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PATIENT FACTORS ASSOCIATED WITH ADHERENCE AND CHANGE IN CARDIAC RISK FACTORS AMONG CARDIAC REHABILITATION PATIENTS IN QATAR

BY

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ABSTRACT

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Title:_PATIENT FACTORS ASSOCIAED with ADHERENCE and CHANGE in CARDIAC RISK FACTORS AMONG CARDIAC REHABILITATION PATIENTS in QATAR

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Background: cardiovascular disease is the number one killer in Qatar. Cardiac rehabilitation (CR) is a cost-effective model of care shown to reduce cardiovascular morbidity and mortality by 20%. However, it is vastly underutilized with low enrollment and adherence rates. This study aimed to (a) examine the association between number of sessions attended and change in cardiac risk factors after completion of CR program, and (b) investigate factors associated with adherence

Methods: This is a retrospective cohort study, consisted of 714 cardiac patients, aged ≥18 years, referred to a cardiac rehabilitation program in Qatar. A simple linear regression analysis (unadjusted model) was used to assess the association between the mean change in each of the following risk factors: cholestrol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and body mass index (BMI and number of sessions attended. Then, we adjusted for clinical and sociodemographic factors that affect the outcome variable via multiple linear regression analyses. Logistic regression model was used to assess factors associated with adherence. Additionally, a paired sample t-test was used to identify mean change in cardiac risk factors pre-post CR and link this change to clinical significant cut off values in the literature. An independent sample t-test was used to identify change between groups (adherence vs. no adherence). **Result:** The mean age of the population was 52.7±10.1 years (mean ± SD). Patients referred to CR program were mostly males (n= 641, 89.8%) and non-Qatari (n= 596, 83.5%), almost one fourth were smokers (n=185, 25.91%), and one fifth (n=128, 18.8%) were diagnosed with severe depression. The main positive predictor for adherence was AACVPR moderate risk [OR=12.71, 95%CI= 7.81-20.68] and high-risk level [OR=10, 95%CI= 6.44-17.44]. PCI [OR=0.39, 95%CI= 0.17-0.89] and musculoskeletal disease [OR=0.17, 95%CI= 0.03-0.95] were negatively associated with adherence. We found clinically significant improvements among adherents to CR; 10% reduction in total cholesterol level and 15% reduction in low-density lipoproteins. **Conclusion:** This study provides new insights in Qatar setting into the factors that lead patients to adhere to their CR sessions. These patient-level variables associated with adherence represent opportunities for program directors in identifying patients who are less likely to adhere to the program; therefore, develope effective interventions to target these patients and consequently improve their health status.

Keywords: Cardiovascular disease, Cardiac rehabilitation, Adherence

DEDICATION

I would like to dedicate this work to my beloved parents, Ahmed and Abeer and my siblings, Sarah, Marwa, Yumna, Abdulrahman, Abdulla, Omar, and Amr

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Cardiovascular disease (CVD) is "the name given to a group of disorders affecting the body's arteries, which may lead to heart attack, stroke, or angina" (1). In addition to the high CVD mortality rate, this disease imposes tremendous pressure on healthcare resources because individuals with ongoing heart conditions need ongoing medical assistance. CVD significantly affects the quality of life for those who suffer from this condition, while also reducing their life expectancy (2). Around the globe, (CVD) is considered killer number one (3). According to the Qatar health strategy 2017 and WHO report, 17.7 million people died due to CVDs, which is equal to 31% of all deaths around the world (2, 4). Most of these deaths (7.4 million) were due to coronary heart disease, and 6.7 million deaths were due to stroke (2). Unfortunately, this number is expected to increase to 23.6 million by 2030 (5).

In the Eastern Mediterranean Region (EMR), CVD is the leading cause of disability, accounting for 9.2% of total disability adjusted life years (DALYs) (6). Whereas in Qatar, non-communicable diseases(NCDs) are estimated to account for 69% of all deaths having CVD in the lead, with 27% of mortality, followed by 16% of other NCDs and 16% cancer (7). Furthermore, CVD in Qatar is considered the number one cause of death from NCDs (2). With this consistency of the CVD burden, countries need to implement prevention strategies to manage it and contain the increased mortality rates.

One crucial and essential strategy adopted is the Cardiac Rehabilitation (CR) program. CR identified as a "comprehensive Secondary prevention program that is medically supervised and designed to improve the physical and emotional condition of patients with heart disease" (8). The program is considered a cost-effective model of care that reduces cardiovascular mortality and morbidity by 20% and encourages a commitment to regular exercise and healthy habits for risk factor modification to establish lifelong cardiovascular fitness (9). According to Hammill and colleagues, there is a strong dose-response relationship between the number of sessions attended and the long-term outcome of CVD. Not only that, but attending all of the 36 sessions entitled by the program resulted in risk reduction in death and myocardial infarction (10). Though the CR program is recommended for patients recovery as different studies established due to its benefit, participation of eligible patients in the program is low such as in Canada with a 20% participation rate and 14% in middle-income countries (11).

Despite all the benefits of the CR program documented in literature, adherence rates are suboptimal(12). In Qatar, there is only one CR program with lack of research on the factors associated with adherence. Only one qualitative study explored reasons for nonattendance to the CR program without identifying the possible factors associated with adherence(13). Hence, this study aimed to (a) identify patients' factors associated with adherence (attending more than or equal to the median number of sessions) to cardiac rehabilitation, (b)explore factors associated with adherence to the median number of sessions non adherence and the mean change in cardiac risk factors from pre to post enrollment in CR program.

CHAPTER 2: LITERATURE REVIEW

Non-communicable diseases (NCDs), known as chronic diseases, are characterized by a long duration and small disease progression. NCDs' five main types are cardiovascular diseases (CVD), e.g. (coronary heart disease and stroke), type 2 diabetes, cancer, respiratory diseases, and mental disorders (5). CVD is the leading among non-communicable diseases, and it is considered the number one killer worldwide(4). Furthermore, over three-quarters of CVD deaths take place in low- and middle-income countries (14).

CVD is defined as a “group of disorders of heart and blood vessels which includes, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, and congenital heart disease” (14). In the year 2015, 17.7 million people died due to CVDs, which is equal to 31% of all deaths around the world (1). Most of these deaths (7.4 million) were due to coronary heart disease, and 6.7 million deaths were due to stroke (2). Unfortunately, This number is expected to increase to 23.6 million by 2030 (5).

In the Eastern Mediterranean Region (EMR), the situation could not be better. CVD mortality in the EMR, mostly attributable to ischemic heart disease, is expected to increase dramatically in the next decade higher than any other region except Africa (6). Approximately 58.4% of total deaths in the EMR were attributable to NCDs in 2015, with the primary cause being CVD (27.4% of total deaths) (6, 15). According to the same study, the author identified that the most prominent CVD risk factors in the EMR include tobacco consumption, physical inactivity, depression, obesity, hypertension, and diabetes mellitus (6).

Within the EMR region, Gulf countries (GCC) have a history of high NCDs, including obesity, diabetes, and, most importantly, CVD. Supporting evidence was reported in a systematic review of the Prevalence of cardiovascular disease in the Gulf region (16). The study stated that, due to the rapid growth of socioeconomic status in the GCC countries, lifestyle changed noticeably in terms of fast food consumption and the adoption of sedentary behaviors (16). Thus, the rate of CVD and associated risk factors increased, and it exceeded the rate of the developed country(16). Besides, the number of deaths resulting from ischemic heart disease and hypertensive heart disease in the Middle East (including the GCC countries) was 294/100,000, whereas the number of disability-adjusted life years (DALYs) resulting from ischemic and hypertensive heart disease is 3702/100,000 (16). In Oman and Kuwait, the estimated number of death reached (49%) and (46%), respectively, which means almost half of the death in both countries was caused by CVD (3, 16). The rate of CVD deaths was also high in the region with Saudi Arabia (42%), UAE (38%), Bahrain (32%), and Qatar 23% (3, 16).

Glancing at the situation here in Qatar, CVD is considered The number one cause of death from non-communicable diseases, as found in other high-income countries (2). Adding to this, in one of Benner's studies, he stated that CVD had been the leading cause of morbidity and mortality for over 20 years (17). If we tried to dig more into the reasons for such a high CVD prevalence rate, we would find various reasons. In recent decades, Qatar has been home to one of the most rapidly growing populations. Since 2002, the population of 275,325 Qatari citizens and 1,9 million expatriates (non-Qatari residents) has risen from 750,000 to around 2,5 million (2). Secondly, and finally, the rapid development of infrastructure played a major role in changing behaviors and lifestyles of the people, leaning more towards unhealthy choices, which over time led to the development of NCDs such as diabetes, obesity, hypertension, and many other diseases (2, 18).

One crucial point to consider is that between the years 2011 and 2013, CVD mortality was 8.3 per 100,000 for Qatari males and 4.1 per 100,000 for non-Qatari males aged 20-44 years. However, after the age of 45, CVD mortality rose significantly to 247 per 100,000 among Qatari males (2). According to Qatar public health strategy 2017-2022, the prevalence of having three or more cardiovascular risk factors was 44.9% among the age 18-64 and 70.4% among the age 45-64 (2). Risk factors include High body mass index, High blood pressure and high fasting plasma glucose (1, 2)

Risk factors could be classified into two groups, modifiable and non-modifiable risk factors. The modifiable risk factors include physical inactivity, smoking, alcohol use, hypertension, obesity, diabetes, and low intake of fruit and vegetables (1). As for non-modifiable factors, it includes age, ethnicity, family history, and socioeconomic status. As the person advances in age, he becomes more at risk of developing CVD.

Moreover, the risk of getting a stroke doubles after the age of 55. Also, having a low socioeconomic status accompanied by stressful life and having depression or anxiety increases the risk of heart disease and stroke (1). Even though there are many risk factors associated with coronary heart disease and stroke, a person will not develop CVD if he has only one risk factor. The more risk factors the person has, the higher the likelihood that he will develop CVD (1). As CVD requires a continual support-specifically people who suffer from ongoing heart condition- and may affect the overall quality of life (1), policy makers in Qatar realized the need to mitigate the problem of high CVD rate by developing strategies with a primary goal to promote healthy behaviors in order to reduce controllable risk factors and also to develop an effective screening programs that identify people who are most at risk(2). Thus, one of the secondary preventions done in Qatar for patients who suffer from heart diseases is the cardiac rehabilitation program.

Before tackling the situation in Qatar, it is essential to have a holistic understanding of how cardiac rehabilitation started. Over the last four decades, CR has advanced from a simple monitoring program that helps patients return to their regular physical activity, to more of a multidisciplinary secondary prevention program, which included various components that can affect patients' outcomes. These components are the following: patient assessment, nutritional counseling, physical activity counseling, weight management, smoking cessation, blood pressure management, and lipid management (8, 19). Back in the 1930s, myocardial infarction (MI) patients were advised to take six weeks of bed rest. Then, they were advised to take a short daily walk of 3-5 minutes after coronary events by four weeks (19). Even though this proved to be effective, there was a concern regarding patient safety due to unsupervised exercise(20). Hence, this concern leads to the development of a more structured, physician-supervised rehabilitation program (20) that can help patients optimize their functional health (19).

By the 1950s, Hellerstein presented his comprehensive multidisciplinary procedure for the rehabilitation of patients recovering from an acute cardiac event(21). His approach was adopted worldwide and has been recommended as an indispensable therapeutic tool in modern cardiology by most cardiovascular professional societies(19, 22, 23). Even though his approach resulted in excellent outcomes for patients, his approach was not translated in a tremendous commendation by the cardiology community, and it was not improved significantly. However, due to changing patient demographics and advanced medical technology, many more patients now have the opportunity to receive the benefits offered by cardiac rehabilitation (20).

Cardiac rehabilitation (CR) is defined as a "Comprehensive exercise, education, and behavior modification program designed to improve the physical and emotional condition of patients with heart disease", another definition presented by the American Heart Association is that "Cardiac rehabilitation and secondary prevention services are comprehensive, long term programs involving medical evaluation, prescribed exercise, cardiac risk factor modification, education, and counselling. These programs are designed to limit the physiological and psychological effects of cardiac illness, reduce the risk for sudden death or re-infarction, control cardiac symptoms, stabilize or reverse the atherosclerotic process, and enhance the psychosocial and vocational status of selected patients" (8).

