QATAR UNIVERSITY

COLLEGE OF HEALTH SCIENCES

IS THERE AN ASSOCIATION BETWEEN ATTENDING CARDIAC REHABILITATION PROGRAM AND HEALTH-RELATED QUALITY OF LIFE AMONG PATIENTS IN QATAR?

BY

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ABSTRACT

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Title: Is There an Association between Attending Cardiac Rehabilitation Program and Health-related Quality of Life among Patients in Qatar?

Supervisors of Thesis: Dr. Karam Turk-Adawi and Dr. Mohammed Al-Hashemi.

Background: Cardiovascular Disease (CVD) is the primary cause of death worldwide and in Qatar. More patients with CVD are living than before due to medical advancements. Therefore, there is an urgent need for secondary prevention strategies. Cardiac rehabilitation (CR) is a secondary prevention model of care for the management of CVD. Participation in CR programs is effective in improving health-related quality of life (HRQOL), reducing cardiovascular mortality, morbidity, and hospital readmissions.

Aim: This study aimed to explore the association between attending at least the median number of CR sessions and change in HRQOL among patients in Qatar.

Methods: This is a retrospective cohort study that included all patients who were enrolled in the CR program in Qatar from (January 2013 to October 2017), with a total of 433 patients. Secondary data were extracted from patients' records before the CR program (pre-CR) and at patient discharge (post-CR). The SF-36 instrument was used to assess HRQOL among patients. The four scales of HRQOL that were assessed are physical functioning, social functioning, emotional well-being, and general health.

Results: The study involved 396 (91.4%) males; the mean age was 52.7±9.8 (SD) years. There was a statistically significant association between attending at least the median number of CR sessions and change in physical functioning scores (95%

CI=8.85-29.11/ p-value=0.002), change in social functioning scores (95% CI=0.04-19.38/ p-value=0.04), change in emotional well-being scores (95% CI= 1.92-22.13/ p-value=0.02), and change in general health scores (95% CI=0.38-16.42/ p-value= 0.03), as compared to attending less than the median number of sessions. The models adjusted for age, gender, comorbidities, level of risk, depression, and baseline HRQOL scores.

Moreover clinically significant associations were found between attendance and improvement in physical functioning, social functioning, emotional well-being, and general health, effect sizes= (0.27, 95% CI= 0.11-0.47), (0.29, 95% CI= 0.11-0.47), (0.33, 95% CI= 0.17-0.48), (0.35, 95% CI= 0.21-0.50), respectively.

Conclusion: CR program improved HRQOL, i.e., physical functioning, social functioning, emotional well-being, and general health. Therefore, there is a need to promote CR utilization among cardiac patients and to implement strategies to keep patients in programs. These findings could motivate policymakers to expand CR program capacity, as the sole program in Qatar.

Keywords: Cardiac rehabilitation, Health-related Quality of life, Cardiovascular disease, Sessions attended.

DEDICATION

I dedicate this work to my first teacher, my beloved mother.

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CHAPTER 1: INTRODUCTION

Cardiovascular disease (CVD) is the primary cause of death globally (1). Every year, 17.7 million people die due to CVD, contributing to 31% of all deaths worldwide (1). In the Eastern Mediterranean Region (EMR), approximately 58.4% of the total deaths in 2015 were attributable to non-communicable diseases (NCDs); CVD was the leading cause (2). In Qatar, CVD is the number one cause of death among NCDs; it accounts for 30% of all deaths (3). Therefore, CVD is a major global, regional, and local public health issue. Currently, more patients with CVD are living than before due to medical advancement and high technology. Thus, there is an urgent need for secondary prevention programs, such as cardiac rehabilitation, to lower the risk of a second heart attack.

Cardiac rehabilitation (CR) is "a comprehensive secondary prevention program that is medically supervised to support patients with CVD who went through a cardiac event to recover quickly and stay healthy" (4). It consists of seven core components, not only exercise (5). These components include "baseline patient assessment, nutritional counseling, risk factor management (lipids, hypertension, weight, diabetes, and smoking), psychosocial counseling, physical activity counseling, and exercise training" (5).

In literature, it is evident that participation in a CR program is essential in improving health-related quality of life (HRQOL), reducing cardiovascular mortality, morbidity, and hospital readmissions (6-9). A systematic review and meta-analysis showed that participation in the CR program lowers cardiovascular mortality by 26% and hospital admissions by 18% (7).

In Qatar, there is only one CR program, which was established in 2013. To the best of our knowledge, there has been no study that has explored any associations between cardiac rehabilitation and patient health outcomes. Therefore, this retrospective cohort study aimed to explore the association between attending the CR program (attending at least the median number of sessions) and HRQOL among patients in Qatar.

CHAPTER 2: LITERATURE REVIEW

The literature review is presented in eight sections: the first section addresses the burden of cardiovascular disease: globally, in the EMR and Qatar; the second section discusses modifiable risk factors and non-modifiable risk factors of cardiovascular diseases; the third section introduces CR program; the fourth section focuses on the core components of CR program; the fifth section addresses the different phases of CR program; the sixth section explains the benefits of participation in CR programs; the seventh section introduces definitions, instruments, and scales of HRQOL, the eighth section discusses the factors associated with HRQOL; and lastly the ninth section emphasizes on the benefits of participation in CR program on HRQOL.

2.1 Burden of Cardiovascular Disease

According to the World Health Organization (WHO), cardiovascular disease "is the name for the group of disorders of heart and blood vessels, and include: hypertension, coronary heart disease, cerebrovascular disease, peripheral vascular disease, heart failure, rheumatic heart disease, congenital heart disease, and cardiomyopathies" (10). CVD is the leading cause of death globally (1). Every year, 17.7 million people die due to CVD, contributing to 31% of total deaths worldwide (1). Around 85% of all CVD deaths are due to strokes and heart attacks; more than 75% of these deaths occur in low-income and middle-income countries (1). In the EMR, nearly 58.4% of the total deaths in 2015 were due to non-communicable diseases, where CVD was the primary cause (2); it accounted for 27.4% of total deaths and is projected to increase to 32.1% by 2030 (2). Similarly, CVD was the primary cause of disability as it was responsible for 9.2% of total disability-adjusted life years (2).

In Qatar, CVD is the primary cause of death; 30 % of all deaths are due to CVD (3). For instance, for Qatari males aged 20-44 years, CVD mortality was 8.3 per 100,000, and 4.1 per 100,000 for non-Qatari males (3). Among Qatari males above the age of 45 years, CVD mortality increased significantly to 247 per 100,000 (3). Therefore, CVD is a major global, regional, and local public health issue. Moreover, because of advanced technology and medical advancement in CVD treatment, more patients with CVD are living than before. Thus, there is an urgent need for secondary prevention programs (cardiac rehabilitation) to reduce the risk of myocardial re-infarction.

2.2 Risk Factors of Cardiovascular Disease

There are two main risk factors of CVD; modifiable and non-modifiable risk factors. The non-modifiable risk factors mostly include age, ethnicity, sex, and family history of cardiovascular disease (11). For instance, African Caribbean people have an elevated risk of developing hypertension than that of the population (11). CVD burden could be reduced by addressing modifiable risk factors including overweight and obesity, diabetes, hypertension, hyperlipidemia, physical inactivity, consumption of unhealthy diet, harmful use of alcohol, and tobacco use (11, 12). Globally, almost three million people die each year due to overweight or obesity (13). Many prospective studies have shown an association between overweight and CVD mortality and morbidity (12). Furthermore, obesity is highly associated with main CVD risk factors such as hypertension, dyslipidemia, and type 2 diabetes (13-17).

Annually, almost six million people die due to tobacco use and passive smoking. Smoking is responsible for almost 10% of CVD (19). Besides, many studies have shown that regular physical activity lowers the risk of dying of coronary heart disease

(12). Furthermore, unhealthy dietary consumption of high levels of salt, tans-fats, saturated fats, and cholesterol, and low consumption of fish, vegetables, and fruits elevate the risk of CVD (12). Additionally, the harmful use of alcohol affects the heart muscle and is associated with an elevated risk of CVD (12). CR program is a multidisciplinary health care model for chronic disease management that addresses CVD modifiable risk factors in order to promote secondary prevention of CVD (5).

2.3 Definition of Cardiac Rehabilitation

Cardiac rehabilitation is "a comprehensive secondary prevention program that is medically supervised to support patients with CVD who went through a cardiac event to recover quickly and stay healthy" (4).

2.4 Core Components of Cardiac Rehabilitation Program

The American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association and the European Association for Cardiovascular Prevention & Rehabilitation endorsed a set of evidence-based CR core components that reduce CVD risk and disability and promote healthy behaviors and healthy lifestyle (5) (20), which are the theoretical foundations used in CR programs. Cardiac rehabilitation programs do not consist only of exercise training, although it is one of its core components. However, comprehensive CR programs are beyond that. According to Balady et al. (2007), the core components of CR programs include (5) :

- Baseline Patient Assessment: a review of the medical history, physical examination through assessment of cardiopulmonary systems, and assessment perceived HRQOL.
- Nutritional Counseling: measure daily caloric intake of saturated fats, cholesterol, and sodium, evaluate dietary behaviors, and define targets for nutrition interventions.

