kui Hian Sim,H,K, Ong, K, T,(2017). Health related quality of life assessment in acute coronary syndrome patients: the effectiveness of early phase I cardiac rehabilitation. Health and Quality of Life *Outcomes* volume 15, Article number: 10 (2017) Cite this article 2704 Accesses
17. Zsilinszka R, Mentz RJ, DeVore AD, Eapen ZJ, Pang PS, Hernandez AF. (2017). Acute Heart Failure: Alternatives to Hospitalization. JACC Heart Fail. 2017 May;5(5):329-336. doi: 10.1016/j.jchf.2016.12.014. Epub 2017 Mar 8. PMID: 28285117
18. Alfonso, S, Gaetano A. Lanza, Antonio Di Monaco, Priscilla, Lamendola.(2011). Relation between Cardiovascular Risk Factors and Coronary microvascular dysfunction in cardiac syndrome X. Journal of

Cardiovascular Medicine, 12,322–327.

19. Uribe-Heredia G, Arroyo-Espliguero R, Viana-Llamas MC, Piccone-Saponara LG. Type 2 Diabetes Mellitus, Glycated Hemoglobin Levels, and Cardiopulmonary Exercise Capacity in Patients with Ischemic Heart Disease. *J Cardiopulm Rehabil Prev*. 2019
20. Löffler, Bourque.(2017). Coronary Microvascular Dysfunction, Microvascular Angina, and Management. *Curr Cardiol Rep*. 18(1), 1
21. Sunamura ,M, Hoeve T, N, , van , G, R, Berg-Emons , Boersma ,E, Domburg , T, V, Geleijnse , M, (2018). Cardiac rehabilitation in patients with acute coronary syndrome with primary percutaneous coronary intervention is associated with improved 10-year survival. *Eur Heart J Qual Care Clin Outcomes* 2018 Jul 1;4(3):168-172. doi: 10.1093/ehjqcco/qcy001.
22. BabuEzhumalai, B, Ananthakrishnapillai, A, J.Selvaraj, R, Satheesh, S, derJayaraman, B, (2015). Cardiac syndrome X: Clinical characteristics revisited. <https://doi.org/10.1016/j.ihj.2015.04.022>Get rights and content
23. Mhanna , M, Nazir P. S, Ramanathan , K, Letcher, R, J. (2021). Acute Compressive Coronary Artery Disease Due to Left Atrial Appendage Epicardial Occlusion. *JACC Journals › JACC: Interventions › Archives › Vol. 14 No. 10 J Am Coll Cardiol Interv*. 2021 May, 14 (10) e113–e114
24. TIMOTHY L. SWITAJ, (2017). Acute Coronary Syndrome: Current Treatment. February 15, 2017 , Volume 95, Number 4 www.aafp.org/afp American Family Physician Journal. Guthrie Ambulatory Health Care Clinic, Fort Drum, New York
25. Agrawal S, Mehta PK, Bairey Merz CN;(2016),. Cardiac Syndrome X: Update. *Heart Fail Clin*. 2016 Jan12 (1):141-56. doi: 10.1016/j.hfc.2015.08.012.
26. Yu-Mi Lee, Bum Kim,R, Jean Lee,H, Kim, K, Min-Ho Shin, Hyeung-Keun Park, (2018). Relationships among medication adherence, lifestyle modification, and health-related quality of life in patients with acute myocardial infarction: a cross-sectional study. *Health Qual Life Outcomes*. 2018; 16: 100 doi: 10.1186/s12955-018-0921-z
27. Tang,Y,H, . Chong, Ch, M, Chua, P, Y, Chui, L, P, Li ,. Tang, Y, | Rahmat, N,. 2018. The effect of mobile messaging apps on cardiac patient knowledge of coronary artery disease risk factors and adherence to a healthy lifestyle. *Journal of Clinical Nursing*. DOI: 10.1111/jocn.14538
28. LV, J, Canqing ,Yu Guo,Zheng Bian, Ling Yang, Yiping Chen, Xuefeng ,Tang, Weiyuan, Zhang, Yijian ,Qian,. (2017). Adherence to Healthy Lifestyle and Cardiovascular Diseases in the Chinese Population. *Journal of the American College of Cardiology* Volume 69, Issue 9, , Pages 1116-1125.
29. Szot, W, A–E, Joanna Zajac, C, D, F, Magdalena Kostkiewicz3, C, E, F, Emilia Kolarzyk2, E, F, 2015. Dietary Patterns Seem to Influence the Development of Perfusion Changes in Cardiac Syndrome X Patients. University, Kraków, Poland Nuclear John Paul II Hospital, Kraków, Poland *Adv Clin Exp Med* 2015, 24, 3, 453–462DOI: 10.17219/acem/34475 ISSN 1899–5276
30. Rajib Mondal, R. Chandra Sarker, R. Prasad Acharya,N. Chandra Banik,P.(2019). Effectiveness of health education-based conventional intervention method to reduce non-communicable diseases risk factors among rural population. *Cardiovasc Diagn Ther*. 2019 Feb; 9(1): 30–34.doi: 10.21037/cdt.2018.10.09