The primary goal of the CR program is to enable patients to achieve optimal physical, psychological, social, and vocational functioning through exercise training and lifestyle changes (24). The short term goals of such programs are classified in short- and long-term goals. The Short-term goals reflect "reconditioning" the patient sufficiently enough, allowing him to resume customary activities, decrease the risk of sudden cardiac arrest, or reinfarction, and finally help control the symptoms of cardiac disease. The long-term goals consist of identification and treatment of risk factors, stabilizing the atherosclerotic process, and enhancing the psychological status of the patients (24).

In Qatar, there is only one CR program that was developed in July 2013 (24). Patients who are eligible to be enrolled in this program are those who have, myocardial infarction, coronary artery bypass surgery (CABG), percutaneous transluminal coronary angioplasty (PTCA/PCI), heart or a heart-lung transplant, and heart failure (25). They are advised to enroll by the inpatient cardiac rehab staff at the hospital, which is phase I, where they get an assessment along with education on risk factors and a discharge plan. In phase II (outpatient), referred patients go through a structured program including physical exercise to improve CVD fitness, education about heart disease as well as counseling on how to stabilize or reverse heart disease by improving the risk factors. The last stage is stage III, consisting of a maintenance program held in the community (not in the cardiac center), not yet available in Qatar (24).

Once patients are referred to the CR program in a heart hospital, the healthcare team contacts them to book an appointment for an initial assessment. Based on the program protocol, the period between referral initiation and patient enrollment (waiting time) should not exceed 60 days (26). Initial assessment includes six different procedures as prescribed in the hospital protocol:

1. Clinical history of Cardiovascular, physical activity, vocational, musculoskeletal, and psychosocial status.
2. Adherence to medication, self-monitoring, smoking status
3. Physical examination, including vital signs, electrocardiogram (ECG), BMI, waist circumferences (WC), waist to hip ratio, heart failure signs, cardiac, and neurological abnormalities.
4. Assessment of routine testing, including full blood count, fasting blood sugar, HbA1c, total cholesterol, LDL, and HDL.
5. “Exercise capacity which includes symptom-limited exercise testing, either on the treadmill or bicycle ergometer.”
6. “Nutrition assessment where healthcare team reviews medical and dietary

history, eating patterns measured by food frequency questionnaire and 24-hour recall method, anthropometric measurements, and behavioral patterns."

Formerly, as the initial assessment is done and the patient's results are in, risk level (low, moderate, high) will be determined based on a combination score of patient's cardiac and metabolic fitness. After patients are classified, the goals of rehabilitation are discussed and agreed on, and the patient can take a written plan of his goal. The cardiac rehabilitation program duration is three months. Based on evidence reported by literature, 36 exercises can result in significant positive changes in exercise capacity, cardiovascular risk factors, and quality of life(26, 27). Worldwide CR programs do not prescribe CR sessions and that cardiac patients are allowed to take up to 36 sessions or more depending on their health condition and coverage by a health insurance company. Some programs give sessions over 12 months and others 3-6 months with 3-5 sessions per week depending on their capacity (28).In Qatar, the same protocol is followed. After identification of the risk level for each patients and based on guideline recomendation, a direct supervision of the exercise should occur for at least 6-18 sessions for low risk, for those with moderate risk, direct supervision should occur for at least 12 to 24 sessions and high-risk patients should be monitored for at least 18 to 36 exercise sessions (29). Furthermore, patients can take more sessions as long as it is safe to remove the ECG monitoring during exercise. Differences and variability in provided CR services were explained in a recent study published in the Lancet Journal. The study indicated that since the CR program is a multi-component and complex intervention, the nature of the services provided may vary widely across programs (30).

At discharge, the patient will have a final assessment where physical activity level, vital signs, blood testing is checked, as well as a return to work- whether the patient is in good condition to pursue his previous work (26).

Attending the CR session was proved to be effective. Several meta-analyses were conducted to identify the effectiveness of cardiac rehabilitation. Studies showed that, among patients with coronary heart disease, exercise-based CR reduces hospitalization by a mean of 31%, cardiac mortality by a mean of 20%, and all-cause mortality by a mean of 19% (9). Another meta-analysis showed that participation in the CR program reduces risk factors of CVD and decreases mortality and morbidity (10). Philip and colleagues (2009) stated that participation in CR leads to a 13% (HR, 0.88; 95% CI, 0.83–0.93) to 24% (HR, 0.77; 95% CI, 0.69–0.87) reduction in mortality over 1 to 3 years, in addition to a reduction in rehospitalization by 31% (HR, 0.69; 95% CI, 0.58–0.81) (31) The most important benefit is the increase in physical function and quality of life. However, with all of the evidence that CR is effective, still, CR services are grossly underutilized with low adherence rates (32). It is essential to identify what could be the factors mediating the suboptimal use of these programs; whether it is due to the low availability of CR services, provider factors, or related to patient factors.

Based on a study done by Turk-Adawi and colleagues (2014) on the global availability of CR, the CR program was poorly implemented globally. Only 38.8% of the world's countries have CR programs. Precisely, 68.0% of high-income countries and 23.0% of low- and middle-income countries, (28.2% for middle- and 8.3% for low-income countries) (33). The aurhors concluded that low availability of the program contributes to its underutilization worldwide (33). Moreover, three interrelated factors were reported in the literature to be associated with CR underutilization; these include: patient, provider, and system (32, 34, 35). Within the global context, Qatar, has only one CR program similar to the global trend of low availability. However, there is no study that has explored the program's utilization in terms of adherence to the program, taking into consideration that it is free for elligable patients.

Patients factors associated with adherence to CR program were reported in one of the studies that aimed at identifying patient and organizational factors that keep patients in the program. Several CR facilities (n=38) were surveyed, and 4412 records of patients enrolled were included in the study. The study showed that patients over the age of 65 years, classified as high-risk category (based on classification of American Association of Cardiovascular and Pulmonary Rehabilitation AACVPR), receiving coronary artery bypass grafting (GABG), and diagnosed with diabetes were significantly associated with increase in adherence to the CR program (32). Organizational factors were offering relaxation training and individual and group diet classes (32). Another study on enrollment showed that enrollment rate was 30% among a cohort of (n=6874) patients. Factors associated with patient enrollment in the program were undergoing CABG and having health insurance (34). In Qatar, there is a lack of research on the program's utilization and factors associated with its utilization and whether these factors are similar to those in literature.

Furthermore, a systematic review of factors associated with attending cardiac rehabilitation revealed that older patients with lower income and suffering from depressive symptoms were less likely to attend their sessions. The authors suggested that the best way to encourage patients to attend is to address the misconception about the program, show how effective it is, and engage physicians to recommend it (36).

To improve patients utilization of a beneficial program, such as CR program, it is crucial that healthcare providers, program directors and policy makers are aware of barriers faced by patients that prevent them from using the offered services effeciantly. A qualitative study conducted in Qatar looked at the reasons for not attending the program (13). The most common reasons highlighted by patients were: exercising at home, work commitment, transportation, no need for rehabilitation, family responsibility and finally a preference to take care of their health alone (13). Building on these results, there is a need for a quantitative baseline study to explore adherence to CR and to identify patient factors associated with it. Findings of such study is expected to inform policy makers about CR situation and interven in the best possible way to improve adherence rate and consequently patients health.

A recent systematic review and meta-analysis of interventions to promote patient’s utilization of the CR program concluded that several interventions could increase enrollment, adherence, and completion rates of CR sessions. Face to face delivery by healthcare providers was recommended to increase enrollment, while offering unsupervised CR sessions would promote adherence considerably (37).

Patients always look for the benefits gain from any program attended. It was proved that adhering to CR is related to the magnitude of clinical benefits. Hammill and colleague's study focused on the relationship between cardiac rehabilitation and long-term risk of death and myocardial infarction among elderly Medicare patients ≥65 living in the United States (10). Thirty thousand one hundred sixty-one elderly patients were included between the first of January 2000 to 31 December 2005. They were interested in the exposure to cardiac sessions given in 3 categories, i.e 36, 24,12 sessions. They found that those who attended 36 sessions had a 14% lower risk of death (HR,0.86 95% CI 0.77–0.97) compared to patients who attended 24 sessions, a 22% lower risk of death compared to those who attended 12 sessions (HR, 0.78; 95% CI, 0.71–0.87) and a 47% lower risk of death compared to patients who attended 1 session only. Thus, this shows that there is a dose-response relationship between the number of CR sessions attended and patients long-term outcomes. Moreover, it shows how attending more sessions is associated with a lower risk of death compared to attending fewer sessions (10).

A recent study tackled the improvement of secondary prevention measures among cardiac rehabilitation patients; specifically among males and female to understand if there is a gender disparity (38). The results showed significant improvement in total cholesterol level, diastolic blood pressure, and HbA1c. A 10% reduction were observed in cholesterol level as well as LDL. These changes were proved to be clinically significant in reducing the risk of coronary heart disease. A systematic review and meta-analysis showed that having a reduction of 10% in cholesterol level is associated with a 15% reduction in risk of coronary heart disease(39). Another meta-analysis reported a 7.2% reduction in risk of coronary heart disease deaths and 4.4% total deaths if a reduction of 10% of LDL was found (40).

While having evidence of the benefit of CR sessions, the service is still underutilized, and there is lower enrollment, referral, and adhered rate. Thus, it is essential to explore the situation from different contexts and settings.

Multiple studies have been done on factors associated with enrollment and adherence to CR in addition to change cardiac risk factors pre-post the program. Recommendation from these studies suggested to identify patient characteristics associated with uptake and adherence to cardiac rehabilitation in different countries.

With the high rate of CVD in Qatar, adhering to CR programs is crucial in this context and studying the related factors will contribute to the improvement CR services and thus patients' clinical outcomes. Since there are no studies done in Qatar on either of these topics, the current study aimed to fill this gap and address patient factors related to adherence and its association with change in risk factors.

CHAPTER 3: STUDY OBJECTIVES

3.1 Objectives

1. To describe the characteristics of patients participated in the program
2. To identify patients factors associated with adherence to CR program and patient sociodemographic and clinical factors including age, gender, nationality, tobacco use, patients indications (mentioned above), depression, exercise capacity (MET), comorbid conditions such as diabetes miletus (DM), hypertension (HTN), back pain, and musculoskeletal disease. Other patient factors to be assessed are BMI, SBP, cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and glucose (HbA1c) for patients with diabetes
3. To examine the relationship between number of sessions attended, and the mean change in cardiac risk factors (Cholesterol, LDL, HDL, and BMI)
4. To examine the relationship between adherence, and the mean change in cardiac risk factors (Cholesterol, LDL, HDL, and BMI) after completion of CR program and identify clinically significant clinical measures

3.2 Research questions

This study is based on three research questions:

1. What is the relationship between patient factors and patient adherence to the CR program in Qatar?
2. Is there a relationship between adherence to CR and the mean change in cardiac risk factors (SBP, cholesterol, LDL, HDL, and BMI) from pre to post CR program?
3. Is there a relationship between number of sessions attended and the change in cardiac risk factors (Cholesterol, LDL, HDL, and BMI) after completion of CR program?

3.3 Hypothesis

1. There is a relationship between patient's sociodemographic and clinical factors and patient adherence to a CR program
2. There is a positive relationship between number of CR sessions attended and improvement in the level of cardiac risk factors at program discharge (post-program)
3. Adhering to CR sessions is associated with the change in CVD risk factors at program discharge

CHAPTER 4: METHODS

4.1 Study design

Based on our study objectives, the second and third objectives were achievable through a cross sectional study, based on patients' records, i.e.secondary data),while the fourth objective achieved through retrospective cohort study. Our study cohort included all patients aged 18 years and over who were referred to a cardiac rehabilitation program in Qatar.