- Weight Management: assess weight, height, and waist circumference, for patients with Body Mass Index (BMI) > 25km/m^2 and/or waist > 40 inches in men and >35 inches in women, determine weight goals and establish a comprehensive program.
- Blood Pressure Management: test blood pressure at rest in ≥ 2 appointments, and evaluate current compliance to treatment.
- Lipid Management: evaluate compliance to lipid-lowering medication, obtain fasting measures of triglycerides, high-density lipoprotein, total cholesterol, and low-density lipoprotein, and re-examine lipid profiles at 4-6 weeks post-hospitalization.
- Diabetes Management: a review of the medical record to check the existence or absence of diabetes in patients, assess the history of complications, and recent glycosylated hemoglobin and fasting plasma glucose.
- Tobacco Cessation: evaluate the patient's smoking status, readiness to change, and update status.
- Psychosocial Management: detect psychosocial distress and ascertain the use of psychotropic medications.
- Physical Activity Counseling: identify the present physical activity level, assess activities related to age and gender, and assess willingness to change.
- Exercise Training: evaluate heart rate, signs, symptoms, exercise capacity, and risk stratify to identify the level of monitoring needed during exercise training.

2.5 Phases of Cardiac Rehabilitation Program

Cardiac rehabilitation program consists of three phases:

- Phase I: also known as inpatient CR, which starts following a CVD event, i.e., myocardial infarction to provide rehabilitative and preventive services to hospitalized patients (21).
- Phase II: it starts within 1-3 weeks post-hospitalization, it includes electrocardiographic monitoring of patients in an outpatient setting for the first 3-6 months post-hospitalization (21).
- Phase III: deliverers long-term rehabilitative and preventive service for patients in an outpatient setting (21)

For the CR program that is available in Qatar, only phase I and phase II are offered. This study is based on data obtained from patients in phase II at the program.

2.6 Benefits of Participation in Cardiac Rehabilitation Programs

The benefits of CR are well-documented in the literature. Many studies have established a dose-response relationship among patients who attended more number of CR sessions and lower mortality as compared to patients who attended a fewer number of sessions (22) (23) (24). A study was conducted to assess improvements in the median attendance of CR sessions and the risk myocardial infarction or death (25). The study revealed that an increase in the median number of sessions attended was associated with an approximate 5-8% reduced risk myocardial infarction and death (25). Another study has shown that for each further CR session attended, there was a decrease of 1% in mortality among CR participants (26).

A systematic review and meta-analysis of 34 randomized controlled trials were conducted to study the effect of exercise-based CR among post-myocardial infarction patients. The study revealed that patients who participated in CR had a lower risk of

all-cause mortality (OR=0.74, 95%CI: 0.58-0.95), cardiac mortality (OR 0.64, 95%CI: 0.46-0.88), and re-infarction (OR=0.53, 95%CI: 0.38-0.76) (6). Besides, CR had a positive influence on cardiovascular risk factors, including the lipid profile, weight, blood pressure, and smoking (6). A meta-analysis of 71 randomized controlled trials of patients with coronary heart disease showed that exercise-based CR reduced hospitalization by a mean of 31%, cardiac mortality by a mean of 20%, and all-cause mortality by a mean of 19%. Moreover, it had a significant decrease in systolic blood pressure, triglycerides, and total cholesterol (27).

A systematic review and meta-analysis of 63 studies was conducted to update the Cochrane systematic review and meta-analysis of exercise-based cardiac rehabilitation for coronary heart disease indicated that CR resulted in a reduction in cardiovascular mortality (RR=0.74; 95% CI: 0.64- 0.86) as well as the risk of hospital admissions (RR=0.82; 95% CI: 0.70- 0.96) (7). Moreover, several studies revealed increased levels of HRQOL among patients who participated in CR compared to those who did not participate (7). A study was conducted in Iran to investigate the effect of attending a different number of CR sessions on exercise capacity among patients with coronary artery disease (28). The study showed that there was a statistically significant increase in exercise training energy expenditure in the group of patients who attended 10-24 sessions as compared to patients who attended 5-10 sessions (28).

A review of the advantages of participation in CR in high-middle- and low-income countries showed that those who participated in CR had a significantly higher progression in HRQOL scores compared to non-participant (29). Additionally, a study conducted among elderly patients to assess the association between the dose of CR sessions attended and the risk of myocardial infarction (MI) and death revealed an inverse dose-response relationship; as the number of sessions increases, the risk of

death and MI decreases (30). For instance, patients who attended 36 sessions had a 14% lower risk of death, (hazard ratio=0.86; 95%CI: 0.77-0.97) as well as a 12% lower risk of MI (hazard ratio=0.88; 95%CI: 0.83-0.93) as compared to patients who attended 24 sessions (30). Moreover, those patients (who attended 36 sessions) had a 22% lower risk of death and a 23% lower risk of MI as compared to those who attended 12 sessions (30). Compared to patients who attended 1 session only, the risk of death was reduced by 47%, and the risk of MI was reduced by 31% among patients who attended 36 sessions (30).

2.7 Health-related Quality of Life (HRQOL)

2.7.1 Definition

There seems to be no single definition of HRQOL; however, most experts agreed that the common definition considered levels of physical, social, mental, role functioning, abilities, perceptions, relationships, life satisfaction, and well-being (31) (32). According to Bowling, HRQOL is defined as "optimum levels of mental, physical, role (e.g., work, parent, career) and social functioning, including relationships, and perceptions of health, fitness, life satisfaction, and well-being" (31).

2.7.2 Instruments and Scales

Several instruments are used to assess HRQOL. For example, the EQ-5D tool was developed by the EuroQol group to provide a generic measure of health status (33). There are three versions of the instrument, EQ-5D-5L, EQ-5D-3L and EQ-5D-Y, the most commonly used one to measure HRQOL is the EQ-5D-3L which consists of two parts, the first part is a descriptive part on the five dimensions of health which are: mobility, self-care, usual activities, pain/discomfort and anxiety/depression (33). Each of these dimensions has three levels where the respondent can choose from: no problems, some problems, extreme problems (33). The second part of the instrument is

the visual analog scale where the respondent can mark his/her health status on that day on a numerical scale from 0-100, where 0 represents worst health and 100 represents the best health (33). Another tool that is used to measure HRQOL is the CDC HRQOL-14 "Healthy Days Measure" (34). It has been used since 1993 to assess both physical and mental HRQOL (34). It consists of 14 questions divided into 3 modules the first module assesses healthy days (4 questions), the second one assesses activity limitations (5 questions), and the third module assesses healthy days symptoms (5 questions) (34).

Moreover, The 36-Item Short-Form Health Survey (SF-36), which is a self-administered, comprehensive and one of the most frequently used instruments to measure physical and mental HRQOL (35). It was developed by RAND, a non-profit research organization for the medical outcomes study (35). Managed care organizations widely use it in order to maintain routine assessment and monitoring of care outcomes among adult patients (35). In CR programs, it is commonly used to assess HRQOL among patients attending the programs. It includes eight scales: "physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, and general health" (36). A systematic review of the following databases, Cinahil, EMBASE, Cochrane, and Psychinfo, assessed the use of SF-36 in CR (37). The review results showed that SF-36 is a valid and sensitive instrument and appropriate to be used among CR patients (37).

Scoring SF-36 is done in two steps; firstly, coded values are given to each response category for all the 36 items. Each item is scored between 0 to 100, where 0 represents the least score of health status, and 100 represents the highest score of health status (36). Secondly, the average of all items is calculated to produce the eight scale scores (36).

2.8 Factors Associated with Health-related Quality of Life

Several factors in the literature are found to be associated with HRQOL among patients with CVD. Most of these factors were inversely associated with HRQOL. For instance, studies have shown that comorbidities, such as diabetes, hypertension, and musculoskeletal disorders, were associated with low HRQOL scores (38-41). Other studies demonstrated that depression and smoking were associated with reduced HRQOL (42-47). Moreover, socio-demographic factors such as gender and age were also associated with HRQOL. As there was an inverse association between age and HRQOL (48, 49). Other studies have shown that there were gender differences in HRQOL. In general, women tend to have lower improvements in HRQOL post- CR compared to men (50, 51).

2.9 Benefits of Participation in the CR Program on Health-related Quality of Life

A systematic review and meta-analysis of 41 randomized controlled trials with 11,747 patients evaluated the effectiveness of CR on HRQOL scales in patients with coronary artery disease (8). The results indicated that CR improved HRQOL in the following scales: physical, standardized mean change (SMC)= (0.47, 95%CI: 0.31-0.81), emotional SMC= (0.37, 95% CI: -0.02.31-0.77), and social SMC=(0.31, 95% CI: -0.06-0.32) (8). Another study was conducted to explore the association between attending the CR program and HRQOL and resuming work. Results revealed that CR participants had significantly higher scores in three scales of SF-36 questionnaire; general health, social functioning, and physical functioning (52). Additionally, a study from Switzerland included patients with heart failure who participated in CR for 12 weeks (53). HRQOL was measured at baseline and program discharge using the SF-36 questionnaire (53). The study results showed that HRQOL improved significantly in the physical functioning scale (p-value< 0.0001), role-functioning scale (p-value<

0.05), and mental component score (p-value< 0.0001) (53).

In the EMR, few studies have investigated the association between CR and HRQOL, mostly in Iran. A quasi-experimental pre-post study was carried out in Iran to assess the effect of a comprehensive cardiac rehabilitation program on HRQOL among patients with coronary artery disease (9). A paired t-test was performed to compare variables pre and post-CR (9). The study results showed a significant improvement in HRQOL scales, including physical functioning, physical limitation, body pain, vitality, and general health (p-value< 0.05) (9).

In Qatar, no study has explored the association between attending CR program and HRQOL among patients who enrolled in the sole program in the country. Therefore, this study aims to fill this gap by exploring if there is an association between attending at least the median number of CR sessions and change in SF-36 scales i.e., physical functioning, social functioning, emotional well-being, and general health.

