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FACTORS AFFECTING DOSE OF CARDIAC REHABILITATION AROUND THE GLOBE

BY

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ABSTRACT

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Title: FACTORS AFFECTING DOSE OF CARDIAC REHABILITATION AROUND THE GLOBE.

Supervisor of Thesis: Dr. Karam Turk-Adawi and Dr. Mohammed Fasihul Alam.

Background: Cardiac Rehabilitation (CR) program promotes secondary prevention of cardiovascular disease. It is well-established that there is a dose-response association between CR participation and health outcomes. However, programs around the world are of varying durations, and sessions are offered at varying frequencies in each program.

Objective: The aims of this study are to describe CR dose by country, World Health Organization's (WHO) region, country income classification and global levels; and to determine factors that could affect the dose of CR worldwide.

Method: This is a cross sectional study based on secondary data collected using Cardiac Rehabilitation Program Questionnaire developed by the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR). Analyses included descriptive frequencies for the dose. A generalized linear model (GLM) used by applying generalized estimating equations to compare the dose among WHO regions and among income country groups, and to identify program -related factors (location of the program, payment, location of the program within hospital, presence of cardiologist, number of patients served in each session, presence of other program within 20 km, presence of any

alternative models, funding of program) and patient related factors (type of diagnosis, level of risk) that might affect the dose of the CR program.

Results: There was a significant difference between the six WHO regions (p-value <0.05), Americas had the largest dose with a mean of 3263.0 ± 2631.4 minutes, and South-East Asia had the smallest dose with a mean of 871 ± 542.3 minutes. The difference in the dose among the country -income groups was not significant (p-value 0.34). The following factors, among others, were positively associated with dose (p-value < 0.05): presence of cardiologist on the CR team (multiplicative effect on the mean [MEM], 1.29; 95% CI: 1.06 to 1.57), funding the CR program by a combination of governmental organizations and private health insurance (MEM, 1.27; 95% CI: 1.03 to 1.57), number of staff in the CR team (MEM: 1.17, 95% CI: 1.01 to 1.36), number of patients per session (MEM: 1.03, 95% CI: 1.01 to 1.04), and location of CR program (MEM:1.35, 95% CI:1.01 to 1.804).

Conclusion: Both patient-related factors and organizational factors have key roles in doses of CR program. Findings of this study have important implications for the directors of CR program. These findings could guide decision-makers towards improving the dose of CR programs to achieve reductions in both mortality and morbidity associated with cardiovascular diseases.

ملخص الدراسة

المقدمة: ان برنامج إعادة تأهيل مرضى القلب يعزز الوقاية الثانوية من أمراض القلب والأوعية الدموية. ومن المعروف أن هناك علاقة بين الجرعة التي يخضع لها مريض القلب في برنامج اعادة التأهيل والنتائج الصحية من هذا البرنامج. ومع ذلك ، فإن برامج التأهيل لامراض القلب في جميع أنحاء العالم تقدم جرعات مختلفة لمرضى القلب.

الهدف الرئيسي للدراسة: تهدف هذه الدراسة إلى وصف جرعة برامج التأهيل لمرضى القلب حسب البلد و حسب أقاليم منظمة الصحة العالمية و حسب التصنيف الاقتصادي للدول حول العالم. وتهدف الدراسة الى تحديد العوامل التي يمكن أن تؤثر على جرعة برامج اعادة التأهيل لمرضى القلب في جميع أنحاء العالم.

منهج الدراسة: تعتمد على معلومات تم جمعها باستخدام استبيان برنامج التأهيل لمرضى القلب الذي طوره المجلس الدولي للوقاية من أمراض القلب وإعادة التأهيل لمرضى القلب و الأوعية الدموية. تحليل البيانات يتضمن تكرارات وصفية لجرعة برامج التأهيل. وتم تحليل البينات باستخدام النموذج الاحصائي (Generalized linear model)عن طريق تطبيق معادلات تقديرية لمقارنة الجرعة بين أقاليم منظمة الصحة العالمية وبين مجموعات البلدان حسب التصنيف الاقتصادي ، ولتحديد العوامل المرتبطة بالبرنامج التي قد تؤثر على جرعة البرنامج وهي (موقع الجغرافي لبرنامج اعادة التأهيل ، والموارد المالية للبرنامج ، و هل يقع البرنامج داخل المستشفى أم لا ، ووجود طبيب القلب في البرنامج ، عدد المرضى الذين تم تدريبهم في كل جلسة ، وجود برنامج آخر ضمن مسافة ٢٠ كم ، وجود أي برامج بديلة في المنطقة ، التشخيص الطبي للمريض ، مستوى الخطورة لدى مريض القلب).