4.2 Data collection methods

The study is based on a secondary dataset collected by the CR professionals in the cardiac rehabilitation program and entered in their internal system. We extracted these data for patients from the inception of the program from January 2013 to September 2018. The data included sociodemographic variables and clinical and behavioral measures that were collected at patient entry (pre-CR) and patient discharge from the program (post-CR). Patients who did not attend the first session of the program (non-enrolled) did not have data post the program. Hence, only their data at baseline were available to use for analysis. Our total sample size was 714 patients.

4.3 Measurements

The study had 2 dependent variables (outcomes) (a) adherence [defined as attending more than or equal to the median number of CR sessions attended by the entire cohort], (b) change in cardiac risk factors (blood pressure, cholesterol, LDL, HDL, and BMI), which defined as the difference between post to pre values of a clinical factor. Baseline values of these factors were measured at the start of the program and at the program discharge. Therefore, patients were followed up from the start of the program to program completion, when they have a formal re-assessment for discharged.

The independent variables for our first outcome, adherence, were patient factors that have been documented in the literature to affect adherence to CR. These variables included: age; gender (male, female); nationality (Qatari, non-Qatari); tobacco use (smoker, non-smoker); American Association of Cardiovascular Pulmonary Rehabilitation (AACVPR) risk category (low, moderate, high); history of depression defined as[not depressed, mild-moderate depression, severe depression], CR indications including heart failure (HF), angina, valve replacement (VR), valve disease, AMI, CAD, CABG, and PCI; comorbid conditions: diabetes mellitus, hypertension, back pain, and musculoskeletal disease; and cardiac risk factors: HDL, LDL, cholesterol, SBP, and BMI.

The independent variables for our third outcome, which is the change in cardiac risk factors after completion of the program, was adherence, i.e., attending more than or equal to the median number of CR sessions [median number =22] (Table 1 We also examined the effect of adherence to the program on change of risk factors in terms of number of sessions attended as a count variable.

Table 1 Study Dependent (Outcome) and Independent Variables

Dependent (Outcome) variables	Independent variables
1. **Adherence (Yes, No)** [Attending ≥ median number of CR sessions attended which was 22]	• Age • Gender • Nationality • Smoking (Yes, No) • History of depression (Not depressed, mild-moderate depression, severe depression) • Exercise capacity (MET) • Comorbidities [diabetes (Yes, No), HTN (Yes, No), back pain (Yes, No), musculoskeletal disease (Yes, No)] • Indications: heart failure (HF), angina, percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), valve disease valve replacement (VR), acute myocardial infarction (AMI), and coronary artery disease (CAD)]
Change in cardiac risk factors pre-post CR (Cholesterol, LDL, HDL, and BMI)	• Variable of interest: **Adherence** [Attending more than or equal to the median number of sessions] • Variable of interest: **Number of CR sessions attended**

4.3.1 Defining cut off value for adherence

Prior to justification of using a cut off value of the median number of sessions, it is essential to underline that there is no standard definition for adherence-in terms of number of sessions attended- to CR programs worldwide due to the wide variation in length of program (duration) and the number of sessions taken by patients. Thus, different studies that investigated adherence used the median number of sessions of their own cohort as a cut off value since patients can attend a range of sessions, ideally

36 sessions in North America or more depending on patient condition and whether CR services are covered by a health insurance company (8). Identifying the cut off value in our study was solely based on similar approach used by these published studies (10, 32, 41, 42). Hence, we followed the same approach and identified the cut off value based on the median number of CR sessions attended by the entire cohort of patients in our study. Interestingly, the median number of sessions of our study (22 sessions) was comparable to those in literature, i.e. 21- 26 sessions (10, 32, 41, 42). Hence, we followed what found in literature and we choose the median number of sessions from our own cohort as other studies did.

It is important to clarify that number of sessions taken by patients is not related to patient risk level. Stratifying patients into low, moderate, and high risk is based on certain criteria (Appendix D) to assess patient safety while exercising. For example, CR staff prescribe the appropriate exercise *intensity* for each individual based on patient's level of risk, and for this purpose cardiac risk stratification is critical to patient safety.

Cardiac risk stratification is used to assess patient safety before enrolment in the program, i.e. it is employed to predict complications during exercise. (29). It mainly assesses the probability of the occurrence of "cardiac arrest" as a criterion to decide if a patient is at high risk for cardiac events during exercise (29)

4.3.2 American Association of Cardiovascular Pulmonary Rehabilitation (AACVPR) risk category.

A key element of exercise safety is stratification of patients according to risk for acute cardiovascular complications during exercise. There are different methods used for risk stratification, the one used in CR program in Qatar is called AACVPR risk category, which classifies the risk of cardiac events during exercise into [Low, moderate, and high risk]. Classification of risk is based on specific criteria attached in (Appendix D). According to guidelines and protocols, it is necessary to prescribe the appropriate exercise intensity for patients so they can be able to obtain the beneficial effects of the program while ensuring safety during physical exercises.

Cardiac risk stratification means careful evaluation of the clinical and functional status of the patient, starting with clinical history and physical, laboratory and ancillary tests. This procedure provides indications for the appropriate targeting of the patient throughout the rehabilitation process and the extent of direct staff supervision while exercising.

Therefore, the identification of risk level is an integral part of the management of patients. For individuals classified as low risk for participating in exercise, the guideline recommends that *direct supervision of the exercise* should occur for at least 30 days post cardiac event or 6-18 sessions. For those with moderate risk, direct supervision should occur for at least 60 days post cardiac event or 12 to 24 sessions and high-risk patients should be monitored for at least 90 days or 18 to 36 exercise sessions.

4.3.3 Cardiac depression scale

In our study, we had depression in terms of scores. Thus, for the purpose of the analysis, we categorized the scale to 3 categories (not depressed, mild-moderate depression, severe depression) based on the cut off value found in the literature(43). Patients with depression score less than 90 were considered not depressed, 90-<100 were considered mild-moderate depression, ≥100 considered with severe depression(43). This scale was validated to be used in research.

A study conducted to validate CDS scales in UK population. The CDS scale was mailed to 487 individuals with coronary heart disease who were recruited from cardiac rehabilitation support group. Then, the process was repeated on subsample of

80 participants four-six weeks later for the purpose of test-retest analysis. Response rate was 81% and the test retest sample 54% response rate. The Factor analysis revealed a one-factor solution with a high internal reliability (Cronbach's $\alpha = 0.93$) and an acceptable test-retest reliability (0.79). The study concluded that, CDS is both a reliable and sensitive instrument for measuring depression in cardiac patients and that using CDS will be an excellent measure for studies of outcome in cardiac patients (44). Additionally, wise and colleagues reported the reliability and validity of CDS cut of scores in which a cut off >100 indicate severe depression with 88% sensitivity and 84% specificity, score of 90 indicate mild-moderate depression with 84% sensitivity 78% specificity (43)

4.3.4 Metabolic equivalent task (MET)

Exercise capacity is assessed by different exercise tests [treadmill Bruce (METs), cycle ergometer (Watts), cardiopulmonary exercise test (VO_{2PEAK}), 6-min walk test (meters)] (26). In this study MET was the used test for patients. MET is identified as "The maximum ability of the cardiovascular system to deliver oxygen to exercising skeletal muscle and of the exercising muscle to extract oxygen from the blood, the oxygen expenditure at rest (> 3.5 mL/min/kg body weight)" (45). Additionally, MET has different levels that is associated with the level of activity patients can tolerate. For example, patients with a MET level of 6.5 can do exercise without a limit while patient with 1.5 MET will be unable to carry out activities without discomfort. These levels are used as a reference point during cardiac rehabilitation. Patients who have had a heart attack or who have undergone open heart surgery are assisted to gradually return to normal activity levels, using MET levels as a guide to ensure that activity does not exceed what the patient's heart can tolerate (46). More information about MET is attached in the (Appendix E).

4.4 Statistical analysis

Prior to analyzing this dataset, various methods were employed to check for any potential errors in the data. Missing values for each variable were also assessed. The only two variables that had missing data were, Cardiac depression scale (4% missing) and Musckelotal disease (4% missing). Thus, no data imputation were needed.In order to prepare data for analysis, data were cleaned and coded using STATA software. To achieve the first study objective, measure the proportion and describe the characteristics of patients who adhered to the CR program, descriptive analyses were performed and presented as percentages for categorical variables, or means and standard deviations for continuous variables. The variables used in the study are shown in Table 2.

For the second objective, to investigate patient factors associated with adherence, a logistic regression analysis was performed. initially, the purposeful selection method was followed. First, univariate analysis was conducted to detect variables in our data that were potentially associated with the outcome. For categorical variables with more than two levels, Wald statistics p-values were used to assess overall significance. The following independent variables were used separately to predict the odd of adherence in the univariate logistic regression analysis: age, gender, nationality, tobacco smoking, AACVPR risk category, patients indications (PCI, CABG, CAD, AMI, valvular replacement), comorbidities including depression, diabetes, HTN, and back pain exercise capacity (MET), BMI, SBP, cholesterol, LDL, and HDL. Each of these variables were tested one at a time against the outcome (adherence).

Second, clinically significant well-established variables in the literature and those with a p-value < 0.25 produced by the univariate analysis were included in the initial full model. Using p-value of 0.25 was important as a more traditional levels such as 0.05 can fail in identifying variables known to be important.(47). Excluded variables were gender, BMI, LDL, depression, AMI, heart failure, valve replacement, angina, valve disease, and HTN. After removing these variables, we obtained our “initial full” model.

After including all variables with p-values less than 0.25[first step] in a full model, we conducted the regression analysis and dropped all variables with p-values greater than .05 ($p>0.05$). The only variables that remained in our model were risk level, PCI, CABG, musculoskeletal disease, and this formed the simpler model. To indicate which model is the best to predict adherence factors, a likelihood ratio test was used to decide whether the full model or the simpler model is a better fit. The likelihood ratio (LR)=11.41, had p-value=0.32 indicating that the simple model is a better fit. Hence, we kept the simpler model and proceeded the analysis with it.

The third step was to adjust for confounders by using $\Delta\beta$ equation in which any of the remaining covariates who got a change ($\Delta\beta>20\%$) were brought back to the model and removed one by one to see their confounding effect. Since the remaining covariate all had a change <20% and no change were spotted when we brought back covariate one at a time that was discarded from the univariate model, we kept our simpler model, which included risk level, PCI, CABG, and musculoskeletal disease. Age and gender are well known potential confounder we brought them back in our final adjusted model.

To achieve the third objective, to examine the relationship between number of sessions attended and change in cardiac risk factors (Cholesterol, LDL, HDL, and BMI), a multiple linear regression was conducted. First, we presented univariate analysis (unadjusted model) then we started to adjust for patients’ variables that is well known in literature to be associated with the outcome. By doing this we were able to examine the difference in each model and whether adjusting for certain variables will affect the change in the outcome. 4 models were presented for each risk factor and we calculated % change in coefficient to easily notice the change in each adjusted model compared to the unadjusted one. (Change= β in the unadjusted model-β in new model), (%change= change÷ β in the unadjusted modelx100). Any variable added and had a change of 20% or more is considered a confounder.

To achieve the fourth and final objective of this study, to explore the relationship between number of sessions attended and the mean change in cardiac risk factors (SBP, cholesterol, LDL, HDL, and BMI) from pre to post CR program), for each of the outcome variable, we determined apriori the independent variables (from literature and those of clinical importance that affect each outcome). Then, we conducted a simple linear regression (unadjusted model) to identify the association between the change of each of these risk factors and number of sessions attended independently. Then, we conducted multiple linear regression analyses (several adjusted models), where other clinical and demographic independent variables were added one by one to the initial unadjust model.

Additionally, a paired sample t-test was performed[dependent t-test] for each clinical measure. All assumptions were tested before running the test. These assumptions included: the dependent variable was continuous, and the outcome was normally distributed.

Once we found the mean change (post clinical measure value minus pre-clinical measure value) for each of the clinical measures, we tested the mean difference between groups (adherence, non-adherence) using an independent sample t-test. All statistical analysis was performed using STATA software version 16.