CHAPTER 3: METHODOLOGY

3.1 Research Objectives

The main objective is to explore the association between attending at least the median number of sessions and change in HRQOL among patients enrolled in the CR program in Qatar, specifically:

a. To explore the association between attending at least the median number of sessions and change in physical functioning scores among CR participants in Qatar.
b. To explore the association between attending at least the median number of sessions and change in social functioning scores among CR participants in Qatar.
c. To explore the association between attending at least the median number of sessions and change in emotional well-being scores among CR participants in Qatar.
d. To explore the association between attending at least the median number of sessions and change in general health scores among CR participants in Qatar.

3.2 Research Questions

The main research question is, “Is there an association between attending at least the median number of sessions and change in HRQOL among patients enrolled in the CR program in Qatar?” The present study addressed four scales of the HRQOL as follows:

a. Is there an association between attending at least the median number of sessions and the change in physical functioning scores among CR participants in Qatar?

b. Is there an association between attending at least the median number of sessions and the change in social functioning scores among CR participants in Qatar?
c. Is there an association between attending at least the median number of sessions and change in emotional well-being scores among CR participants in Qatar?
d. Is there an association between attending at least the median number of sessions and change in general health scores among CR participants in Qatar?

3.3 Research Hypothesis

The main hypothesis is, "There is an association between attending at least the median number of sessions of and change in HRQOL among CR participants in Qatar." The study included two sub-hypotheses:

a. There is an association between attending at least the median number of sessions and the change in physical functioning scores among CR participants in Qatar.
b. There is an association between attending at least the median number of sessions and the change in social functioning scores among CR participants in Qatar.
c. There is an association between attending at least the median number of sessions and the change in emotional well-being scores among CR participants in Qatar.
d. There is an association between attending at least the median number of sessions and the change in general health scores among CR participants in Qatar.

3.4 Study Design

This is an observational retrospective cohort study based on patients' records obtained from the CR program at the Heart Hospital in Qatar.

3.5 Study Population

The study sample included all patients who were enrolled in the sole CR program in Qatar from January 2013-October, 2017.

3.6 Source of Data

CR professionals collected data at patient entry (pre-CR) and patient discharge from the program (post-CR). A list of the all patient's health card numbers was provided to us. We accessed patients' electronic medical records, i.e., computerized health information system (Cerner) to extract the data on variables of interest. We have encountered some issues when extracting our outcome of interest, as sometimes it was missing from the patient's electronic record. Thus, we tracked the paper-based files of patients as well to include all the available information and reduce the level of missing data.

1. Patient admitting data included:

A) Patient demographics: age (in years), gender (male, female), and risk level for cardiac events during exercise (low, moderate, high).

B) Clinical measures: comorbid conditions (diabetes mellitus (DM) (yes, no) (hypertension (HTN) (yes, no), and musculoskeletal disorders (yes, no), depression (none, mild to moderate, severe), and HRQOL (continuous).

2. Patient discharge data:

these included the same admitting data but after completion of the CR program.

The SF-36 instrument was used to assess HRQOL among patients attending the CR program. It included eight scales: "physical functioning, role limitations due to

physical health, role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, and general health" (36). This study focused on four scales, i.e., physical functioning, social functioning, emotional well-being, and general health. Our initial plan was to analyze the eight scales; however, due to the high level of missing data in the remaining four scales, we decided to base our analysis on the aforementioned scales, which had the highest level of complete data that would allow us to have meaningful conclusions.

3.7 Measures

1. Dependent variable (outcome): change in HRQOL scores for each of the four scales (i.e., physical functioning, social functioning, emotional well-being, and general health). The change in each scale was computed based on this equation = (HRQOL score at program discharge - HRQOL score at program entry). HRQOL is a continuous variable with a range of 0-100 scores.
2. Independent variables: the variable of interest was attending at least the median number of CR sessions, i.e., attending at least 23 sessions for this cohort (yes / no).

In addition, other covariates were entered in the analysis model. These covariates included:

A. Categorical variables: gender (male / female), risk level for cardiac events during exercise (low / moderate / high), comorbidities (DM/ HTN / musculoskeletal disorders), depression (none/ mild to moderate/ severe).

B. Continuous variables: age (in years).

3.8 Data Analysis

The data cleaning step was performed before the analysis to ensure that all the values are within a plausible range and to detect any imprecise values. Following this step, data were coded and labeled appropriately. Variables were coded according to well-established cut-off values in the literature. For instance, the median number of CR sessions was computed from the number of sessions attended by this cohort, due to unavailability of data on cardiac patients who did not enroll in the CR program, we were not able to compare our findings with an unexposed group (non-enrollee), as these data do not exist. Therefore, we made an internal comparison group to explore this relationship when attending at least a certain cut-off value, which is the median number of sessions as compared to not attending it. That would make our interpretation of the results more pronounce when changes in outcomes i.e., HRQOL are shown in one group who attended at least the median number of sessions as compared to another who attended less than the median. Categorizing the number of CR sessions into the median was also documented in the literature in several studies (54, 55) (25). Other studies categorized the number of CR sessions into four categories from 1 to 11 sessions, 12-23 sessions, 24-35 sessions and lastly 36 sessions to assess long-term outcomes on a large sample size of 30,161 patients (30).

Moreover, CR professionals in the heart hospital used the cardiac depression scale (CDS) instrument to measure depression. We coded depression based in literature as the following cut-off values (1-89) indicates no depression, (90-99) indicates mild to moderate, (100 or above) indicates severe depression (56) CDS instrument is shown in Appendix H, further, CR professionals used risk level (low, moderate, high) to assess the probability of cardiac events during exercise, based on the "American Association of Cardiovascular and Pulmonary Rehabilitation's stratification algorithm for risk of

event" (Appendix B). STATA 16 software (57) was used to analyze the data. Descriptive analysis was carried out to describe characteristics of the study population, i.e., means and standard deviations (SD) for continuous variables, and percentages and frequencies for categorical variables. Additionally, the median number of sessions by this cohort was computed.

To examine the four objectives of the study: *to explore the association between attending at least the median number of sessions and change in each of the following dependent variables:* ***physical functioning, social functioning***, ***emotional well-being*** *and* ***general health*** *scores, a* multiple linear regression analysis was fitted, where change in physical functioning scores (continuous variable) was the dependent variable in the first model, change in social functioning scores (continuous variable) was the dependent variable in the second model, change in emotional well-being scores (continuous variable) was the dependent variable in the third model and change in the general health scores was the dependent variable in the fourth model. Attending at least the median number of sessions (yes/no) was the independent variable of interest in the four models. An additional analysis was done using the independent variable as a count variable i.e., the number of CR sessions attended with each of the four aforementioned outcomes.

The four models adjusted for potential confounders including: age (in years), gender (male / female), risk level for cardiac events during exercise (low / moderate / high), comorbidities (DM: yes, no/ HTN: yes, no / musculoskeletal disorders: yes, no), and depression (none/ mild to moderate / severe).

3.9 Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to explore the association between attending at least the median number of sessions and change in each of the

four scales i.e., physical functioning, social functioning, emotional well-being and general health between patients enrolled in the program in Qatar. 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. 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, i.e., age, gender, risk level, diabetes, hypertension, musculoskeletal disorders, and depression.

Third, the regression model was fitted for each outcome separately by entering attending at least the median number of sessions (the independent variable) besides the aforementioned outcome-related variables. After that, variables with p-values greater than 0.05 were dropped except clinically essential variables in the literature; therefore, a simpler model was fitted for each outcome. Further, the initial full model was compared with the simpler model using the likelihood ratio test (LRT) to decide which model fits the data better.

Finally, multiple linear regression *diagnostics* were performed for each of the final physical functioning, social functioning, emotional well-being, and general health models to assess unusual and influential data, normality of residuals, heteroscedasticity, multi-collinearity, and model specifications to ensure selection of the most appropriate model for our data.

3.10 Potential Reasons for Missing Data

Descriptive statistics showed missing data on some variables. Missing values were detected in five variables; percentages of missing for each variable are as follows; depression (42.8%), change in physical functioning scores (71.3%), change in social functioning scores (71.3%), change in emotional well-being scores (71.3%) and change

in general health scores (71.3%). There could be several factors underlying the issue of missing values in our dataset. These reasons could be divided into patients-related factors and organizational factors. Firstly, for the patient-related factors, since the SF-36 is a self-administered survey some patients might not feel encouraged answering all its parts fully. Therefore, they might tend to skip part of it and leave it blank, and that is a common issue in self-administered surveys in general. In addition, although some patients might have answered the survey fully, however, when they show up for their last session they forget to bring it back and they did not fill it again in the program due to time constraints (as informed by CR staff based on their observations). Second, for the organizational factors, CR professionals might be overloaded with the routine practice; they might not have enough time to follow-up regularly patients who do not have their survey filled by their last visit. Moreover, some patients have had a language barrier, which hindered them from taking the survey. Therefore, translation of the survey to other languages in addition to Arabic and English is needed in order to assess HRQOL outcomes in all cardiac patients.

3.11 Ethical Consideration

Two institutions approved the protocol of the study: Hamad Medical Cooperation Medical Research Center, (MRC-01-18-431), and Qatar University Institutional Review Board, (QU-IRB 1068-E/19).

CHAPTER 4: RESULTS

Our study consisted of 433 patients. Characteristics of patients at program entry, i.e., baseline data, are shown in Table 1. The majority of the patients were males (n=396, 91.4%), the mean age of the patients was 52.7 ± 9.8 years (mean ± SD). Of the patients, 112 (25.8%) were at high risk, and 67 (15.4%) had depression. As for comorbidities, (n=180, 41.5%) of patients had diabetes, (n=185, 42.7%) had hypertension and (n=19, 4.3%) had musculoskeletal disorders On a scale from 0-100, the highest mean of baseline scores was in social functioning (77.9±22.1), whereas the lowest mean was in general health (67.8±19.2). Scores of physical functioning, social functioning, emotional well-being, and general health increased significantly from pre to post CR, p-value= 0.004, 0.001, <0.001, <0.001, respectively (Table 2). Missing values were detected in five variables; numbers and percentages of missing values are depression (n=185, 42.8%), change in physical functioning (n= 309, 71.3%), change in social functioning (n= 309, 71.3%), change in emotional well-being (n= 309, 71.3%), and change in general health (n= 309, 71.3%).