نتائج الدراسة: أثبتت الدراسة ان هناك اختلاف كبير في جرعة برامج التأهيل لمرضى القلب بين مناطق منظمة الصحة العالمية الستة (p-value <0.05) ، وكانت أمريكا الشمالية وأمريكا الجنوبية تمتلك الجرعة الأكبر بمتوسط ٥٤ ساعة للبرنامج، وكانت جنوب شرق أسيا تمتلك الجرعة الأقل مع ١٥ ساعة للبرنامج. و أثبتت الدراسة انه لايوجد فرق في الجرعة بين المناطق المصنفة حسب الدخل الاقتصادي. وأثبتت الدراسة أن العوامل

التالية ترتبط بجرعة برامج التأهيل بشكل ايجابي و هي: وجود طبيب القلب ضمن فريق برامج اعادة التاهيل ، تمويل برنامج اعادة التأهيل من خلال المنظمات الحكومية والتأمين الصحي الخاص معاً ، عدد الموظفين في فريق برنامج الـتأهيل ، عدد المرضى في كل جلسة من برامج التأهيل ، وموقع برنامج التأهيل في المناطق الريفية.

الاستنتاج من الدراسة : ان العوامل التي أثبتت هذه الدراسة ارتباطها بجرعة برامج التأهيل لمرضى القلب لها أدوار رئيسية ومهمة في تحسين برامج الـتأهيل لمرضى القلب. هذه النتائج قد توجه مدراء برامج التأهيل لتحسين جرعات برامج التأهيل لتحقيق تنائج صحية أفضل لمرضى القلب والأوعية الدموية.

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CHAPTER 1: INTRODUCTION

Cardiovascular disease (CVD) is the first cause of death worldwide (1). In 2015, 17.7 million people died due to CVD, of which 6.7 million deaths are due to stroke and 7.4 million deaths are due to coronary heart disease. CVD's deaths contribute to 31% of all deaths worldwide and to 10% of the global burden of disease (1). About 80% of deaths of CVD happen in low and middle-income countries (LMICs) (1).

Cardiac rehabilitation (CR) program promotes secondary prevention of CVD, it is an essential health care for individuals with cardio-vascular disease (2). In 1993, the World Health Organization (WHO) defines CR as "a group of activities with the collaboration of multidisciplinary team of health professionals are required to affect the underlying cause of cardiovascular disease to maintain the patients' best mental, physical, and social conditions, so they will be able to preserve and continue their places as usual as possible in the life of their surrounding community". CR consists of social, physical, and psychological interventions that promote a healthy and active lifestyle (2). Specifically, CR consists of the following core components: initial assessment of patient, i.e. medical history, family history of CVD, behavioral risk factors (sedentary life, smoking, unhealthy food), assessment of clinical risk factors including hypertension, lipids in blood, obesity, and depression; risk factor management (e.g., smoking, hypertension, sedentary life, obesity, high levels of glucose and lipids (cholesterol, triglycerides, and low-density lipoprotein); structured exercise; patient education; and psychosocial counseling (2). CR is evidence-based program designed to address the

health needs of patients diagnosed with acute coronary syndrome, heart valve surgery, coronary artery surgery or percutaneous coronary intervention (3).

Cardiac rehabilitation program improves quality of life, reduces morbidity and mortality via reduced cardiovascular disease symptoms; improved exercise tolerance; improved cardiac function; maintained activities of daily living and decreased levels of depression, stress, and anxiety (3). A recent systematic review showed that CR reduces CVD mortality by 25% and hospital readmissions by 18 % (4). Structured supervised exercise is central to the success of CR program for patients who have acute coronary syndrome, coronary revascularization, patients who have undergone heart transplant or heart valve surgery, in addition to patients with chronic heart failure (2).

However, CR is underutilized globally, with only 38.8% of countries implementing this beneficial program(5). This global problem has triggered the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR), a non-profit organization dedicated to promote CVD prevention and cardiac rehabilitation, to conduct a global survey in 2016 characterizing cardiac rehabilitation programs and gaps in the services around the globe. The present study is based on secondary data collected by the ICCPR.

It is well-established that there is a dose-response association between CR participation and health outcomes (6). However, programs around the world are of varying durations, and sessions are offered at varying frequencies (7). Therefore, the main goal of this study is to describe the dose of cardiac rehabilitation (CR) programs

offered worldwide, and identify the factors that could affect the dose of CR globally.