Table 2 Types Of Study Variables

Types of variable	**Variables included in the study**
Continuous Variables	Age (years) Exercise capacity (MET) Systolic blood pressure (SBP) mmol/L Body mass index (BMI) Kg/m^2 Cholesterol (mmol/L) Low-density lipoprotein (LDL) High-density lipoprotein (HDL) Exercise capacity (MET)
Categorical variables	Gender (Male, Female) Nationality (Qatari, Non-Qatari) Smoking status History of depression (not depressed, mild-moderate, severe depression) AACVPR risk category (low, moderate, high) CR indications [PCI, CABG, CAD, AMI, angina, valve disease, valve replacement, and heart failure] Comorbidities [diabetes mellitus, hypertension, back pain, musculoskeletal disease]

4.5 Ethical Approval

The study was approved by IRB at Hamad Medical Corporation [**MRC-01-18-430]** Heart Hospital and Institutional Review Committee from Qatar university **[QU-IRB 1039-E/19]**

4.6 Research Significance and Implications

Cardiac rehabilitation is a cost-effective model of care shown to reduce cardiovascular mortality and morbidity by 20%(9). Based on an existing meta-analysis, participation in a cardiac rehabilitation program reduces risk factors of CVD and decreases mortality and morbidity of the disease(10, 31). However, despite all the benefits documented, cardiac rehabilitation is still underutilized, and the adherence rate is meager (12). Considering CR in Qatar, there is only one qualitative study that explored reasons for nonattendance to the CR program without identifying what the possible factors associated to adhere to the program, or what are the factors associated with enrollment (12) are. Hence, it is essential to conduct this research to investigate possible factors associated with enrollment and adherence to serve as a guideline for policymakers and program directors. This will enable them to identify where is the gab and improve patient adherence, which will lead to improvement in patient's quality of life, CVD risk factors, and make the program tailored to patient's needs.

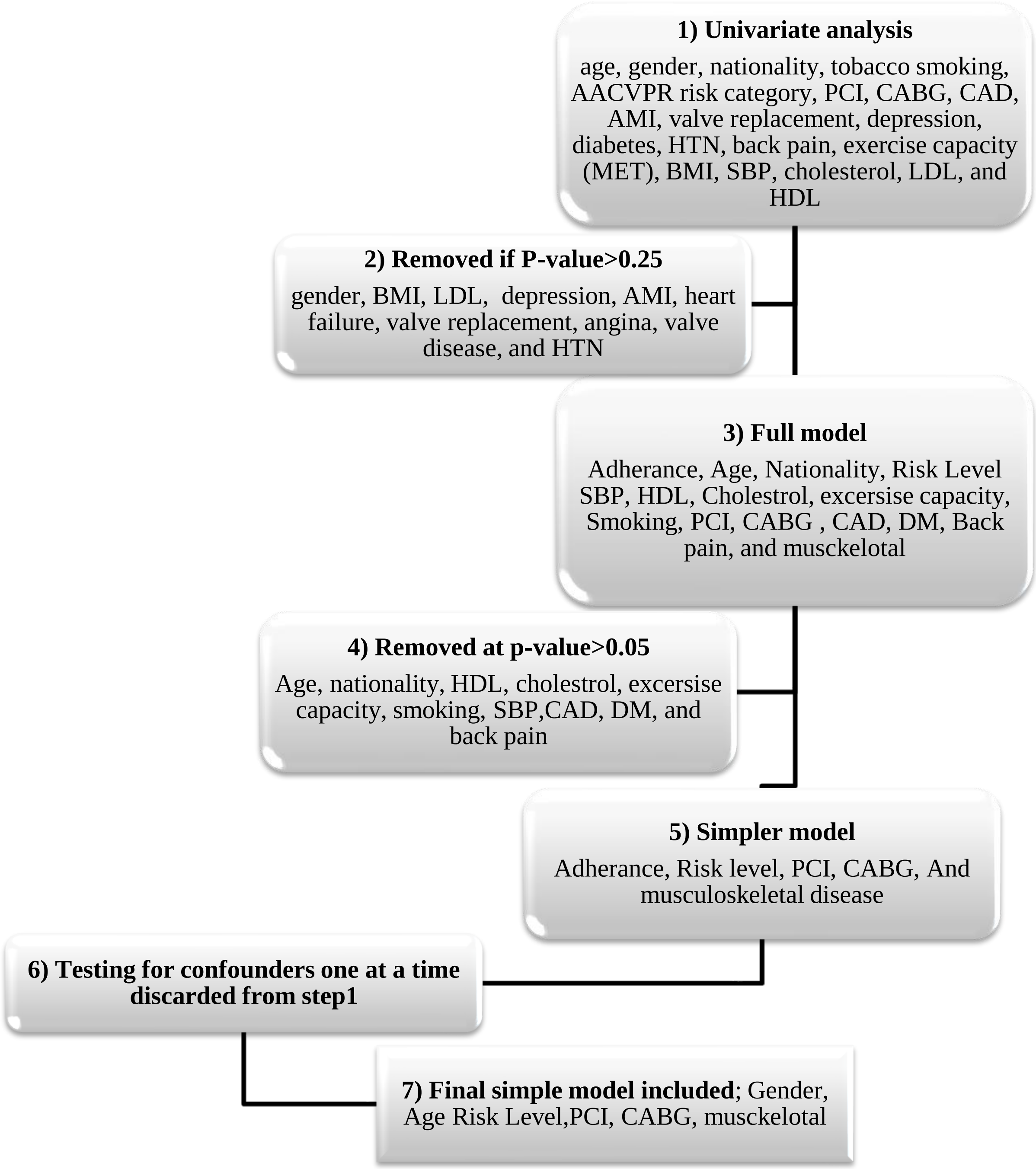

Figure 1 Logistic regression analysis

CHAPTER5: RESULTS

Over the study period, 2013-2018, a total of 714 patients were referred to the CR program. Of whom 682 (95.5%) patients enrolled in the program, i.e., attended at least one session (Figure 2). This graph represents the number of those patients' records who were entered in the system at the program level, there could be patients who referred but the CR staff did not enter as the patients did not show up at the program.

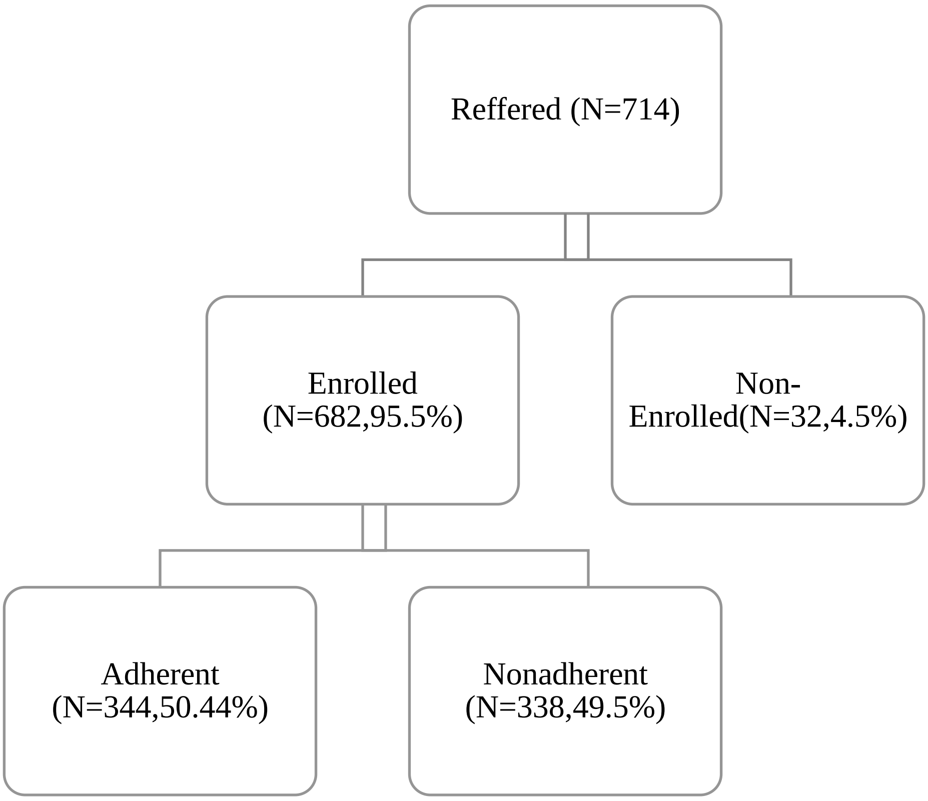

Figure 2 Study Flowchart showing the number of patients who were referred, enrolled and adhered to the CR

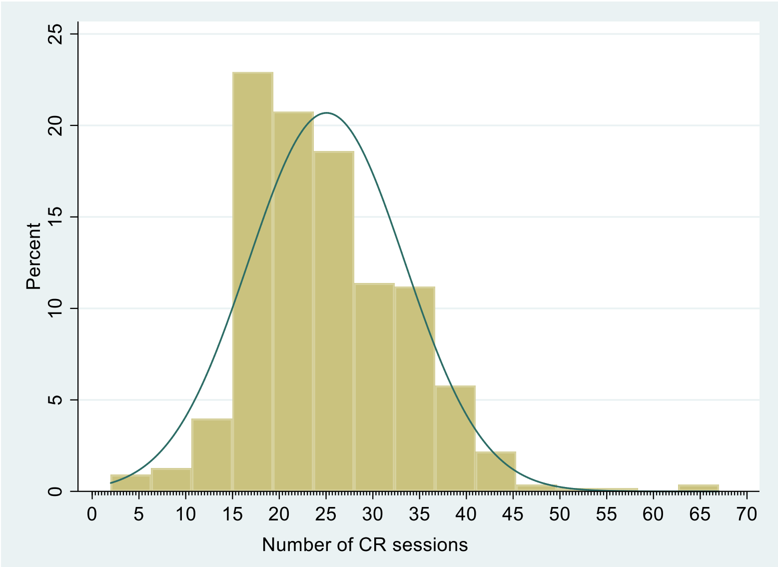

Figure 3 Distribution of CR sessions attended by patients

Table 3 Summary description for Number of sessions attended

Mean	Median	Minimum	Maximum
20.5	22	5	67

5.1 Patients Characteristics

Table 4 shows the characteristics of patients who were referred to the CR program (N=714) between January 2013 and September 2018. The majority of the patients were males (n= 641, 89.8%) and non-Qatari (n= 596,83.5%). The mean age of our study population was 52.7±10.1 years (mean ± SD). About one-fourth of the referred patients were smokers (n=185, 25.91%). Among our cohort, 128 patients

(18.8%) were diagnosed with severe depression while 74 patients (10.9%) were diagnosed with mild-moderate depression.

Further, PCI was the most common CR indication (n=442, 61.9%) among the study's population. Patients diagnosed with CAD represented (41.2%) of our cohort and about one-fifth (n=154, 21.6%) of the patients had undergone CABG. Of the referred patients, 291 (40.8%) had AMI. Less than 5% of the population had the following CR indications: angina (n= 12, 1.7%), heart failure (n=28, 3.9%), valve replacement (n=28, 3.4%), and valve disease (n=24, 3.4%).

Considering comorbidities, hypertension was the most prevalent comorbid condition among our patients (n= 322, 45.1%) followed by diabetes (n=301, 42.2%). Only 3.9% (n=28) of the patients had back pain, and 3.1% had a musculoskeletal disease. Means and standard deviations of baseline clinical measures were as following: HDL:1.30±0.94mmol/L, LDL:1.98±1.03 mmol/L, cholesterol: 3.73±1.17 mmol/L, BMI: 29.60±9.68 mmol/L, exercise capacity: 9.29±3.17 MET, and SBP: 128.80±17.9 mmHg (Table 3).