Table 1

Sociodemographic and Clinical Characteristics at Baseline of All Patients who Attended CR Program in Qatar between January 2013- October 2017, (N=433):*

Variable	n (%) or Mean ± SD
Age (years)	52.7±9.8
Gender:	
Male	396 (91.4)
Female	37 (8.5)
Risk level:	
Low	151(34.8)
Moderate	170 (39.2)
High	112 (25.8)
Attending the at least the median number of sessions	
Yes	236 (55.0)
No	193 (44.9)
Depression:	
None	181(41.8)
Mild to moderate	27 (6.2)
Severe	40 (9.2)
Comorbidities:	
DM:	
Yes	180 (41.5)
No	253 (58.4)
HTN:	
Yes	185 (42.7)
No	248 (57.2)
Musculoskeletal disorders:	
Yes	19 (4.3)
No	414 (95.6)
SF-36 Health-related quality of life (scores): (n=209)	
Physical functioning	68.8±24.1
Social functioning	77.8± 22.1
Emotional well-being	74.5±17.7
General health	66.4± 19.6

*: Unless indicated

CR: Cardiac rehabilitation

DM: Diabetes mellitus

HTN: Hypertension

SF-36: 36-Item Short-Form Health Survey

SD: Standard deviation

Table 2

Pre and Post-CR Physical Functioning, Social Functioning, Emotional Well-being, and General Health Scores:

Variable	Pre-CR Mean ± SD	Post-CR Mean ± SD	Change (post-pre)	95% CI	p-value
Physical functioning *(n=124)*	68.2±24.0	74.9±24.4	6.7	(2.08-11.35)	0.004*
Social functioning *(n=124)*	77.9± 22.2	84.5±18.1	6.5	(2.66-10.53)	0.001*
Emotional well-being *(n=124)*	75.5±17.5	81.3±15.3	5.8	(3.13-8.57)	<0.001*
General health *(n=125)*	67.8± 19.2	74.6±19.1	6.8	(4.10-9.61)	<0.001*

CR: Cardiac rehabilitation

*: p-value <0.05 is considered significant

CI: Confidence intervals

4.1 Physical Functioning Scale

4.1.1 Univariate Analysis

The results of the univariate analysis describing the change in physical functioning scores by each variable separately, i.e., one variable at a time, are shown in Table 3, variables with a p-value <0.25 were added in the initial full model. These variables included attending at least the median number of CR sessions, gender, depression, risk level, and diabetes, along with clinically important variables. The regression model was fitted, and all variables with p-values >0.05 were eliminated from the new simpler model, except the variables that were clinically significant and well-established in the literature to have important associations with the outcome of interest (i.e., change in physical functioning scores). The likelihood ratio test (LRT) showed that the new simpler model was better than the initial full model. LRT= 1.68, p-value= 0.19.

4.1.2 Multiple Linear Regression

Adjusted estimates of the change in physical functioning scores by patient demographics and clinical characteristics are shown in Table 4. There was a statistically significant association between attendance and change in physical functioning scores; participants attending at least 23 sessions had a greater improvement in physical functioning by 23.98 units compared to those attending less than 23 sessions (95% CI= 8.85-29.11/ p-value=0.002), adjusting for age, gender, risk level, depression, diabetes, hypertension, musculoskeletal disorders, and baseline physical functioning scores.

Table 3

Univariate Analysis of the Change in Physical Functioning Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Attending at least the median number of sessions			
No	*Reference*		
Yes	15.39	(5.19-25.59)	0.003
Age (years)	0.01	(-0.49-0.53)	0.94
Gender			
Male	*Reference*		
Female	24.49	(-11.00-59.99)	0.17
Risk level			
Low	*Reference*		
Moderate	12.39	(-0.09-24.84)	0.05
High	11.76	(-2.45-25.98)	0.10
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	13.60	(-6.54-33.75)	0.18
Severe	-7.02	(-23.47-9.42)	0.39
Comorbidities:			
DM:			
No	*Reference*		
Yes	7.72	(-3.32-18.77)	0.16
HTN:			
No	*Reference*		
Yes	-2.23	(-13.34-8.86)	0.69
Musculoskeletal disorders:			
No	*Reference*		
Yes	7.28	(-15.04-29.62)	0.51

†: Results in the table were obtained by conducting separate univariate analyses, i.e., the dependent variable with each factor listed in the table.

CI: Confidence interval

DM: Diabetes mellitus, HTN: Hypertension

Table 4

Adjusted Estimates of the Change in Physical Functioning Scores by Patient Demographics and Clinical Characteristics (n=106):

Patient characteristic	Coefficient	95%CI	p-value
Attending at least the median number of sessions			
No	*Reference*		
Yes	23.98	(8.85-29.11)	0.002*
Age (years)	0.08	(-0.43-0.61)	0.74
Gender			
Male	*Reference*		
Female	23.65	(-17.81-65.12)	0.26
Baseline physical functioning scores	0.40	(0.59-0.21)	<0.001
Risk level			
Low	*Reference*		
Moderate	-13.48	(-33.10-6.12)	0.17
High	-14.92	(-39.89-10.05)	0.23
Depression			
No	*Reference*		
Mild to moderate	13.20	(-6.54-32.95)	0.18
Severe	-10.09	(-25.88-5.69)	0.20
Comorbidities:			
DM:			
No	*Reference*		
Yes	10.95	(-2.63-24.54)	0.11
HTN:			
No	*Reference*		
Yes	-4.42	(-17.43-8.59)	0.50
Musculoskeletal disorders**:**			
No	*Reference*		
Yes	9.74	(-12.80-32.28)	0.39

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.1.3 Multiple Linear Regression Diagnostics

Multiple linear regression diagnostics were conducted; normality of residuals analysis showed that residuals were normally distributed, as shown in Figure 5-Appendix F. Heteroscedasticity was assessed using White's test and Breusch-Pegan test. These tests resulted in a p-value= 0.12 and 0.82, respectively. This supported homogeneity of variance because the p-value of the heteroscedasticity test was not significant. The regression diagnostics also showed that there was no issue of multi-collinearity as variance inflation factor (VIF) was <10 for all the variables as shown in Appendix G. Finally, we concluded that our model was correctly specified, the p-value of the squared predictor= 0.38, which indicated that there was no specification error.

4.2 Social Functioning Scale

4.2.1. Univariate Analysis

The results of the univariate analysis describing the change in social functioning scores by each variable separately, i.e., one variable at a time, are shown in Table 5, variables with a p-value <0.25 were added in the initial full model. These variables included depression, risk level, and diabetes, along with clinically important variables. The regression model was fitted, and all variables with p-values >0.05 were eliminated from the new simpler model, except the variables that were clinically significant and well-established in the literature to have important associations with the outcome of interest (i.e., change in social functioning scores). The likelihood ratio test (LRT) showed that the new simpler model was better than the initial full model. LRT=0.01, p-value=0.90.

4.2.2. Multiple Linear Regression

Adjusted estimates of the change in social functioning scores by patient demographics and clinical characteristics are shown in Table 6. There was a statistically significant association between attendance and change in social functioning scores; participants attending at least 23 sessions had a greater improvement in social functioning by 9.96 units compared to those attending less than 23 sessions (95% CI=0.04-19.38/ p-value=0.04), adjusting for age, gender, risk level, depression, diabetes, hypertension, musculoskeletal disorders, and baseline social functioning scores.

Table 5

Univariate Analysis of the Change in Social Functioning Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Attending at least the median number of sessions			
No	*Reference*		
Yes	0.86	(-6.94-8.66)	0.82
Age (years)	-0.18	(-0.55-0.18)	0.32
Gender			
Male	*Reference*		
Female	-6.76	(-32.44-18.92)	0.6
Risk level			
Low	*Reference*		
Moderate	-3.71	(-12.73-5.30)	0.41
High	-8.46	(-18.76-1.83)	0.1
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	12.45	(-2.89-27.81)	0.11
Severe	-5.5	(-18.04-7.02)	0.38
Comorbidities:			
DM:			
No	*Reference*		
Yes	-7.78	(-15.66-0.09)	0.05
HTN:			
No	*Reference*		
Yes	-4.09	(-12.04-3.86)	0.31
Musculoskeletal disorders:			
No	*Reference*		
Yes	-1.37	(-17.45-14.70)	0.86

†: Results in the table were obtained by conducting separate univariate analyses, i.e., the dependent variable with each factor listed in the table.

CI: Confidence interval

DM: Diabetes mellitus, HTN: Hypertension

Table 6

Adjusted Estimates of the Change in Social Functioning Scores by Patient Demographics and Clinical Characteristics (n=106):

Patient characteristic	Coefficient	95%CI	p-value
Attending at least the median number of sessions			
No	Reference		
Yes	9.69	(0.04-19.38)	0.04*
Age (years)	-0.01	(-0.35-0.26)	0.77
Gender			
Male	Reference		
Female	-2.45	(-22.93-18.03)	0.81
Baseline social functioning scores	0.64	(0.79-0.50)	<0.001
Risk level			
Low	Reference		
Moderate	-8.42	(-18.35-1.50)	0.09
High	-11.93	(-24.77-0.90)	0.06
Depression			
No	Reference		
Mild to moderate	0.71	(-9.29-10.70)	0.88
Severe	-20.48	(-29.52,-11.44)	0.22
Comorbidities:			
DM:			
No	Reference		
Yes	-4.05	(-10.98-2.87)	0.24
HTN:			
No	Reference		
Yes	-0.25	(-6.98-6.46)	0.93
Musculoskeletal disorders:			
No	Reference		
Yes	-6.76	(-17.92-4.38)	0.23

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.2.3 Multiple Linear Regression Diagnostics

Multiple linear regression diagnostics were conducted; normality of residuals analysis showed that residuals were normally distributed, as shown in Figure 6-Appendix F . Heteroscedasticity was assessed using White's test and Breusch-Pegan test. These tests resulted in a p-value= 0.83 and 0.61, respectively. This supported homogeneity of variance because the p-value of the heteroscedasticity test was not significant. The regression diagnostics also showed that there was no issue of multi-collinearity as variance inflation factor (VIF) was <10 for all the variables as shown in Appendix G. Finally, we concluded that our model was correctly specified, the p-value of the squared predictor= 0.22, which indicated that there was no specification error.