CHAPTER 2: LITERATURE REVIEW

The literature review is divided into nine separated sections, the first section is about cardiovascular diseases, its burden and prevalence in the world, second section addresses risk factors of CVD with a focus on physical inactivity as a risk factor, third section focuses on the relationship between physical activity and CVD, fourth section explains the recommended level of physical activity for CVD's patient to achieve the outcomes, fifth section is an introduction about cardiac rehabilitation program, sixth section explains the component of CR program, seventh section explains the phases of CR program, the eighth section focuses on the benefits of participation on CR program and finally the last section focuses on the variation in the number of sessions offered in CR programs worldwide and the factors that could affect the dose of CR programs.

Cardiovascular Disease, Burden and Prevalence:

CVD is a group of abnormal conditions that affect body vessels (vascular) and heart (cardio) (8). CVD includes abnormal conditions in the function and/or structure of the heart (i.e. cardiomyopathy, rheumatic heart disease and heart failure) or abnormal condition of the blood vessels such as: coronary heart disease (CHD) and peripheral vascular disease (8).

Cardiovascular Disease is the first cause of death worldwide (1). In 2015, 17.7 million people died due to CVDs which is equal to 31% of all deaths around the world (1). The majority of these deaths (7.4 million) were due to coronary heart disease, and

6.7 million deaths were due to stroke (1). This number is expected to increase 23.6 million by 2030. Cardiovascular diseases (CVD) continue to be the number one killer worldwide (9).

Risk Factors of Cardiovascular Disease:

Several risk factors can increase the risk of CVD (10). Risk factors are classified to non-modifiable risk factors and modifiable risk factors. Non-modifiable risk factors include age, family history, gender, and race. Males tend to have heart attacks earlier in life than females (11). A family history of stroke or coronary heart disease increases the risk of CVD (11).

The modifiable risk factors include: alcohol, hypertension, physical inactivity, hyperlipidemia, overweight, tobacco smoking, and low fruit and vegetable intake (10). The two types of diabetes mellitus are also considered as major risk factors, 60% of death in diabetic patients is caused by CVD (10). Physical in-activity is considered a major risk factor for mortality in the globe and around 5.2 million deaths of all causes in 2008 are due to physical in-activity (12). Many studies revealed that high sedentary life style and low physical activity levels have an impact on adverse outcomes of health (12), therefore the core idea of CR is to raise the level of physical activity among patients with CVD to reverse mechanism of disease.

Cardiovascular Disease and Physical Activity:

CR program is based on the concept that health outcome is affected by the amount or dose of physical activity (7). Dose is determined by multiplying the frequency with the

duration (7). Frequency is the number of sessions performed per week multiplied by number of weeks in the CR program (2). Duration is the time of each individual session of physical activity (2).

Cardiorespiratory fitness is the capability of the heart and lung to supply oxygen to the muscles of the body during physical exercise (13), cardiorespiratory fitness have a protective effect because it decreases the risk of morbidity and mortality from CVD (14). Persons who are actively engaged in a suggested level of physical activity, at least 150 minutes per week of modest to strong exercise (15), have a decreased mortality risk for all causes of death (12). However, around 31% of the population in the world does not meet the suggested levels of physical activity (16).

A study done by Warburton in 2006 showed a proof of a linear association between CVD and level of physical activity, as level of physical activity increased the risk of CVD decreased (14). As per the World Health Organization (WHO), 85% of chronic diseases like CVD can be prevented by healthy diet and regular exercise (15). A study comparing the mortality risk among 242,397 individuals, based on their engagement in physical activity, revealed that all-causes of mortality was less by 27% for people without any co-morbidities, and less by almost 50% in those with chronic co-morbidities who engaged in a suggested level of physical activity (17).

In order to maintain and promote health, the American Heart Association (AHA) and the American College of Sports Medicine (ACSM) encourage all individuals who are 18 to 65 years to engage in at least 30 minutes of modest intensity of physical activity

five days per week or at least of 20 minutes of strong-intensity of physical activity in three days per week (18).

Many studies provided evidence on the association between CVD and physical activity. For example, a cohort study included 44,452 professional healthy males, their age ranged from 40 to 75 years and they were followed for 12 years at 2-year intervals, revealed that increasing level of physical activity resulted in decreasing level of risk of CHD in a dose-response relationship (19). The similar dose-response relationship between CVD and physical activity risk was also found in Haskell et al (18).

Recommended Level of Physical Exercise for Patients with Cardiovascular Disease:

The recommended levels of physical activity by American College of Cardiology and American Heart Association for patients with cardiovascular disease are as following:

- Assess the patient risk with exercise by history and exercise test to help for determine the suitable level of physical activity (20).
- All patients are encouraged to engage in modest intensity of physical activity for 30-60 minutes per day, for example: brisk walking for five days per week (20).
- Patients with low risk for adverse event are encouraged to engage in resistance training sessions 2 times per week (20).
- Patients with high-risk are encouraged to participate in medically supervised program (e.g. recent myocardial infarction or revascularization) (20).
- Patients with CVD are encouraged to participate in cardiac rehabilitation program

in order to improve their levels of physical activity (20).