Table 4 Sociodemographic and Clinical Characteristic of Study Population [Referred Patients] at Baseline (N=714)

Patients Characteristics	**N (%)**
Age (years) Mean±SD	52.7±10.1
Gender	
Male	641(89.8)
Female	73(10.2)
Nationality	
Qatari	118(16.5)
Non-Qatari	596(83.5)
Smoking	
Smoker	185(25.9)
Non-smoker	529(74.1)
History of depression*	
Not depressed	480(67.23)
Mild-moderate depression	74(10.36)
Severe depression	128(17.93)
AACVPR Risk Category	
Low	208(29.1)
Moderate	262(36.7)
High	244(34.2)
Indications	
PCI	
Yes	442(61.9)
No	272(38.1)
Coronary artery disease	
Yes	294(41.2)
No	420(58.8)
Myocardial infarction	
Yes	291(40.8)
No	423(59.2)
CABG	
Yes	154(21.6)
No	560(78.4)
Heart failure	
Yes	28(3.9)
No	686(96.1)
Valve replacement	
Yes	28(3.9)
No	686(96.1)
Valve disease	
Yes	24(3.4)
No	690(96.6)

AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; PCI, Percutaneous Coronary Intervention

Patients Characteristics	N (%)
Indications	
Angina	
Yes	12(1.7)
No	702(98.3)
Comorbid conditions	
HTN	
Yes	322(45.1)
No	392(54.9)
Diabetes mellitus	
Yes	301(42.2)
No	413(57.8)
Back pain	
Yes	28(3.9)
No	686(96.1)
Musculoskeletal diseases*	
Yes	21(2.9)
No	661(92.6)
Clinical measures	
Systolic blood pressure (mmHg) (Mean±SD)	128.80±17.9
BMI (Kg/m^2) (Mean±SD)	29.60±9.68
Exercise capacity (MET)	9.29±3.17
Cholesterol (mmol/L) (Mean±SD)	3.73±1.17
LDL (mmol/L) (Mean±SD)	1.98±1.03
HDL (mmol/L) (Mean±SD)	1.30±0.94

AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; CR, cardiac rehabilitation. HTN, hypertension. LDL, low-density lipoprotein. HDL, high-density lipoprotein. PCI, Percutaneous Coronary Intervention. CABG, Coronary artery bypass grafting SD, standard deviation. (%) given for categorical variables. * missing

5.2 Patients Characteristics Associated with Adherence

Patient sociodemographic and clinical characteristics by adherence are presented in Table 5. Patients in the adherent group were older (54.05±10.0 years) compared to non-adherent (51.1±9.8). The majority of adherents were males (91.0%), non-smokers (79.1%), and without depression (71.5%). Almost half (49.7%) of the adherents had moderate AACVPR risk. For indications, 58.7% of the adherents had PCI, 52.3% diagnosed as CAD, and 37.5% diagnosed as AMI. The adherents were less likely to have angina (1.5%), heart failure (4.1%), valve replacement (4.1%), and valve disease (3.5%).

Considering the non-adherent group, PCI (70.1%), CAD (44.4%), and AMI (36.7%) were also the most common CR indications. With the highlight that patients undergoing PCI were the highest compared to adherent patients. Patients undergoing CABG represented only (17.2%). Angina (0.95%), heart failure (3.25%), valve replacement (3.55%), and valve disease (2.96%) were the least common indication among the non-adherent group

The results also showed that (44.19%) patients had diabetes among adherent group compared to (55.81%) nondiabetic. The non-adherent group had (36.98%) diabetic patients compared to (63.02%) nondiabetic. Whereas HTN patients represented (45.35%) in the adherent group compared to (54.65%) not hypertensive. The non-adherent group had (43.20%) of hypertensive patients and (56.80%) non-hypertensive. Back pain and musculoskeletal disease were the least common comorbidities among both groups. In which adhered patients with back pain represented (1.45%) compared to (6.21%) of non-adhered patients having back pain. As for musculoskeletal disease, (1.45%) of adhered patients had it compared to (5.03%) non adhered patients without musculoskeletal disease.

Finally, Clinical measures at baseline were almost similar in both groups except for a minor difference in some of the measures. Mean HDL among adherent group was (1.06±0.31) compared to (1.05±1.28) among non-adherent groups. AS for LDL, non-adherent group had slightly higher HDL mean (2.02±1.14) compared to adherent group LDL mean (1.95±0.93). The cholesterol level among adhered patients was (3.66±1.09) compared to (3.81±1.26) among non-adhered group. Adhered patients had higher SBP mean (130.35±18.65) than non-adhered group (126.89±17.06). Last measure we have was BMI (kg/m^2). Mean BMI did not differ in both groups. Adherent patients had a mean BMI of (29.18±5.36) compared to (28.83±5.02) in non-adherent group.

Table 5 Sociodemographic and Clinical Characteristic of Patients at Baseline by Adherence (N=682)

Characteristics	**Adherent (*N=344, 50.44%)***	**Nonadherent (N=338, 49.5%)**
	n (%)/ Mean±SD	**n (%)/ Mean±SD**
Age	54.05±10.00	51.1±9.77
Gender		
Male	313(91.0)	300(88.8)
Female	31(9.0)	38(11.2)
Nationality		
Qatari	40(11.6)	65(19.2)
Non-Qatari	304(88.4)	273(80.8)
Smoking		
Smoker	72(20.9)	103(30.5)
Non-smoker	272(79.1)	235(69.5)
History of depression		
Not depressed	246(71.5)	234(69.2)
Mild-moderate	35(10.2)	39(11.5)
Severe	63(18.3)	65(19.2)
AACVPR Risk Category		
Low	29(8.4)	174(51.5)
Moderate	171(49.7)	81(24.0)
High	144(41.9)	83(24.6)
Indications		
PCI		
Yes	202(58.7)	237(70.1)
No	142(41.3)	101(29.9)
CABG		
Yes	89(25.9)	58(17.2)
No	255(74.1)	280(82.8)
Myocardial infarction		
Yes	129(37.5)	124(36.7)
No	215(62.5)	214(63.3)
Angina		
Yes	5(1.4)	2(0.9)
No	339(98.5)	208(99.0)
Heart failure		
Yes	14(4.1)	11(3.2)
No	330(95.9)	327(96.7)

Characteristics	Adherent (*N=344, 50.44%)*	Nonadherent (N=338, 49.5%)
	n (%)/ Mean±SD	**n (%)/ Mean±SD**
Indications		
Valve replacement		
Yes	14(4.1)	12(3.5)
No	330(95.9)	326(96.4)
Valve disease		
Yes	12(3.5)	10(3.0)
No	332(96.5)	328(97.0)
Coronary artery disease		
Yes	183(53.2)	150(44.4)
No	161(46.8)	188(55.6)
Comorbid conditions		
Diabetes mellitus		
Yes	152(44.2)	125(37.0)
No	192(55.8)	213(63.0)
HTN		
Yes	156(45.3)	146(43.2)
No	188(54.6)	192(56.8)
Back pain		
Yes	5(1.45)	21(6.21)
No	339(98.55)	317(93.79)
Musckelotal diseases		
Yes	5(1.4)	17(5.0)
No	339(98.5)	321(95.0)
Clinical measures		
HDL (mmol/L)	1.06±0.31	1.05±1.28
LDL (mmol/L)	1.95±0.93	2.02±1.14
Cholesterol (mmol/L)	3.66±1.09	3.81±1.26
Systolic blood pressure (mmHg)	130.35±18.65	126.89±17.06
Exercise capacity (MET)	8.9±3.4	9.7±2.7
Body mass index (Kg/m^2)	29.18±5.36	28.83±5.02

P-value<0.001 and 0.05 is considered significant. OR, Odd ratio; CI, Confidence interval. AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; CR, cardiac rehabilitation. HTN, hypertension. LDL, low-density lipoprotein. HDL, low-density lipoprotein. PCI, percutaneous coronary intervention. CABG, coronary artery bypass grafting

5.3 Patient characteristics associated with adherence [Univariate logistic regression]

Table 6 shows the crude association between adherence and potential patient factors, the following factors were significantly associated with adherence: age ($p<0.001$), nationality ($p=0.006$), risk level ($p<0.001$), smoking ($p=0.01$), PCI ($p<0.001$), CABG ($p=0.01$), CAD ($p=0.021$), DM with borderline significant result ($p=0.05$), back pain ($p<0.001$), musculoskeletal disease ($p=0.013$), SPB ($p=0.01$), and HDL ($p<0.001$). Age was positively associated with adherence [OR=1.02, 95%CI= 1.01-1.05], i.e., for every one-year increase in age, the odds of being adherent increased by (2%), without adjusting for other variables. Compared to Qatari, non-Qatari patients were 81% more likely to adhere [OR=1.81, 95%CI=1.18-2.77]. As for the risk category, the odd of being adhered to the CR program among the moderate-risk group [OR=12.67, 95%CI=7.89-20.34] was 12.67 times the odd of adhering compared to the low-risk group. Additionally, the odd of adhering among the high-risk group [OR=10.41, 95%CI=6.46-16.77] was 10.41 times the odd of adhering compared to the low-risk group. Further, the odd of adherence were 40% less among smokers compared to non-smoker patients. The results also revealed that the odd of adhering to CR decreased by 39% among patients with PCI indications compared to those without PCI. On the other hand, the odd of being adhered to the program among patients who had CABG increased by 68% [OR=1.68, 95%CI=1.16-2.44] compared to patients without CABG. Similarly, the odd of adhering to CR increased by 42% [OR=1.42, 95%CI=1.05-1.93] in patients with CAD compared to those without CAD.

For comorbid conditions, the odd of adhering to CR among diabetic patients increased by 35% [OR=1.35, 95%CI=0.99-1.83] compared to non-diabetic patients. The odd of adhering to CR among patients with back pain decreased by 78% [OR=0.22, 95%CI=0.07-0.60] compared to those without back pain, whereas the odd of adherence among patients with musculoskeletal disease decreased by 72% [OR=0.28, 95%CI=0.10-0.76] compared to those without the musculoskeletal disease. The result also showed that for each one (mmHg) increase in SBP, the odd of adherence increased by 1% [OR=1.01, 95%CI=1.00-1.02]. Finally, for each one unit (mmol/L) increase in HDL the odd of being adherent to CR decreased by 60% [OR=0.40, 95%CI=0.29-0.54].

Table 6 Univariate logistic regression analysis of Adherence (dependent variable). The Crude association between Adherence and potential patients' factors.

Variables	**OR**	**95%CI**		**P-value**
Age	1.02	1.01	1.05	**<0.001**
Gender				
Female	**Ref**			
Male	1.28	0.78	2.11	0.34
Nationality				
Qatari	**Ref**			
Non-Qatari	1.81	1.18	2.77	**0.006**
AACVPR Risk Category				
Low risk	**Ref**			
Moderate risk	12.67	7.89	20.34	**<0.001**
High risk	10.41	6.46	16.77	**<0.001**
Cardiac Depression Scale (CDS)				
No depression	**Ref**			
Moderate-mild depression	0.85	0.52	1.39	0.53
Severe depression	0.92	0.62	1.36	0.68
Smoking				
No	**Ref**			
Yes	0.60	0.43	0.86	**0.01**
Indications				
PCI				
No	**Ref**			
Yes	0.61	0.44	0.83	**<0.001**
CABG				
No	**Ref**			
Yes	1.68	1.16	2.44	**0.01**
Coronary artery disease				
No	**Ref**			
Yes	1.42	1.05	1.93	**0.021**
Myocardial infarction				
No	**Ref**			
Yes	1.04	0.76	1.41	0.83
Heart failure				
No	**Ref**			
Yes	1.26	0.56	2.82	0.57
Valve replacement				
No	**Ref**			
Yes	1.15	0.53	2.53	0.72
Angina				
No	**Ref**			
Yes	1.53	0.29	7.98	0.61
Valve disease				
No	**Ref**			
Yes	1.19	0.51	2.78	0.70

Variables	OR	95%CI		P-value
Comorbid Conditions				
Diabetes mellitus				
No	**Ref**			
Yes	1.35	0.99	1.83	**0.05**
HTN				
No	**Ref**			
Yes	1.09	0.81	1.48	0.57
Back pain				
No	**Ref**			
Yes	0.22	0.07	0.60	**<0.001**
Musculoskeletal disease				
No	**Ref**			
Yes	0.28	0.10	0.76	**0.013**
Body mass index (Kg/m^2)	1.01	0.98	1.04	0.381
Systolic blood pressure (mmHg)	1.01	1.00	1.02	**0.01**
LDL (mmol/L)	0.94	0.81	1.08	0.38
HDL (mmol/L)	0.40	0.29	0.54	**<0.001**
Cholesterol (mmol/L)	0.90	0.79	1.03	0.12

P-value<0.001 and 0.05 is considered significant. OR, Odd ratio; CI, Confidence interval. AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; CR, cardiac rehabilitation. HTN, hypertension. LDL, low-density lipoprotein. HDL, low-density lipoprotein. PCI, percutaneous coronary intervention. CABG, coronary artery bypass grafting

5.4 Patient characteristics associated with adherence [Multivariable logistic regression]- Adjusted model

Results of the adjusted multivariable regression model presented in Table 7. Our final model had three patients' factors significantly associated with adherence, which were AACVPR risk (p<0.001), PCI (p=0.03), and musculoskeletal disease (p=0.05). Compared to patients with low AACVPR risk, patients with moderate risk were almost 13 times more likely to adhere [OR=12.71, 95%CI=7.81-20.68], while patients with high risk were almost 11 times more likely to adhere [OR=10.60, 95%CI=6.44-17.44]. The results of the adjusted model also showed that patients with PCI were 61% less likely to adhere [OR=0.39, 95%CI=0.17-0.89] compared to those without PCI.