4.3 Emotional well-being Scale

4.3.1 Univariate Analysis

The results of the univariate analysis describing the change emotional well-being scores by each variable separately, i.e., one variable at a time, are shown in Table 7. Variables with a p-value <0.25 were added in the initial full model. These variables included attending at least the median number of sessions, gender, risk level, and depression, along with clinically important variables. The regression model was fitted, and all variables with p-values >0.05 were eliminated from the new simpler model, except the variables that were clinically significant and well-established in the literature to have important associations with the outcome of interest (i.e., change in emotional well-being scores). The likelihood ratio test (LRT) showed that the new simpler model was better than the initial full model. LRT=0.37, p-value=0.54.

4.3.2 Multiple Linear Regression

Adjusted estimates of the change in emotional well-being scores by patient demographics and clinical characteristics are shown in Table 8. There was a statistically significant association between attendance and change in emotional well-being scores; participants attending at least 23 sessions had 12.02 units greater improvement in emotional well-being compared to those attending less than 23 sessions (95% CI=1.92-22.13/ p-value=0.02), adjusting for age, gender, risk level, depression, diabetes, hypertension, musculoskeletal disorders, and baseline emotional well-being scores.

Table 7
Univariate Analysis of the Change in Emotional Well-being Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Attending at least the median number of sessions			
No	*Reference*		
Yes	18.84	(10.42-27.25)	<0.001
Age	-0.09	(-0.51-0.32)	0.6
Gender:			
Male	*Reference*		
Female	-21.86	(-50.72-6.98)	0.13
Risk level:			
Low	*Reference*		
Moderate	20.09	(10.41-29.76)	<0.001
High	11.61	(0.56-22.65)	0.04
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	9.03	(-5.55-23.62)	0.2
Severe	-3.09	(-15.0-8.81)	0.6
Comorbidities:			
DM:			
No	*Reference*		
Yes	4.26	(-4.76-13.30)	0.3
HTN:			
No	*Reference*		
Yes	2.99	(-6.03-12.02)	0.5
Musculoskeletal disorders			
No	*Reference*		
Yes	7.21	(-10.95-25.37)	0.43

†: Results in the table were obtained by conducting separate univariate analyses, i.e., the dependent variable with each factor listed in the table.
CI: Confidence interval
DM: Diabetes mellitus, HTN: Hypertension

Table 8

Adjusted Estimates of Change in Emotional Well-being Scores by Patient Demographics and Clinical Characteristics (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Attending at least the median number of sessions:			
No	*Reference*		
Yes	12.02	(1.92-22.13)	0.02*
Age	-0.04	(-0.50-0.40)	0.83
Gender	*Reference*		
Male	-15.0	(-45.41-15.41)	0.33
Female			
Baseline emotional well-being scores	0.40	(0.58-0.23)	<0.001
Risk level			
Low	*Reference*		
Moderate	6.30	(8.08-20.68)	0.38
High	-5.09	(-23.41-13.2)	0.58
Depression			
None	*Reference*		
Mild to moderate	11.10	(-3.37-25.58)	0.13
Severe	-0.84	(-12.42-10.73)	0.88
Comorbidities:			
DM:			
No	*Reference*		
Yes	-1.00	(-10.96-8.96)	0.84
HTN:			
No	*Reference*		
Yes	1.60	(-7.94-11.15)	0.73
Musculoskeletal disorders			
No	*Reference*		
Yes	9.87	(-6.65-26.41)	0.23

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.3.3 Multiple Linear Regression Diagnostics

Multiple linear regression diagnostics were conducted; normality of residuals analysis showed that residuals were normally distributed, as shown in Figure 7-Appendix F. Heteroscedasticity was assessed using White's test and Breusch-Pegan test. These tests resulted in a p-value= 0.49 and 0.25, respectively. This supported homogeneity of variance because the p-value of the heteroscedasticity test was not significant. The regression diagnostics also showed that there was no issue of multi-collinearity as variance inflation factor (VIF) was <10 for all the variables as shown in Appendix G. Finally, we concluded that our model was correctly specified, the p-value of the squared predictor= 0.53, which indicated that there was no specification error.

4.4 General Health Scale

4.4.1 Univariate Analysis

The results of the univariate analysis describing the change in general health scores by each variable separately, i.e., one variable at a time, are shown in Table 9, variables with a p-value <0.25 were added in the initial full model. These variables included attending at least the median number of sessions, age risk level, depression, and diabetes, along with clinically important variables. The regression model was fitted, and all variables with p-values >0.05 were eliminated from the new simpler model, except the variables that were clinically significant and well-established in the literature to have important associations with the outcome of interest (i.e., change in general health scores). The likelihood ratio test (LRT) showed that the new simpler model was better than the initial full model. LRT=0.21, p-value=0.64.

4.4.2 Multiple Linear Regression

Adjusted estimates of the change in general health scores by patient demographics and clinical characteristics are shown in Table 10. There was a statistically significant association between attendance and change in general health scores; participants attending at least 23 sessions had 8.40 units greater improvement in general health compared to those attending less than 23 sessions (95% CI=0.38-16.42/ p-value=0.03), adjusting for age, gender, risk level, depression, diabetes, hypertension, musculoskeletal disorders, and baseline general health scores.In addition to the statistical significant associations that were found, we found clinically significant associations between attendance and improvement in physical functioning, social functioning, emotional well-being, and general health, effect sizes= (0.27, 95% CI= 0.11-0.47), (0.29, 95% CI= 0.11-0.47), (0.33, 95% CI= 0.17-0.48), (0.35, 95% CI= 0.21-0.50), respectively. Effect sizes were computed as follows (mean change in each

HRQOL scale overtime/ baseline standard deviation) (66). According to Cohen, an effect size of 0.2 is an indicator of minimal clinical significance change (67). McGee et al., have shown that among CR patients, an increase in an effect size of 0.3 is an indicator of a positive clinical effect (66).

Table 9

Univariate Analysis of the Change in General Health Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95%CI	p-value
Attending at least the median number of sessions: *(n=123)*			
No	*Reference*		
Yes	3.76	(-1.84-9.38)	0.18
Age	-0.16	(-0.42-0.09)	0.21
Gender:			
Male	*Reference*		
Female	1.47	(-16.65-19.60)	0.87
Risk level:			
Low	*Reference*		
Moderate	3.84	(-2.55-10.23)	0.23
High	0.98	(-6.31-8.28)	0.78
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	-1.09	(-11.19-9.00)	0.83
Severe	-5.15	(-13.40-3.08)	0.21
Comorbidities:			
DM:			
No	*Reference*		
Yes	-04.09	(-9.68-1.50)	0.15
HTN:			
No	*Reference*		
Yes	-2.28	(-7.89-3.33)	0.42
Musculoskeletal disorders			
No	*Reference*		
Yes	-0.02	(-11.36-11.31)	0.99

†: Results in the table were obtained by conducting separate univariate analyses, i.e., the dependent variable with each factor listed in the table.

CI: Confidence interval

DM: Diabetes mellitus, HTN: Hypertension

Table 10

Adjusted Estimates of the Change in General Health Scores by Patient Demographics and Clinical Characteristics (n=106)

Patient characteristic	Coefficient	95%CI	p-value
Attending at least the median number of sessions:			
No	*Reference*		
Yes	8.40	(0.38-16.42)	0.03*
Age	0.12	(-0.13-0.39)	0.34
Gender			
Male	*Reference*		
Female	2.66	(-14.86-20.18)	0.76
Baseline general health scores	0.39	(0.53-0.25)	<0.001
Risk level			
Low	*Reference*		
Moderate	0.93	(-7.35-9.22)	0.82
High	-3.86	(-14.42-6.70)	0.46
Depression			
None	*Reference*		
Mild to moderate	-0.19	(-8.63-8.24)	0.96
Severe	-6.42	(-13.41-0.57)	0.07
Comorbidities:			
DM:			
No	*Reference*		
Yes	-1.98	(-7.71-3.74)	0.49
HTN:			
No	*Reference*		
Yes	-1.06	(-6.58-4.46)	0.70
Musculoskeletal disorders:			
No	*Reference*		
Yes	-6.29	(-15.79-3.21)	0.19

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.4.3 Multiple Linear Regression Diagnostics

Multiple linear regression diagnostics were conducted; normality of residuals analysis showed that residuals were normally distributed, as shown in Figure 8-Appendix F Heteroscedasticity was assessed using White's test and Breusch-Pegan test. These tests resulted in a p-value = (0.48 and 0.92, respectively). This supported homogeneity of variance because the p-value of the heteroscedasticity test was not significant. The regression diagnostics also showed that there was no issue with multi-collinearity as variance inflation factor (VIF) was <10 for all the variables as shown in Appendix G. Finally, we concluded that our model was correctly specified, the p-value of the squared predictor= 0.38, which indicated that there was no specification error.