Cardiac Rehabilitation:

Cardiac rehabilitation is based on the advantages of physical activity in reducing the risk of CVD. In 1930, patients with acute coronary conditions were encouraged to be bed rest for 6 weeks (21). In the early 1950, a short walk for 3 to 5 minutes per day was encouraged for 4 weeks after the acute coronary condition, then it was noticed that early ambulation did not increase risk of coronary conditions but it prevent many complications of bed rest (21).

In 1968, a published study showed strong evidence for the benefits of early exercise and the adverse effect of bed rest for long time (21). The establishment of the physiologic basis of the benefits from exercise by many researchers, result in the development of Cardiac rehabilitation program to help cardiovascular patients optimize and recover their functional status (21).

In 1993, the World Health Organization (WHO) defines CR as "a group of activities with the collaboration of multidisciplinary team of health professionals are required to affect the underlying cause of cardiovascular disease to maintain the patients' best mental, physical, and social conditions, so they will be able to preserve and continue their places as usual as possible in the life of their surrounding community" (22).

CR promotes secondary prevention of CVD and it is the essential core component of care for all individuals with CVD (2). CR is designed mainly to patients who

developed an acute coronary syndrome, heart valve surgery, coronary artery surgery or percutaneous coronary intervention (3). It consists of physical, social and psychological interventions that promote a healthy and active lifestyle (2). Several systematic reviews showed that CR is a cost-effective model of care (23) that reduces CV mortality by up to 25% and hospital readmissions by about 18% (4), (24), (25), (26), (27), (28).

CR achieves these benefits through its' core components, which are internationally agreed, namely initial assessment, risk factor management (e.g., diet, smoking, hypertension, physical activity), structured exercise, patient education, and psychosocial counseling (2).

Structured supervised exercise has been identified as being a core to the success of cardiac rehabilitation for individuals with acute coronary syndrome, revascularization of coronary arteries, patients who have undergone heart transplant or heart valve surgery, in addition to patients with chronic heart failure (2).

Core Components of Cardiac Rehabilitation Program:

As per the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation, cardiac rehabilitation program includes the following core components:

- Patient Assessment: Medical History, complete physical Examination, obtains resting 12-lead electrocardiogram (ECG)(2).
- Nutritional Counseling: obtain dietary contents and calculate an estimation of total calorie intake per day, assess eating habits and alcohol consumption, and

prescribe specific dietary modifications (2).

- Weight Management: measure waist circumference, height and weight. Obtain the body mass index (BMI). Develop program that includes intervention for physical activity and diet to maintain ideal weight or to reduce over weight (2).
- Blood Pressure Management: measure blood pressure while resting on two different visits and assesses current treatment and compliance. Encourage for changes in lifestyle such as smoking cessation, sodium intake restriction, weight management, and regular physical exercise (2).
- Cholesterol Management: obtain complete lipid profile after fasting for 8 to 12 hours. Assess the treatment of the patient and his compliance. Provide advice for diet modification consistent with the current treatment (2).
- Diabetes Management: test blood sugar level before and after each exercise. Obtain fasting blood glucose and glycosylated hemoglobin (HbA1c). Avoid physical exercise at peak insulin times. Educate staff and patient about signs of hypoglycemia and how to provide appropriate interventions (2).
- Tobacco Cessation: assess the patient's status of smoking and if he or she use other tobacco products. Specify how many cigarettes per day and duration of smoking. Develop and implement plan for smoking cessation (2).
- Psychosocial Management: assess for symptoms of psychological distress such as social isolation, anxiety, depression, anger, and drug abuse. Offer individual and small group counseling on stress management and lifestyle changes (2).
- Physical Activity Counseling: assess current status of physical activity relevant to

gender, age and daily life, such as sports, household tasks, driving, and gardening. Provide counseling about the needs of physical activity. Modified exercise program to meet the need of individual. Encourage patients to engage on 30-60 minutes per day of mild to moderate intensity physical exercise for five days per week (2).