The same negative association was found among patients with musculoskeletal disease, who were 83% [OR=0.17, 95%CI=0.03-0.95] less likely to adhere compared to those without musculoskeletal disease.

Since we did not find any confounding factors to bring back in our simpler model, we decided to bring clinical variables that shown to be well-known confounders from literature, and these are age and gender even though they were not statistically significant. Results of the final model, with confounders, are presented in Table 8.

Table 7 Multivariable Logistic Regression to Determine Predictors of Adherence (Adjusted Association)

Variables	AOR	95%CI		P-value
Age (years)	1.01	0.98	1.04	0.42
Gender				
Female	Ref			
Male	1.20	0.53	2.74	0.66
AACVPR Risk Category				
Low risk	Ref			
Moderate risk	12.71	7.81	20.68	**<0.001**
High risk	10.60	6.44	17.44	**<0.001**
PCI				
No	Ref			
Yes	0.39	0.17	0.89	**0.03**
CABG				
No	Ref			
Yes	0.49	0.19	1.28	0.14
Musculoskeletal diseases				
No	Ref			
Yes	0.15	0.06	0.5	**0.003**

P-value<0.05 is significant. AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation. PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting

5.5 Adherence association with change in risk factors from pre to post CR program

Initially, a paired t-test was run to determine whether there was a statistically significant mean difference between patients' clinical measures before and after the program (3 months follow up) in both groups separately [adherence and non-adherence. As shown in table 8, there was a statistically significant mean difference for all clinical measures, including BMI, LDL, HDL, cholesterol, and SBP (p-value <0.001, for all). The mean SBP had the most significant change from pre to post CR program,130.35±18.65 to 124.98±15.81, respectively, among the adhered group.

Table 10 shows the change in measures between adherents and non-adherents in addition to the total mean difference between groups. The result revealed that the mean difference between groups were BMI (-0.34, 95%CI= -1.113-0.44), HDL (-0.004,95%CI= -0.65-0.05), LDL (0.008, 95%CI= -0.14-0.16) and SBP (-1.62, 95%CI= -4.37-1.11). Additionally, the independent samples t-test results revealed that there was no statistically significant difference in the means though there was a mean change pre and post the program.

Table 8 and 9 demonstrates the change and percentage of change in clinical measures among the adherent and non adherent group afte program completion. The result showed improvements in all measures. Specifically, there was a 10% reduction in total cholesterol level [95%CI= -0.31- -0.50] and a 15% reduction in LDL level [95%CI= -0.22- -0.40]. Among non adherent group, A 16% reduction was found in LDL level level [95%CI= -0.19- -0.44] , compared to adherent group it is is considered better reduction eventhough it's a reduction difference by 1% only.

Table 8 Change in Clinical Measures Among Adherent group

Measures	Adherence						
	Pre	Post	Mean Difference	95% CI		P-value	% change
BMI (Kg/m^2)	29.18±5.36	27.63± 5.23	-0.54±2.40	-0.29	-0.80	**<0.001**	-1.8%
LDL (mmol/L)	1.95±0.93	1.26±0.78	-0.31±0.86	-0.22	-0.40	**<0.001**	**-15%**
HDL (mmol/L)	1.06±0.31	0.92± 0.29	-0.13±0.26	-0.10	-0.16	**<0.001**	-12%
Cholesterol(mmol/L)	3.66±1.09	3.26±0.74	-0.40±0.89	-0.31	-0.50	**<0.001**	**-10%**
SBP (mm Hg)	130.35±18.65	124.98±15.81	-5.36±17.33	-3.53	-7.20	**<0.001**	-4%

Values are expressed as mean ± standard deviation. P-value<0.05 is significant. BMI, body mass index; LDL, low-density lipoprotein; HDL, high-density lipoprotein; SBP, systolic blood pressure; 95%CI= confidence interval

Table 9 Change in Clinical Measures Among Adherent group

Measures	Non-adherence						
	Pre	Post	Mean difference	95% CI		P-value	% change
BMI (Kg/m^2)	28.07±5.03	27.62±5.23	-0.44±2.09	-0.16	-0.73	**0.002**	-1.5%
LDL (mmol/L)	1.95±1.02	1.63± 1.51	-0.32±0.93	-0.19	-0.44	**<0.001**	**-16%**
HDL (mmol/L)	1.03±0.44	0.90± 0.32	-0.13±0.44	-0.06	-0.19	**<0.001**	-12%
Cholesterol(mmol/L)	3.62± 1.25	3.28±0.92	-0.33±0.96	-0.20	-0.47	**<0.001**	-9.1%
SBP (mm Hg)	125.4± 15.85	121.7± 12.90	-3.74±13.41	-1.91	-5.56	**<0.001**	-2.9%

Values are expressed as mean ± standard deviation. P-value<0.05 is significant. BMI, body mass index; LDL, low-density lipoprotein; HDL, high-density lipoprotein; SBP, systolic blood pressure

Table 10 Mean Change between Adherent and Non-adherent group

Measure	Mean difference between groups	95%CI		P-value
BMI (Kg/m^2)	-0.34	-1.13	0.433	0.38
LDL (mmol/L)	0.008	-0.14	0.16	0.90
HDL (mmol/L)	-0.004	-0.65	0.05	0.89
Cholesterol(mmol/L)	0.03	-0.12	0.19	0.68
SBP (mm Hg)	-1.62	-4.37	1.11	0.24

Values are expressed as mean ± standard deviation. P-value<0.05 is significant. BMI, body mass index; LDL, low-density lipoprotein; HDL, high-density lipoprotein; SBP, systolic blood pressure; 95%CI= confidence interval

5.6 CVD risk factors and its association with number of sessions attended in CR program

Table 11 shows the association between change in BMI (outcome) and patient factors. the unadjusted BMI model (univariate model) had a β coefficients of (β =0.0027). When adjusting for age, this led to a reduction of 55.5% in β coefficients and it became (β=0.0012). We then adjusted for gender(β=0.0016) that showed a reduction of 40.7%, then we added risk level to adjust for in our model we noticed a reduction of 174 in beta coefficients (β=-0.0020), PCI ahd a reduction of 170 and the coefficient was (β=-0.0019), when adjusting for CABG(β=-0.0039) we had a reduction of 244 compared to the unadjusted model, diabetes(β=-0.0053) with a reduction of269, when adjusting for Musckelotal disease the coefficients did not change (β=-0.0053). we then adjusted for CAD that showed a reduction of 274 in the coefficients (β=-0.0047), and finally we adjusted for smoking and the β coefficients was (β=-0.005) with a reduction of 285. All of these 11 models we have in table 11 had a very low R^2 which mean the explanatory variables does not explain the variability in the outcome.

Table 12 shows the association between cholesterol and main explanatory variable (number of sessions) adjusting for well-known variables to compare the change in each model. Compared to the unadjusted model(β=-0.0064), multiple model adjusting for age showed a reduction in beta coefficient by -4.7(β=-0.0067) adjusting for more variables, R^2 increased somehow however the increase was not that huge as the model explanatory variable did not explain the variability in the outcome (only 1% is explained). We then kept on adding more variables that were reported in literature to be associated with the outcome. Thus, we adjusted for risk level (β=-0.0083, -29.6

reduction), PCI(β=-0.0081, -26.56), CABG(-0.0084, -31.25 reduction compared to unadjusted model), Musckelotal disease (β=-0.0088, -37.5 reduction), Smoking(β=-0.0078, -21.8 reduction), and when adjusting for diabetes and CAD same reduction was experience in beta coefficient (β=-0.009, -40.6 reduction).

Table 13 and 14 shows the results of our last two outcomes high density lipoprotein (HDL) and low density lipoprotein (LDL) against the number of attended sessions adjusting for patients factors one at a time. In HDL when adjusting for age and gender they had the same effect as beta coefficients did not change much (β=-0.0017) compared to the unadjusted model. we kept adding to the model without having extreme changes in beta coefficient until the final multiple model were, we had (β=-0.007, -53.3 reduction) after adding CAD variable. As for LDL, the highest beta coefficient reduction was explained when adding CAD variable in which (β=-0.0052, -29.03 reduction) compared to unadjusted model that had a (β=-0.0074).

Even though we are adding more variable to our four models, still we can notice R^2 to be very low which could be explained that other important variables not included in our study is needed to explain the variability in the outcome. Additionally, all of the models did not have any statistically significant change in CVD.

Table 11 Association of Number of Sessions Attended with Chamge in BMI (adjusted and unadjusted models)

BMI	**β**	**β % change**	**95%CI**		**P-value**	**R^2**
Main model (BMI+ **Number of attended sessions)**	0.0027	N/A	-0.0202	0.0257	0.8160	0.0001
BMI+ Number of attended sessions+ **Age**	0.0012	55.5	-0.0222	0.0246	0.9210	0.0009
BMI + Number of attended sessions + Age + **Gender**	0.0016	40.7	-0.0219	0.0250	0.8960	0.0039
BMI+ Number of attended sessions + Age +Gender +**Nationality**	0.0014	48.1	-0.0220	0.0248	0.9070	0.0045
BMI +Number of attended sessions +Age +Gender+ Nationality+ **Risk level**	-0.0020	174	-0.0348	0.0309	0.9070	0.0046
BMI+ Number of attended sessions+ Age+ Gender +Nationality +Risk level+ **PCI**	-0.0019	170	-0.0348	0.0310	0.9090	0.0046
BMI+ Number of attended sessions+ Age +Gender +Nationality +Risk level+ PCI+ **CABG**	-0.0039	244	-0.0368	0.0291	0.8180	0.0105
BMI+ Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ **Musckelotal diseases**	-0.0053	269.3	-0.0383	0.0278	0.7550	0.0122
BMI+ Number of attended sessions+ Age+ Gender+ Nationality +Risk level+ PCI+ CABG+ Musckelotal diseases+ **Diabetes**	-0.0053	269.3	-0.0384	0.0278	0.7550	0.0122
BMI+ Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes +**CAD**	-0.0047	274	-0.0380	0.0286	0.7810	0.0124
BMI+ Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes+ CAD+ **Smoking**	-0.0050	285	-0.0384	0.0284	0.7690	0.0125

*PCI; Percutaneous **Coronary** Intervention CABG; **Coronary artery bypass** grafting, CAD; **Coronary** artery disease

Table 12 Association of Number of Sessions Attended with Chamge in Cholesterol (adjusted and unadjusted models)