A Comparison between the Sociodemographic and Clinical Characteristics of Patients with Complete Data and those with Missing Data:

As shown in Table 11, 89% (n=275) of those who had missing data on the four scales of HRQOL were males, with a mean age and standard deviation of 52.8±9.5 years. Almost 40% (n=121) were at a moderate-risk level for cardiac events during exercise. Over 70% (n=100) of these patients were none depressed. As for comorbidities, 42.72% (n=132) had hypertension, 41.42% (n=128) had diabetes, and 3.56% (n=13) had musculoskeletal disorders. Almost 55% (n=167) of them have attended at least the median number of CR sessions. As shown in Table 11, the sociodemographic and clinical characteristics of patients who had complete data were similar to that of patients with missing data.

Table 11

A Comparison of the Sociodemographic and Clinical Characteristics of Patients who had Missing data in Change in Physical Functioning, Social Functioning, Emotional well-being and General Health Scores to those with Complete Data, (N=433):

Variable	n (%) or Mean ± SD Missing data *(n=309)*	n (%) or Mean ± SD Complete data *(n=124)*
Age (years)	52.8±9.5	52.47±10.65
Gender:		
Male	275 (89.0)	121(97.58)
Female	34 (11)	3 (2.42)
Risk level:		
Low	106 (34.3)	45 (36.29)
Moderate	121 (39.1)	49 (39.52)
High	82 (26.5)	30 (24.19)
Attending at least the median number of sessions		
Yes		
No	167 (54.5)	69 (56.10)
	139 (45.4)	54 (43.90)
Depression:		
None		
Mild to moderate	100 (70.9)	81 (75.70)
Severe	17 (12.0)	10 (9.35)
	24 (17.0)	16 (14.95)
Comorbidities:		
DM:		
Yes	128 (41.42)	52 (41.94)
No	181 (58.58)	72 (58.06)
HTN:		
Yes	132 (42.72)	53 (42.74)
No	177 (57.28)	71 (57.26)
Musculoskeletal disorders:		
Yes	11 (3.56)	8 (6.45)
No	298 (96.44)	116 (93.55)

DM: diabetes mellitus, HTN: hypertension.

4.5 Additional Analysis Using the Count Independent Variable

Further analysis of the four outcomes i.e., change in physical functioning scores, change in social functioning scores, change in emotional well-being scores, and change in general health scores using the independent variable i.e., the number of CR sessions attended as a count variable was conducted. The results were similar to the aforementioned results where we categorized the independent variable into two groups i.e., using the median number of sessions. As shown in Tables 13, 15, 17, 19, there was a statistically significant association between attendance and change in physical functioning scores, change in social functioning scores, change in emotional well-being scores and change in general health scores (95% CI=0.01-1.65/ p-value=0.04), (95% CI=0.20-1.96/ p-value= 0.01), (95% CI=0.10-1.17/ p-value=0.01) (95% CI=0.09-0.92/ p-value=0.01) respectively, adjusting for age, gender, risk level, depression, diabetes, hypertension, musculoskeletal disorders and baseline HRQOL scores.

4.5.1 Physical Functioning Scale

Table 12

Univariate Analysis of the Change in Physical Functioning Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Number of sessions attended	0.20	(-0 .26-0.59)	0.36
Age	-0.14	(-0.28-0.58)	0.49
Gender:			
Male	*Reference*		
Female	25.56	(-4.36-55.49)	0.09
Risk level:			
Low	*Reference*		
Moderate	-2.94	(-13.60-7.72)	0.58
High	4.93	(-7.24-17.10)	0.42
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	21.44	(4.52-38.36)	0.01
Severe	-3.86	(-17.67-9.93)	0.58
Comorbidities:			
DM:			
No	*Reference*		
Yes	5.76	(-3.60-15.14)	0.22
HTN:			
No	*Reference*		
Yes	2.66	(-6.73-12.05)	0.57
Musculoskeletal disorders:			
No	*Reference*		
Yes	-9.85	(-28.70-8.99)	0.30

CI: Confidence interval, DM: Diabetes mellitus, HTN: Hypertension

Table 13

Adjusted Estimates of the Change in Physical Functioning Scores by Patient Demographics and Clinical Characteristics (n=106):

Patient characteristic	Coefficient	95% CI	p-value
Number of completed sessions	0.83	(0.01-1.65)	0.04*
Age (years)	0.09	(-0.41-0.61)	0.70
Gender			
Male	*Reference*		
Female	15.37	(-18.27-49.01)	0.36
Baseline physical functioning scores	0.43	(0.63-0.24)	<0.001
Risk level			
Low	*Reference*		
Moderate	-0.34	(-12.29-11.55)	0.95
High	-8.74	(-18.76-1.83)	0.39
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	16.55	(-0.27-32.79)	0.04*
Severe	-13.19	(-26.43-0.04)	0.05
Comorbidities:			
DM:			
No	*Reference*		
Yes	2.05	(-9.09-13.21)	0.71
HTN:			
No	*Reference*		
Yes	-5.62	(-16.31-5.06)	0.29
Musculoskeletal disorders:			
No	*Reference*		
Yes	1.87	(-16.68-20.43)	0.84

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.5.2 Social Functioning Scale

Table 14

Univariate Analysis of the Change in Social Functioning Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Number of sessions attended	0.16	(-0.60-0.27)	0.44
Age	-0.18	(-0.55-0.18)	0.32
Gender:			
Male	*Reference*		
Female	-6.76	(-32.44-18.92)	0.60
Risk level:			
Low	*Reference*		
Moderate	-3.71	(-12.75-3.10)	0.58
High	-8.46	(-18.76-1.83)	0.16
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	12.45	(-2.89-27.81)	0.11
Severe	-5.50	(-18.04-7.02)	0.38
Comorbidities:			
DM:			
No	*Reference*		
Yes	-7.78	(-15.06-0.09)	0.05
HTN:			
No	*Reference*		
Yes	-4.09	(-12.04-3.86)	0.31
Musculoskeletal disorders:			
No	*Reference*		
Yes	-1.37	(-17.45-14.70)	0.86

CI: Confidence interval, DM: Diabetes mellitus, HTN: Hypertension

Table 15

Adjusted Estimates of the Change in Social Functioning Scores by Patient Demographics and Clinical Characteristics (n=106):

Patient characteristic	Coefficient	95% CI	p-value
Number of completed sessions	0.87	(0.20-1.96)	0.01*
Age (years)	0.05	(-0.61-0.73)	0.86
Gender			
Male	*Reference*		
Female	-21	(-66.01-22.63)	0.33
Baseline social functioning scores	0.66	(0.80-0.52)	<0.001
Risk level			
Low	*Reference*		
Moderate	14.47	(-1.20-30.15)	0.07
High	8.69	(-17.83-35.22)	0.51
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	8.59	(-12.82-30.01)	0.4
Severe	-18.06	(-35.51, -0.62)	0.04*
Comorbidities:			
DM:			
No	*Reference*		
Yes	-12.09	(-26.79-2.61)	0.10
HTN:			
No	*Reference*		
Yes	-8.87	(-22.95-5.20)	0.21
Musculoskeletal disorders:			
No	*Reference*		
Yes	-5.28	(-29.74-19.16)	0.66

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.5.3 Emotional Well-Being Scale

Table 16

Univariate Analysis of the Change in Emotional Well-being Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Number of sessions attended	0.33	(0 .06-0.59)	0.01
Age	-0.12	(-0.35-0.09)	0.25
Gender:			
Male	*Reference*		
Female	-15.24	(-4.36-55.49)	0.04
Risk level:			
Low	*Reference*		
Moderate	5.05	(-0.31-10.42)	0.01
High	6.14	(0.01-12.27)	0.86
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	18.41	(10.40-26.42)	0.01
Severe	0.56	(-5.97-7.10)	0.86
Comorbidities:			
DM:			
No	*Reference*		
Yes	0.75	(-4.05-5.56)	0.75
HTN:			
No	*Reference*		
Yes	3.52	(-1.23-8.27)	0.14
Musculoskeletal disorders			
No	*Reference*		
Yes	-4.25	(-13.88-5.38)	0.38

CI: Confidence interval, DM: Diabetes mellitus, HTN: Hypertension

Table 17

Adjusted Estimates of the Change in Emotional Well-being Scores by Patient Demographics and Clinical Characteristics (n=106)

Patient characteristic	Coefficient	95% CI	p-value
Number of completed sessions	0.64	(0.10-1.17)	0.01*
Age (years)	-0.13	(-0.46-0.19)	0.41
Gender			
Male	*Reference*		
Female	-18.87	(-40.68-2.93)	0.08
Baseline emotional well-being scores	0.38	(0.05-0.200)	<0.001
Risk level			
Low	*Reference*		
Moderate	7.29	(-0.42-15.00)	0.06
High	-1.50	(-14.56-11.54)	0.81
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	12.04	(1.50-22.58)	0.02*
Severe	-3.98	(-12.57-4.59)	0.35
Comorbidities:			
DM:			
No	*Reference*		
Yes	-1.90	(-9.14-5.32)	0.60
HTN:			
No	*Reference*		
Yes	3.77	(-3.12-10.70)	0.28
Musculoskeletal disorders:			
No	*Reference*		
Yes	-6.76	(-18.79-5.27)	0.26

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

4.5.4 General Health Scale

Table 18

Univariate Analysis of the Change in General Health Scores by Patient Factors† (n=124):