31. Noumani,A.H· RongWu· Barksdale^cD,Sherwood,G, Khasawneh· E,GeorgeKnafl.(2019). Health beliefs and medication adherence in patients with hypertension: A systematic review of quantitative studies. *Patient Education and Counseling (PEC Journal)*. Volume 102, Issue 6, June 2019, Pages 1045-1056
<https://doi.org/10.1016/j.pec.2019.02.022>
32. Yi-QinSun, An-LiJiang, San-MeiChen, HuiLiRN, Hai-YanXing, FangWang. (2017). Quality of life and self-care in elderly patients with cardiovascular diseases: The effect of a Traditional Chinese Medicine health educational intervention. *Applied Nursing Research*, Volume 38, December 2017, Pages 134-140
<https://doi.org/10.1016/j.apnr.2017.10.003>
33. Akyuz, A, (2020). Exercise and Coronary Heart Disease, *Adv. Exp Med Biol* 2020;1228:169-179. doi: 10.1007/978-981-15-1792-1_11.
34. Mertens , E, Markey , O, Geleijnse , M,J, Julie A Lovegrove , A, J, Givens, D,(2018). Adherence to a healthy diet in relation to cardiovascular incidence and risk markers: evidence from the Caerphilly Prospective Study. PMID: 28293738 PMCID: PMC5861161 DOI: 10.1007/s00394-017-1408-0
35. Bakker, De, M, Uijl , den, I, Hoeve , Ter, N, Domburg , T, Van, R, Geleijnse , L, M, Rita J van den Berg-Emons , Boersma,E, Sunamura,M, (2020). Association Between Exercise Capacity and Health-Related Quality of Life During and After Cardiac Rehabilitation in Acute Coronary Syndrome Patients: A Sub study of the OPTICARE Randomized Controlled Trial. *Arch Phys Med Rehabil*. 2020 Apr;101(4):650-657 . Epub 2020 PMID: 31904342 DOI: 10.1016/j.apmr.2019.11.017
36. Wang ZJ· Zhang LL, Elmariah S, Han HY, Zhou YJ.(2017). Prevalence and Prognosis of Non-Obstructive Coronary Artery Disease in Patients Undergoing Coronary Angiography or Coronary Computed Tomography Angiography: A Meta-Analysis. *CIRCULATIONAHA* ;92(3):329-346.
37. Linqi Xu, Feng Li, Zhou, Ch, Jinwei Li, Chengcheng Hong , Ch,, Tong, Q. (2019). The effect of mobile applications for improving adherence in cardiac rehabilitation: a systematic review and meta-analysis. *BMC Cardiovascular Disorders* volume 19, Article number: 166 (2019) Cite this article
38. Anderson, L., Oldridge, N., Thompson, D. R., Zwisler, A.-D., Rees, K., Martin, N., & Taylor, R. S. (2016). Exercise-based cardiac rehabilitation for coronary heart disease: Cochrane systematic review and meta-analysis. *Journal of the American College of Cardiology*, 67(1), 1–12.
<https://doi.org/10.1016/j.jacc.2015.10.044>
39. Zsilinszka R, Mentz RJ, DeVore AD, Eapen ZJ, Pang PS, Hernandez AF. (2017). Acute Heart Failure: Alternatives to Hospitalization. *JACC Heart Fail*. 2017 May;5(5):329-336. doi: 10.1016/j.jchf.2016.12.014. Epub 2017 Mar 8. PMID: 28285117
40. Bartlett,S,E, Luisa S Flor,S, L, Medeiros,S, D, Colombara,V, D, Johanns, K, C, Fernando o Vaz, C, A, Wilson,Sh, Duber, C, H, (2020). Public knowledge of cardiovascular disease and response to acute cardiac events in three municipalities in Brazil. *Open Heart*. 2020; 7(2): e001322. Published online 2020 Aug 26. doi: 10.1136/openhrt-2020-001322. PMCID: PMC7451281 PMID: 32847995
41. Forman, D. E., LaFond, K., Pancch, T., Allsup, K., Manning, K., & Sattelmair, J. (2014). Utility and efficacy of a smartphone application to enhance the learning and behaviour goals of traditional cardiac rehabilitation: A feasibility study. *Journal of Cardiopulmonary Rehabilitation and Prevention*, 34, 327–334. <https://doi.org/10.1097/HCR.0000000000000058>