Cholesterol	**β**	**β % change**	**95%CI**		**P-value**	**R^2**
Cholesterol + **Number of attended sessions**	-0.0064	N/A	-0.0156	0.0028	0.1750	0.0033
Cholesterol + Number of attended sessions+ **Age**	-0.0067	-4.7	-0.0161	0.0027	0.1640	0.0035
Cholesterol + Number of attended sessions + Age + **Gender**	-0.0068	-6.3	-0.0162	0.0026	0.1560	0.0062
Cholesterol + Number of attended sessions + Age +Gender +**Nationality**	-0.0069	-7.8	-0.0163	0.0025	0.1490	0.0084
Cholesterol +Number of attended sessions +Age +Gender+ Nationality+ **Risk level**	-0.0083	-29.6	-0.0215	0.0049	0.2160	0.0101
Cholesterol + Number of attended sessions+ Age+ Gender +Nationality +Risk level+ **PCI**	-0.0081	-26.56	-0.0213	0.0051	0.2280	0.0112
Cholesterol + Number of attended sessions+ Age +Gender +Nationality +Risk level+ PCI+ **CABG**	-0.0084	-31.25	-0.0217	0.0048	0.2100	0.0123
Cholesterol + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ **Musckelotal diseases**	-0.0088	-37.5%	-0.0221	0.0045	0.1930	0.0131
Cholesterol + Number of attended sessions+ Age+ Gender+ Nationality +Risk level+ PCI+ CABG+ Musckelotal diseases+ **Diabetes**	-0.0090	-40.6	-0.0223	0.0042	0.1820	0.0153
Cholesterol + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes +**CAD**	-0.0080	-40.6	-0.0214	0.0053	0.2390	0.0189
Cholesterol + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes+ CAD+ **Smoking**	-0.0078	-21.8	-0.0212	0.0056	0.2520	0.0193

*PCI; Percutaneous **Coronary** Intervention CABG; **Coronary artery bypass** grafting, CAD; **Coronary** artery disease

Table 13 Association of Number of Sessions Attended with Chamge in HDL (adjusted and unadjusted models)

HDL	**β**	**β % change**	**95%CI**		**P-value**	**R^2**
HDL + **Number of attended sessions**	-0.0015	N/A	-0.0051	0.0020	0.3990	0.0013
HDL + Number of attended sessions+ **Age**	-0.0017	-13.33	-0.0054	0.0019	0.3560	0.0017
HDL + Number of attended sessions + Age + **Gender**	-0.0017	-13.33	-0.0053	0.0020	0.3630	0.0023
HDL + Number of attended sessions + Age +Gender +**Nationality**	-0.0018	-20	-0.0054	0.0019	0.3470	0.0058
HDL +Number of attended sessions +Age +Gender+ Nationality+ **Risk level**	-0.0011	-26.6	-0.0062	0.0040	0.6810	0.0094
HDL + Number of attended sessions+ Age+ Gender +Nationality +Risk level+ **PCI**	-0.0011	-26.6	-0.0062	0.0040	0.6720	0.0096
HDL + Number of attended sessions+ Age +Gender +Nationality +Risk level+ PCI+ **CABG**	-0.0010	-33.3	-0.0061	0.0042	0.7140	0.0110
HDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ **Musckelotal diseases**	-0.0011	-26.67	-0.0062	0.0041	0.6880	0.0114
HDL + Number of attended sessions+ Age+ Gender+ Nationality +Risk level+ PCI+ CABG+ Musckelotal diseases+ **Diabetes**	-0.0011	-26.67	-0.0063	0.0041	0.6720	0.0122
HDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes +**CAD**	-0.0007	-53.3	-0.0059	0.0044	0.7790	0.0153
HDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes+ CAD+ **Smoking**	-0.0008	-46.6	-0.0060	0.0044	0.7510	0.0160

*HDL; high density lipoprotein PCI; Percutaneous **Coronary** Intervention CABG; **Coronary artery bypass** grafting, CAD; **Coronary** artery disease

Table 14 Association of Number of Sessions Attended with Chamge in LDL (adjusted and unadjusted models)

LDL	**β**	**β % change**	**95%CI**		**P-value**	**R^2**
LDL + **Number of attended sessions**	-0.0074	N/A	-0.0163	0.0015	0.1040	0.0048
LDL + Number of attended sessions+ **Age**	-0.0075	-1.35	-0.0166	0.0016	0.1060	0.0048
LDL + Number of attended sessions + Age + **Gender**	-0.0075	-1.35	-0.0166	0.0016	0.1080	0.0049
LDL + Number of attended sessions + Age +Gender +**Nationality**	-0.0076	-2.7	-0.0167	0.0015	0.1010	0.0083
LDL +Number of attended sessions +Age +Gender+ Nationality+ **Risk level**	-0.0084	-13.51	-0.0211	0.0043	0.1930	0.0171
LDL + Number of attended sessions+ Age+ Gender +Nationality +Risk level+ **PCI**	-0.0083	-12.16	-0.0210	0.0044	0.2000	0.0175
LDL + Number of attended sessions+ Age +Gender +Nationality +Risk level+ PCI+ **CABG**	-0.0078	-5.41	-0.0206	0.0049	0.2290	0.0201
LDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ **Musckelotal diseases**	-0.0077	-4.05	-0.0205	0.0051	0.2390	0.0202
LDL + Number of attended sessions+ Age+ Gender+ Nationality +Risk level+ PCI+ CABG+ Musckelotal diseases+ **Diabetes**	-0.0076	-2.7	-0.0204	0.0053	0.2480	0.0210
LDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes +**CAD**	-0.0052	-29.7	-0.0180	0.0076	0.4220	0.0406
LDL + Number of attended sessions+ Age+ Gender+ Nationality+ Risk level+ PCI+ CABG+ Musckelotal diseases+ Diabetes+ CAD+ **Smoking**	-0.0054	-27.03	-0.0182	0.0074	0.4070	0.0410

*LDL; low density lipoprotein PCI; Percutaneous Coronary Intervention CABG; Coronary artery bypass grafting, CAD; Coronary artery disease

CHAPTER 6: DISCUSSION

6.1 Patient adherence

The present study examined patients' factors associated with adherence to cardiac rehabilitation program and change in cardiac risk factors. Findings concerning patient factors associated with adherence to CR program were aligned with other published studies and literature. To the best of our knowledge, this is the first study that investigated patients' factors associated with enrollment and adherence in Qatar.

Variations in adherence rate could be due to different definitions of adherence as there is no standard definition in terms of the number of sessions attended by the patients. However, the median number of sessions has been used in literature for patient adherence(32). The median number of sessions (22 sessions) attended by our cohort is comparable to the median number of 21, and 25 sessions attended in published studies in the USA, where a standard program consists of 36 exercise sessions(10, 31, 32). Additionally, the program in Qatar follows the North American guidelines with 36 sessions for program completion.

Patients factors found to be positively associated with adherence were age, nationality, risk level, being diabetic, undergoing CABG procedure, and having coronary artery disease. These factors were consistent with other patients factors associated with adherence and reported in other studies findings(32, 34, 48).

Our finidings revealed that only 11% of Qatari adhered to the program compared to 89% non Qatrai. This high variation between Qatari and non Qatari might be explained due to the fact that Qatri have portable health insurance that they can seek treatment outside the country, i.e. the insurance company covers most of the expenses.

Adding to this and based on the insight of one health care providers working in governmental hospoital in Qatar, he stated that in general, Qatari patients do not adher to their appointments or services provided by the healthcare system because of delays in the appointnments or any services provideded. Moreover, the change in their physiscians they used to follow up may play a role of nonadherence. For example a ptient will follow up with a consultant and when he comes for the next follow up appointment he will be surprised to see another physiscan (specialist or resident physisans). He also added that waiting list fo certin procedures is a huge issue for Qatari, especially for at-high risk patients. Since these patients know their risk conditions, they are worried and don’t wait rather they travel abroad, where they do a full assesment and seek treatment for the condition. Finally, some Qatari patients who travel abroad think that outside health services is better but it is not necessirealy the case. Peninsula one of the most well known electronic newspaper in Qatar, reported that, despite huge investments in healthcare, a growing number of Qataris are seeking treatment abroad, costing the government $329.6 million (QR1.2bn) in 2012 – which is more than double what it spent two years ago (49). We believe that research is needed for a better understanding of why Qatari travel abroad for treatment. The aforementioned suggested explanation was based on personal experience of a healthcare provider not a well established research.

Regarding predictors of adherence, most studies found combinations of variables to be related (32, 36, 48, 50). Patient factors that were negatively associated with adherence in our study included PCI and musculoskeletal disease. These findings are consistent with other studies(48, 50). The reason PCI might be negatively associated with adhereance could be due to the fact that the majority of PCI patients in our study are of low risk. And based on literature, they might perceive themselves as not a risk group thus no need for them to take exercise sessions under supervision of CR staff so they most likely continue exercising at home(51). Wherase for patients with musckelotal diseases, they do not adhere to CR program as they are mostly not advised to enter CR due to thecomplication. Having musckelotal diseases limit the ability to do moderate exercise. Additionally, a low CR adherance rate is expected in patients with pain and those with movement difficulty, but this depends on the degree of pain and severity of movement difficulty that our patients could have more severe conditions. Thus, it may be the reason for being negatively associated with adherence (52).

Further, in our final predicted model for adherence, the risk category was a strong predictor for adherence. This finding is supported by other studies (32). In general, patients with higher risk levels, are prescribed more number of sessions to assist them towards recovering their cardiac health as well as resuming their regular daily activities. However, the odds ratio for both risk levels was large with a wide range of confidence intervals, which indicates large variability in these predictors.

A plausible reason could be the large variation in the number of sessions attended by the high-risk patients; some patients attended sessions up to 67 sessions which is more than the maximum range found in literature which is 36 sessions. Looking at our data, the range of attended sessions among the high-risk group was [5 to 67] sessions, moderate risk group ranged between [5 to 40] sessions, and low-risk group [5 to35] session as patients in the program were allowed to take more than the prescribed session as long as it is safe to remove the electrocardiography (ECG) monitoring during exercise. Importantly, the program was free regardless of the number of sessions attended by patients, which may have an essential role in attending more sessions, especially among patients who did not have a job or retired.

6.2 Change in CVD risk factors

Our study showed a significant mean change for each of the patient's clinical measures pre-post the program, including body mass index, systolic blood pressure, LDL, HDL, and cholesterol. These results are similar to findings of other studies (38, 53) to CR. The paired t-test showed a significant difference in cardiac risk factors among the non-adherent group as well.

We ended up having equal reduction in both groups which further confirm adherence does not play a role in this reduction. This could be due to the lack of critical patient data in our study affecting adherence e.g., social support, educational level, transportation, employment, marital status, family support, and medication. More informative results on factors associated with adherence would be revealed if these variables been involved.

Additionally, the independent samples t-test results revealed that the association between adherence, attending at least 22 sessions, and the mean change for each of the clinical measure was not statistically significant, i.e., attending more sessions was not a predictor for the change in any of these clinical measures: cholesterol, BMI, SBP, LDL, and HDL. Additionally when conductin the analysis using multiple linear regression with the number of sessions attednd, all of the model did not show any statisticall significant change in CVD risk factors. The small sample size could explain this statistically insignificant result in both groups. Further, it seems other variables, not captured in our data, contributed to this change as mentioned previously such as medication, patient lifestyle, and duration of the program. Further research should be conducted to interpret the change in clinical measures.

Even though these results were not statistically significant, clinical improvements was noted in total cholesterol levels and LDL. In our study, reduction in cholesterol was of clinical significance among the adherent group, with a reduction of 10%. This result was supported by literature where a previous meta-analysis reported that a reduction of 10% in total cholesterol is associated with a significant reduction of 15% in coronary heart disease-related mortality and a reduction of 11% in the risk of all-cause mortality (39, 54). In our study there was a reduction of 15% in LDL level. A systematic review and meta-analysis showed that a reduction of 7.2% in LDL is clinically significant in reducing coronary heart deaths, and a reduction of 4.4% in total LDL level is associated with a reduction in total deaths (40).