Patient characteristic	Coefficient	95% CI	p-value
Number of sessions attended	0.30	(0 .02-0.59)	0.03
Age	-0.06	(-0.29-0.17)	0.61
Gender:			
Male	*Reference*		
Female	-1.17	(-17.64-15.30)	0.88
Risk level:			
Low	*Reference*		
Moderate	7.27	(1.57-12.9)	0.01
High	4.21	(-2.29-10.71)	0.20
Depression:*(n=107)*			
None	*Reference*		
Mild to moderate	3.91	(-5.37-13.21)	0.40
Severe	-1.14	(-8.73-6.44)	0.76
Comorbidities:			
DM:			
No	*Reference*		
Yes	-1.91	(-7.02-3.20)	0.46
HTN:			
No	*Reference*		
Yes	-0.85	(-5.97-4.25)	0.74
Musculoskeletal disorders			
No	*Reference*		
Yes	-2.78	(-13.07-7.51)	0.59

CI: Confidence interval, DM: Diabetes mellitus, HTN: Hypertension

Table 19

Adjusted Estimates of the Change in General Health Scores by Patient Demographics and Clinical Characteristics (n=106):

Patient characteristic	Coefficient	95% CI	p-value
Number of completed sessions	0.51	(0.09-0.92)	0.01*
Age (years)	0.12	(-0.14-0.38)	0.35
Gender			
Male	*Reference*		
Female	1.11	(-15.99-18.22)	0.89
Baseline general health score	0.39	(0.53-0.26)	<0.001
Risk level			
Low	*Reference*		
Moderate	4.28	(-1.75-10.32)	0.16
High	-4.82	(-15.06-5.41)	0.35
Depression:*(n=107)*			
No	*Reference*		
Mild to moderate	-0.12	(-8.49-8.24)	0.97
Severe	-7.74	(-14.78,-0.70)	0.03*
Comorbidities:			
DM:			
No	*Reference*		
Yes	-2.94	(-8.61- 2.72)	0.30
HTN:			
No	*Reference*		
Yes	-0.68	(-8.61-2.72)	0.80
Musculoskeletal disorders:			
No	*Reference*		
Yes	-6.25	(-15.68-3.17)	0.19

CI: Confidence interval

*: p-value <0.05 is considered significant, DM: Diabetes mellitus, HTN: Hypertension

CHAPTER 5: DISCUSSION

5.1 Cardiac Rehabilitation and Health-related Quality of Life

Due to the global epidemiological transition from communicable diseases to non-communicable diseases, a large number of people nowadays are living with NCDs. These diseases are multifactorial as several risk factors are associated with its occurrence. Primordial and primary prevention of these risk factors is the ideal method in some cases; however, with the current medical advancements in healthcare technologies and the aging population, more patients live with CVD than before, therefore, they require secondary prevention programs to slow their disease progression and manage its complications. Prior studies of the highest level of evidence have shown that attending CR programs was associated with better health outcomes. For instance, it was effective in reducing cardiovascular mortality by 26% and hospital admissions by 18% (7). As well as, it showed significant improvements in HRQOL in both physical and mental scales (8)

Health-related quality of life is a subjective topic; it is perceived differently from one person to another. Thus, it is challenging to measure and interpret. In the CR program, the primary goal is to help patients, who underwent a cardiac event, to recover to a healthy status quickly, both physically and mentally. There is a scarcity of studies on the association between the number of CR sessions attended and HRQOL globally as well as locally. To the best of our knowledge, this was the first study to explore the association between the number of CR sessions attended and HRQOL among patients in Qatar.

Our findings which were based on the complete case analysis showed that there were a statistically significant associations between attendance of CR program and

change in physical functioning scores, change in social functioning scores, change in emotional well-being scores, and change in general health scores among participants attending at least 23 sessions as compared to those attending less than 23 sessions, adjusting for age, gender, risk level, depression, diabetes, hypertension and musculoskeletal disorders. Moreover, we found clinically significant associations between attendance and improvement in HRQOL.

5.2 Duration in CR Program and Change in Health-Related Quality of Life

Due to a lack of studies on the association between the number of CR sessions attended and HRQOL, we used duration in the CR program as a proxy to interpret our variable of interest, which was the number of CR sessions attended. Eventually, the increase in the number of CR sessions attended will result in a longer duration in the program, which is organized on the delivery of sessions on fixed days of the week. In accordance with our findings, a study aimed to investigate the changes in HRQOL, which was assessed at three time points, at the beginning of the CR program, at the end, and after 6-months (68). The study revealed statistically significant changes in physical and mental scales at the end of the program (36 sessions); however, from the end of the program to 6-months, there was no significant improvement, p-value >0.05(68). Similar to our results, the aforementioned study showed a significant clinical important difference in HRQOL, effect size $\geq$ 0.5, in the physical functioning scale (68). Moreover, Muller-Nordhorn and his colleagues revealed that after a one-year follow-up of CR patients, significant improvements in HRQOL which were assessed using SF-36 were shown, p-value< 0.05 (69).

Additionally, a randomized controlled trial was conducted to investigate the dose of CR sessions and HRQOL. The Eight aspects of physical and mental HRQOL were measured at baseline and month 6 with the use of the Medical Outcomes Study

SF-36 survey. The results of the study showed higher doses of exercise were associated with larger improvements in mental and physical aspects HRQOL (70).

However, Hevey and his colleagues have compared a 4-week duration (20 sessions) to a 10-week duration (30 sessions) CR program (71). No significant differences in the attendance duration of CR and the HRQOL were detected, p-value >0.05 (71). This could be due to the small sample size of the study or because the difference between the number of sessions in the two groups was relatively small.

5.3 Attending Compared to Non-attending CR Program and Change in Health-related Quality of Life

In accordance with the findings of this study. An observational study conducted in Canada among CR patients who completed 3-month and 6-month CR programs (72). HRQOL was assessed using the SF-36 survey (72). After a 12-week duration in the CR program, significant improvements occurred in the mental health aspects of HRQOL, p-value <0.0001(72).

A systematic review of 16 randomized controlled trials in nine countries has explored the effect of CR intervention on quality of life among patients with coronary heart disease; however, there were variations in the findings, as some studies have shown significant improvements in some of HRQOL scales. It showed that participation in the CR program was effective in improving the quality of life for patients with coronary heart disease, p-value <0.05 (73), whereas others did not show any statistically significant differences between intervention and control groups (73).

Furthermore, a study published in 2018 by Choo and his colleagues aimed to explore the effect of CR on HRQOL among Asian patients in Singapore (43). The study compared the means and SD of pre-and-post- HRQOL scores and found statistically significant differences between pre-and post-scores, p-value <0.0001. Additionally, a

clinical trial study was conducted in Iran among patients with acute coronary syndrome has shown that in the intervention group, the mean scores in all scales of HRQOL using SF-36 tool increased significantly after CR, p-value <0.05, whereas, no significant differences were shown between the intervention and control groups in social functioning and general health scales, p-value >0.05 (74).

A quasi-experimental study before-after study was conducted to assess the effect of CR on HRQOL (9). The study results indicated significant improvements in scores of all physical scales, including physical functioning, general health as well as improvement in social functioning, especially among older patients and females as compared to baseline scores, p-value <0.05 (9). However, the study only compared age and sex groups after CR. Other variables might have confounded this association, such as depression and comorbidities, as documented in the literature. Duarte Freitas and his colleagues have used the SF-36 tool to assess HRQOL after a four-week intensive cardiac rehabilitation program (75). The study results revealed that after participation in the CR program, physical and mental scores improved significantly p-value <0.0001 (75).

Riaz and his colleagues have used the SF-36 survey to measure patient's outcomes after attending the CR program (76). The results showed a significant improvement in the physical capacity score; however, there were no significant improvements in the mental capacity score, (p-value=0.96) (76). This could be due to the relatively healthy level of mental capacity among patients at baseline.

5.4 Study Strengths

There were several strengths to our study. The main strength is that we informed the CR program director about the quality of data issue; therefore, they are now working toward improving the quality of the collected data through establishing of CR registry, where the completeness of the data will be monitored regularly. Moreover. In the analysis, multiple linear regression models adjusted for well-established confounders such as age, gender, level of risk, depression, and comorbidities.

5.5 Study Limitations

One of the limitations of this study is that it was an observational study; it used secondary data that were collected before the study initiation; hence, it might not be very accurate concerning our objective. Besides, our study was based on secondary data that had missing values; however, there were no significant differences between those with complete data and those who had missing data on sociodemographic and some clinical characteristics. Moreover, the sample size was relatively small Furthermore, although we adjusted for potential confounders in our analysis model, the residual confounding cannot be eliminated. Moreover, there are several significant variables that we should have controlled for to have better understanding of the association with health-related of life such as medications, marital status, employment, and level of education; however, these variables were not collected from patients, therefore, we were not able to obtain it from their records.

5.6 Research Implications and Future Recommendations

The findings of this study showed that the number of sessions attended was associated with improved HRQOL (physical, social, emotional and general health scales). The more the number attended, the higher the improvement in those HRQOL scales. Therefore, there is a need to promote CR utilization among cardiac patients and to implement strategies to keep patients in programs. These findings also could motivate policymakers to expand CR program capacity, as the sole program in Qatar.

Moreover, this study has revealed the issue of missing data, our recommendation is to improve the quality of data collection and entry at the program this could be achieved by collecting data directly from patients and entering these data in the system, or by following up patients either by telephone calls or mobile messages to collect the outcomes of CR. Future research should be carried out while adjusting for other patient factors such as medications, social support/family support, marital status, employment, and level of education to explore the relationship between these factors and HRQOL. The association between attendance and the other four scales of the SF-36 survey could also be explored, namely: role limitations due to physical health, role limitations due to emotional problems, pain, and energy/fatigue.

CHAPTER 6: CONCLUSIONS

In conclusion, CVD is a major public health issue worldwide. In Qatar, it is the number one cause of death among NCDs. Nowadays, due to medical advancements; more patients with CVD are living than before. Therefore, this increases the demand for the CR program as a secondary prevention tool to reduce the risk of myocardial re-infarction and its complications. Many studies showed that participation in the CR program, where the patient attends at least a certain number of sessions, was associated with better health outcomes, including improvement in HRQOL.