42. Klimis ,H, Thiagalingam, A Chow, K, C,. (2020). Text messages for primary prevention of cardiovascular disease: TextMe2 randomised controlled trial protocol, *BMJ Open* 2020;10:e036767. doi:10.1136/ bmjopen-2020-036767
43. Khonsari, S, Parker,R, Holloway,A, (2020). Increasing cardiovascular medication adherence: A medical research council complex mHealth intervention mixed-methods feasibility study to inform global practice. *Journal of Advanced Nursing, J Adv Nurs.* 2020;00:1–15. DOI: 10.1111/jan.
44. Coorey, G. M., Neubeck, L., Mulley, J., & Redfern, J. (2018). Effectiveness, acceptability and usefulness of mobile applications for cardiovascular disease self-management: Systematic review with meta-synthesis of quantitative and qualitative data. *European Journal of PreventiveCardiology*, 25(5), 505–521. <https://doi.org/10.1177/2047487317750913>
45. Thakkar, J., Kurup, R., Laba, T.-L., Santo, K., Thiagalingam, A., Rodgers, A., ... Chow, C. K. (2016). Mobile telephone text messaging for medication adherence in chronic disease: A meta-analysis. *JAMA Internal Medicine*, 176(3), 340–349. <https://doi.org/10.1001/jamainternmed.2015.7667>
46. International Telecommunication Union (2018). Key Information and communications technology (ICT) indicators for developed and developing countries and the world. Retrieved from <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.
47. Kayyali,R, Hesso, I, Mahdi, A, Hamzat, O, Adu, A, Shereen Nabhani Gebara, N, Sh,. (2017). Telehealth: misconceptions and experiences of healthcare professionals in England. *Int J Pharm Pract.* 2017 Jun;25(3):203-209. PMID: 28261891 DOI: 10.1111/ijpp.12340 Epub 2017
48. Fang, R., & Li, X. (2016). Electronic messaging support service programs improve adherence to lipid-lowering therapy among outpatients with coronary artery disease: An exploratory randomised control study. *Journal of Clinical Nursing*, 25(5/6), 664–671. <https://doi.org/10.1111/jocn.12988>
49. Bostrom, J, Sweeney G,. Whiteson J, A Dodson, J,.(2020). Mobile health and cardiac rehabilitation in older adults. *Clin Cardiol* . 2020 Feb;43(2):118-126. PMID: 31825132 PMCID: PMC7021651 DOI: 10.1002/clc.23306
50. Mansoori, P, Majdzadeh, R., Abdi, Z., Rudan, I., Chan, K. Y., Aarabi, M., Zare, M. (2018). Setting research priorities to achieve long-term health targets in Iran. *Journal of Global Health*, 8(2), 020702. <https://doi.org/10.7189/jogh.08.020702>
51. World Health Organization {WHO}. (2016). Process of translation and adaptation of instruments. Retrieved 19 April, 2016, from http://www.who.int/substance_abuse/research_tools/translation/en/
52. Bandura, A. (2006). Health promotion by social cognitive means. *Health Education and Behavior*, 143-164. doi:10.1177/1090198104263660
53. Arnett, K, D, Blumenthal, S, R, Albert, A, M, Buroker, B, A, Zachary D, et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease. *Journal of the American College of Cardiology* Volume 74, 2019DOI: 10.1016/j.jacc.2019.03.010

Figures

Figure 1

CONSORT Flow diagram of the study