Among non adherent group, LDL showed a clinically significant reduction of 16% wich is 1% higher than adherent group. This reduction could be explained that non adhering patients have better educational level, married or they had a netweok support by their spouse who might have encouraged them to adher to medications as well as supporting their belovedemotionally and sociallyat home, or it could be that non-adherents had healthy habits, or were knowledge seekers; once they had the information on how to exercise, they prefer to implement at home.

The qualitative study done in Qatar showed the major reason for not attending the sessions is because people believe they can do these exercises at home and take good care of themselves(13) this could also justify why non adherent group had this good reduction in LDL level.

6.3 Strength and limitations

To the best of our knowledge, this is the first study conducted in Qatar to establish an association between patients' factors and adherence to CR program. Therefore, our study provided essential information about the characteristics of non-non-adherent patients eligible to the CR program in Qatar.

The study has few limitations that findings should be interpreted with caution. First, the nature of the data and study design (cross sectional) that cannot establish a causation between adherence and improvement. Second, lack of critical patient data affecting adherence (e.g., social support, educational level, transportation, employment, marital status, family support, physical activity, and medication) could affect the change in risk factors as well as adherence, i.e.ore informative results on factors associated with adherence would be revealed if these variables been involved (32, 48, 50, 55-59). Finally, Systolic blood pressure readings were only pre/post the program without having continuous reading throuought the program. Thus it was challenging to assess the change in SBP with the number of sessions attended.

CHAPTER 7: CONCLUSION

In summary, the current study unveiled just the tip of the iceberg of patient factors associated with enrollment in and adherence to CR program, along with the change in clinical cardiac measures [risk factors].

In conclusion, patient factors predicting adherence were percutaneous coronary intervention (PCI), musculoskeletal disease, and AVVCPR risk category. Factors positively associated with enrollment were nationality, coronary artery bypass grafting (CABG), and coronary artery disease (CAD), whereas factors negatively associated with enrollment were back pain, diabetes mellitus, body mass index, and hypertension. Cholesterol and low-density lipoproteins had a clinical improvement among adhered patients with 10% and 15% reduction, respectively. These patient-level variables associated with enrollment and adherence represent opportunities for targeted interventions to improve CR enrollment and adherence to get the benefit of the program.

7.1 Recommendation and research implications

Cardiac rehabilitation is a guideline-recommended strategy structured for the management of CVD. Despite its well-documented benefits, it is vastly underutilized. The current findings add to a growing body of literature on patient factors associated with adherence to the program to help policy makers tailoring their resources and effort in addressing these patients to get the benefit of adhering to the CR program including reduction in morbidity and mortality.

Research is needed to understand patient factors associated with enrollment in the program as we were unable to assess it due to lack of data. We recommend to re-conduct this study to identify variables associated with enrollment as well as reconducting this study but includingcritical variables associated with adherence, such as education, employment status, social support, and social status. Additionally, we recommend the program directors to adopt strategies that underline a longer follow up of patients after discharge, so other studies can be conducted to identify benefit of CR program on hard outcome like mortality. A combination of quantitative and qualitative research on why people drop out of the program or what could be the reasons Qatari patients do not adhere to such programs could be a good future study in this area. Finally, a systematic reporting method to report patient's data in the Cerner is highly recommended to generate data of good quality that can be used for conducting future research to evaluate the effectiveness of the program.

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APPENDIX

Appendix A: HMC IRB Approval

Hamad Medical Corporation

APPROVAL LETTER
MEDICAL RESEARCH CENTER
HMC, DOHA-QATAR

Dr. Mohammed Abdulla A A Al-Hashemi **Sr. Consultant** **Department of Cardiology** **HH- HMC**	**Date: 07 March 2019**
Protocol No.	MRC-01-18-430
Study Title:	Factors Affecting Cardiac Rehabilitation Enrollment And Adherence Among Referred Patients In Qatar
The above titled research study has been approved to be conducted in HMC summarized as below:	
Study Type:	Data Review
Data Collection Period:	01 January 2013 - 01 September 2018
Hospitals/ Facilities Approved:	Heart Hospital (HH)
Team Member List:	Dr. Karam I Adawi , Dr. Mohammed Abdulla A A Al-Hashemi , Mr. Daniel Martinez Buission , Mr. Theodoros Papasavvas , Ms. Eman Faisal , Ms. Rahma Ahmed Saad
Review Type:	'Exempt' under MOPH guidelines "Category 3: Research involving the collection or study of existing: Data, documents, records and the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects".

This study must be conducted in full compliance with all the relevant sections of the Rules and Regulations for Research at HMC and the Medical Research Center should be notified immediately of any proposed changes to the study protocol, that may affect the 'exempt' status of this study. Wherever amendments to the initial protocol are deemed necessary, it is the responsibility of the Principal Investigator to ensure that appropriate reviews and renewed approvals are in place before the study will be allowed to proceed.

Please note that only official, stamped versions of the approved documentation are to be utilized at any stage in the conduct of this study. The research team must ensure that progress on the study is appropriately recorded in ABHATH, the online research system of the Medical Research Center.

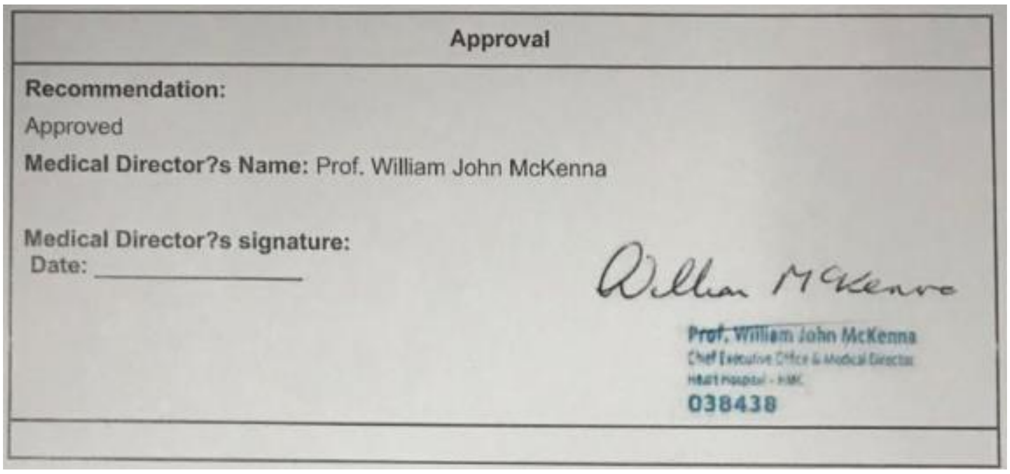
We wish you success in this research and await the outcomes in due course.

Thank you

Ms. Emma Pendleton
Assistant Director Business Development and Research
Medical Research Center- Hamad Medical Corporation

Date:07 March 2019

Appendix B: Heart hospital Approval



Approval

Recommendation:

Approved

Medical Director?s Name: Prof. William John McKenna

Medical Director?s signature:

Date: ________________

Prof. William John McKenna
Chief Executive Office & Medical Director
Heart Hospital - HMC
038438

Appendix C: Qatar university IRB Approval

جامعة قطر
QATAR UNIVERSITY

Qatar University Institutional Review Board
QU-IRB

April 01, 2019

Dr. Karam Turk-Adawi
MPH Graduate Student Supervisor
Qatar University
Tel.: 4403-7508
Email: kadawi@qu.edu.qa

Dear Dr. Karam Turk-Adawi,

Sub.: Research Ethics Review Exemption / MPH Graduate Student Project
Ref.: Student, Rahma A.A. Saad / Email: rs1203827@student.qu.edu.qa
Project Title: "Factors affecting cardiac rehabilitation adherence and change in cardiovascular risk factors among referred patients in Qatar"

We would like to inform you that your application along with the supporting documents provided for the above graduate student project, has been reviewed by the QU-IRB, and having met all the requirements, has been granted research ethics **Exemption** based on the following category(ies) listed in the Policies, Regulations and Guideline for Research Involving Human Subjects provided by MoPH:

Category 3: Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified

Documents reviewed: QU-IRB Checklist (S1), QU-IRB Application (F5), Heart Hospital Approval, HMC Approval, MRC Data Collection Sheet, MRC Research Protocol, IRB review forms, responses to IRB queries and updated documents.

Please note that exempted projects do not require renewals; however, any changes/modifications to the original submitted protocol should be reported to the committee to seek approval prior to continuation.

Your Research Ethics Approval No. is: **QU-IRB 1039-E/19**. Kindly refer to this number in all your future correspondence pertaining to this project. Further, please submit a closure report to QU-IRB upon completion of the project.

Best wishes,

Dr. Ahmed Awaisu
Chairperson, QU-IRB

Institutional Review Board
(IRB)
Office Of Academic Research

Qatar University-Institutional Review Board (QU-IRB), P.O. Box 2713 Doha, Qatar
Tel +974 4403-5307 (GMT +3hrs) email: QU-IRB@qu.edu.qa

Appendix D: AACVPR Criteria

AACVPR Stratification Algorithm for Risk of Event

Not specific solely to exercise events.

❶ Patient is at **HIGH RISK** if ANY ONE OR MORE of the following factors are present:

- Left ventricular ejection fraction < 40%
- Survivor of cardiac arrest or sudden death
- Complex ventricular dysrhythmias (ventricular tachycardia, frequent [> 6/min] multiform PVCs) at rest or with exercise
- MI or cardiac surgery complicated by cardiogenic shock, CHF, and/or signs/symptoms of post-procedure ischemia
- Abnormal hemodynamics with exercise, especially flat or decreasing systolic blood pressure or chronotropic incompetence with increasing workload
- Significant silent ischemia (ST depression 2mm or greater without symptoms) with exercise or in recovery
- Signs/symptoms including angina pectoris, dizziness, lightheadedness or dyspnea at low levels of exercise (< 5.0 METs) or in recovery
- Maximal functional capacity less than 5.0 METs*
- Clinically significant depression or depressive symptoms

❷ Patient is at **LOW RISK** if ALL of the following factors are present:

- Left ventricular ejection fraction > 50%
- No resting or exercise-induced complex dysrhythmias
- Uncomplicated MI, CABG, angioplasty, atherectomy, or stent:
  - Absence of CHF or signs/symptoms indicating post-event ischemia
- Normal hemodynamic and ECG responses with exercise and in recovery
- Asymptomatic with exercise or in recovery, including absence of angina
- Maximal functional capacity at least 7.0 METs*
- Absence of clinical depression or depressive symptoms

❸ Patient is at **MODERATE RISK** if they meet neither High Risk nor Low Risk standards:

- Left ventricular ejection fraction = 40–50%
- Signs/symptoms including angina at "moderate" levels of exercise (60–75% of maximal functional capacity) or in recovery
- Mild to moderate silent ischemia (ST depression less than 2mm) with exercise or in recovery

**If measured functional capacity is not available, this variable can be excluded from the risk stratification process.*

Appendix E: MET Levels

Endurance Exercises and Their Metabolic Requirement

	Metabolic Requirement		
Activity	**Intensity Level**	**METs***	**kcal/h**
Walking at 3–5 km/h (2–3 miles/h) Cycling on level terrain at 10 km/h (6 miles/h) Light stretching exercises Swimming (using a float board) Light to moderate housework	Low	2–4	180–300
Walking at 6 km/h (4 miles/h) Cycling at 13 km/h (8 miles/h) Golf (walking or pulling a cart) Light calisthenics Swimming (treading water) Heavy housework or yard work	Moderate	5–6	300–360
Walking or jogging at 8 km/h (5 miles/h) Cycling at 18–19 km/h (11–12 miles/h) Swimming (0.8 km [1/2 mile] in 30 min) Recreational tennis Hiking	High	7–8	420–480

*The oxygen expenditure at rest (> 3.5 mL/min/kg body weight).

METs = metabolic equivalents.

Adapted from Hanson PG, et al: Clinical guidelines for exercise training. *Postgraduate Medicine* 67(1):120–138, 1980. Copyright McGraw-Hill, Inc.