This observational retrospective cohort study was based on secondary data extracted from the medical records of all patients who were enrolled in the CR program at the heart hospital in Qatar over a period of five consecutive years. The study has explored the association between attending at least the median number of CR sessions and change in HRQOL scores while adjusting for other covariates such as age, gender, the risk level for cardiac events during exercise, depression, and comorbidities. HRQOL was assessed using the SF-36 survey. The study results showed statistically significant associations between attending at least the 23 CR sessions and change in physical functioning scores, change in social functioning scores, change in emotional well-being scores, and change in general health scores. In addition, there were minimal clinically significant associations between attendance and improvement in HRQOL. CR professionals should consider immediate action regarding the quality of data collected to minimize missing values. Future research should be carried out on larger sample size, addressing the other four scales of SF-36 survey, while adjusting for other factors that were not available in this dataset to explore its relationship with HRQOL, if any.

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APPENDICES

APPENDIX A: Short-Form Health Survey (SF-36)

RAND 36-Item Health Survey 1.0 Questionnaire Items

1. In general, would you say your health is:

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

2. Compared to one year ago, how would you rate your health in general now?

1 - Much better now than one year ago
2 - Somewhat better now than one year ago
3 - About the same
4 - Somewhat worse now than one year ago
5 - Much worse now than one year ago

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?
(Circle One Number on Each Line)

	Yes, Limited a Lot	Yes, Limited a Little	No, Not limited at All
3. **Vigorous activities,** such as running, lifting heavy objects, participating in strenuous sports	[1]	[2]	3
4. **Moderate activities,** such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	[1]	[2]	3
5. Lifting or carrying groceries	[1]	[2]	3
6. Climbing **several** flights of stairs	[1]	[2]	3
7. Climbing **one** flight of stairs	[1]	[2]	3
8. Bending, kneeling, or stooping	[1]	[2]	3
9. Walking **more than a mile**	[1]	[2]	3
10. Walking **several blocks**	[1]	[2]	3
11. Walking **one block**	[1]	[2]	3
12. Bathing or dressing myself	[1]	[2]	3

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?
(Circle One Number on Each Line)

	Yes	No
13. Cut down the amount of time you spent on work or other activities	1	2
14. **Accomplished less** than you would like	1	2
15. Were limited in the **kind** of work or other activities	1	2
16. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

During the **past 4 weeks**, have you had any of the following problems with your work or
other regular daily activities **as a result of any emotional problems** (such as feeling
depressed or anxious)?

	Yes	No
17. Cut down the **amount of time** you spent on work or other activities	1	2
18. **Accomplished less** than you would like	1	2
19. Didn't do work or other activities as **carefully** as usual	1	2

20. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

(Circle One Number)

Not at all 1

Slightly 2

Moderately 3

Quite a bit 4

Extremely 5

21. How much **bodily** pain have you had during the **past 4 weeks**?

(Circle One Number)

None 1

Very mild 2

Mild 3

Moderate 4

Severe 5

Very severe 6

22. During the **past 4 weeks**, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

(Circle One Number)

Not at all 1

A little bit 2

Moderately 3

Quite a bit 4

Extremely 5

Note: The WSIB acknowledges that the RAND 36-Item Short Form Health Survey was developed at RAND as part of the Medical Outcomes Study.

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks . . .

(Circle One Number on Each Line)

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
23. Did you feel full of pep?	1	2	3	4	5	6
24. Have you been a very nervous person?	1	2	3	4	5	6
25. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
26. Have you felt calm and peaceful?	1	2	3	4	5	6
27. Did you have a lot of energy?	1	2	3	4	5	6
28. Have you felt downhearted and blue?	1	2	3	4	5	6
29. Did you feel worn out?	1	2	3	4	5	6
30. Have you been a happy person?	1	2	3	4	5	6
31. Did you feel tired?	1	2	3	4	5	6

32. During the **past 4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

(Circle One Number)

All of the time 1

Most of the time 2

Some of the time 3

A little of the time 4

None of the time 5

How **TRUE** or **FALSE** is each of the following statements for you.

(Circle One Number on Each Line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
33. I seem to get sick a little easier than other people	1	2	3	4	5
34. I am as healthy as anybody I know	1	2	3	4	5
35. I expect my health to get worse	1	2	3	4	5
36. My health is excellent	1	2	3	4	5

APPENDIX B: AACVPR Stratification Algorithm for Risk of Event

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 C: Multiple Linear Regression Diagnostics

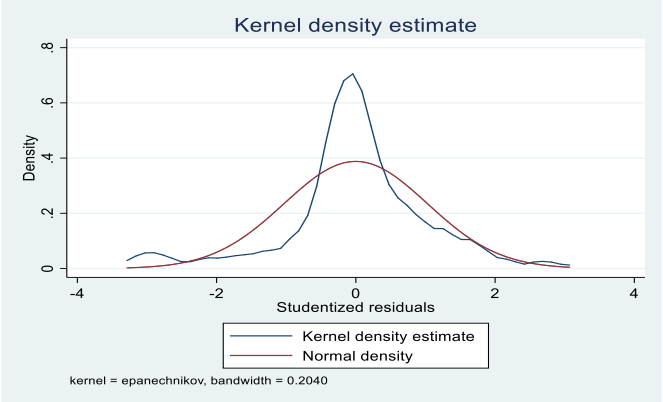

Figure 5: Kernel density plot of residuals of the change in physical functioning scores

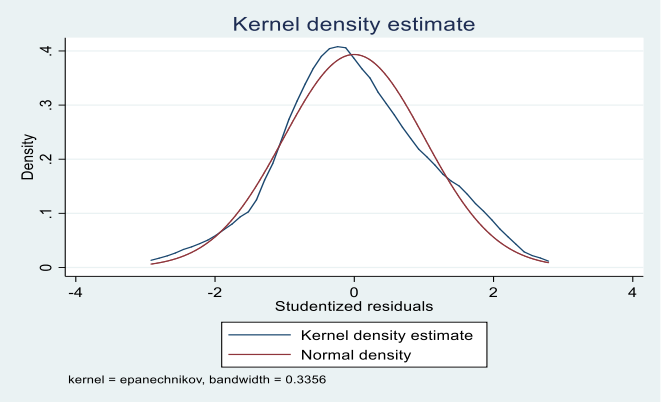

Figure 6: Kernel density plot of residuals of the change in social functioning scores

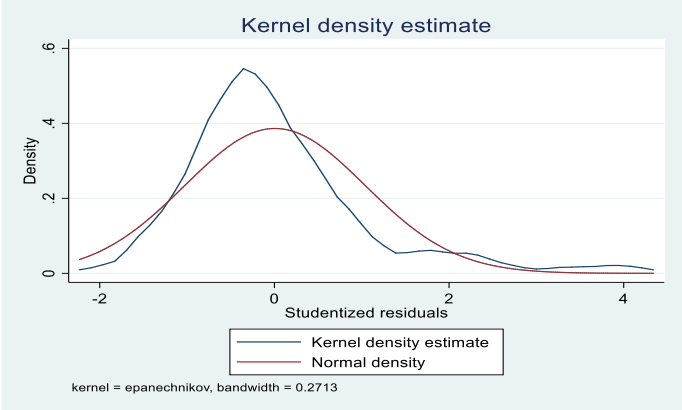

Figure 7: Kernel density plot of residuals of the change in emotional well-being scores

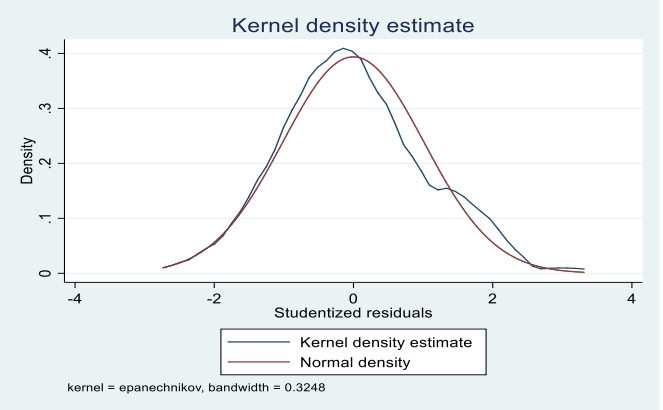

Figure 8: Kernel density plot of residuals of the change in general health scores

Variance Inflation Factor of Each Covariate:

Variable	Variance inflation factor
Attending At least the median number of sessions	3.02
	1.43
Age	1.08
Gender	
Risk level:	3.09
Moderate	3.81
High	
Depression:	1.13
Mild to moderate	1.08
Severe	1.53
DM	1.42
HTN	
Musculoskeletal disorders	1.06

Variance inflation factor of <10 indicates no issue of multi-collinearity
DM: diabetes mellitus, HTN: hypertension

APPENDIX D: Cardiac Depression Scale (CDS)

Cardiac Depression Scale (CDS)

This questionnaire consists of a number of statements about the way you feel **at present.**

Next to each statement there is a rating scale from 1 to 7 for you to indicate how much you agree or disagree with the statement

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Please indicate how strongly you agree or disagree with each statement by circling one of the numbers on the scale.

THERE ARE NO RIGHT OR WRONG ANSWERS

PLEASE ENSURE YOU HAVE COMPLETED ALL 26 ITEMS CDS

1. I have dropped many of interests and activities …	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	None dropped						All dropped
2. My concentration is as good as it ever was…	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Very poor concentration						Excellent concentration
3. I can't be bothered doing anything much…	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Keen to do things						Can't be bothered
4. I get pleasure from life at present....	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	No pleasure						Great pleasure