- Exercise Training: perform symptom-limited exercise testing before participation in any exercise. Testing parameters should include assessment of signs and symptoms, blood pressure, heart rate, ST-segment changes in the 12-lead electrocardiogram (ECG), capacity of exercise and perceived exertion. Classify the patient according to the level of risk to determine the required level of for the exercise training program. Follow risk stratification system as recommended by the American Association of Cardiovascular And Pulmonary Rehabilitation and the American Heart Association (2). Based on the findings of the evaluation and risk classification of patients, a modified exercise prescription of aerobic and resistance training. The modified exercise program should be evaluated by referring physician or the program medical director. The exercise prescription should include duration modalities, duration, frequency, intensity and progression (2). For aerobic exercise: duration (20-60 minutes), frequency (3 to 5 days/week); intensity (50-80%) of capacity of the exercise; and modalities: walking, stair climbing, treadmill, and cycling (2). For resistance training: frequency (2 to 3 days/week); intensity of 10-15 repetitions per set to moderate fatigue; duration (1-3 sets of different lower and upper body exercises); and modalities, weight

machines, dumbbells, elastic bands, and free weights (2). Modify the prescription of exercise according to the changes of the clinical status. Exercise includes flexibility exercises, warm-up, and cool-down, in each exercise session (2).

Phases of Cardiac Rehabilitation:

There are four phases for CR program:

- Phase I: starts in the hospital immediately after a cardiac event. A member of CR team provides the patient and his family with information regarding the disease, risk factors, medications and social issues. Also, they discuss the importance of lifestyle changes and the appropriate level of activity for the patient (29).
- Phase II: starts 4-6 weeks after discharge of patient from the hospital. The main goal is to help patients to comply with the lifestyle changes recommended in Phase I (29).
- Phase III: consists of 6-12 weeks supervised exercise classes and education about cardiac anatomy and physiology; symptom management; medication, stress management, risk factors management, behavior modifications, smoking cessation, healthy diet, physical activity, daily living activities; and sexual activity. Before starting Phase III program, patients will be examined by stress test for exercise to determine the capacity for exercise. The main area of interest in this research study is the dose of phase III with a focus on exercise during cardiac rehabilitation program (29).
- Phase IV: The main goal is to help patient to maintain the recommended changes

in the life style implemented in the previous three phases (29).

Benefits of Participation in Cardiac Rehabilitation:

Participation in cardiac rehabilitation program has many clinical, psychological, and behavioral outcomes, i.e. prevents recurrence of disease, relieves symptoms, improves cardiac function, decreases level of anxiety and depression; promotes management of stress, increases compliance with physical activity and ceases smoking. In addition, participation in CR program improves quality of life, and reduces morbidity and mortality.

A study done by Sharif (2012) showed that participation in cardiac rehabilitation program resulted in improvement in the physical level and decrease level of depression after 2 months from coronary artery bypass grafting surgery (30). Further, mortality rates from myocardial infarction have significantly decreased after participation in CR program (23-27, 30). Systematic reviews and meta- analysis showed a significant reduction in all-cause mortality by 13%-26%, cardiac mortality by 20%- 36%, myocardial re-infarction by 25%-47% (23-27). In many studies, improved quality of Life was documented as a result of participation in cardiac rehabilitation programs (32) (33). For example, a systematic review carried out to identify the efficiency of cardiac rehabilitation on health related quality of life (HRQOL), morbidity, and mortality of individuals with coronary heart disease (25). The review was carried out by the Cochrane Collaboration, which searched for seven databases (using The Cochrane Library Issue 4, 2009), EMBASE (1980 - December 2009), CINAHL (1982 - December 2009), Expanded

Science Citation Index (1900 - December 2009) in addition to MEDLINE (1950 - December 2009). Results showed a reduction by 13% in mortality among participants with cardiovascular condition who have medium to long period of follow up in cardiac rehabilitation (≥ 12 months) and reduction in hospital readmissions by 31% in short period of follow up in cardiac rehabilitation (< 12 months). From ten studies measuring the HRQOL, seven studies showed greater level of HRQOL after participation in CR compared to normal care groups (25)..

Many studies showed that participation in cardiac rehabilitation led to improvement in the level of exercise tolerance and physical activity, improvement in blood lipid level, reduction in symptoms, decreased rate of cigarette smoking, improvement of stress management and psychosocial well-being, decreased rates of recurrence cardiac events, reduction of the atherosclerotic process, reduction in hospitalization, readmission and in the mortality and morbidity (3), (26), (34).

Number of CR Sessions:

The optimal number of sessions to achieve the benefits outlined above is not known, though some national guidelines recommend a minimum number of sessions (6). Still, it is well-established that there is a strong dose-response association between cardiac rehabilitation sessions and long term outcome, and lower risk for mortality and myocardial infarction (6). Comprehensive cardiac rehabilitation programs around the world are of varying durations, and sessions are offered at varying frequencies (35). For example, in a recent meta-analysis the recommended duration ranged from a minimum of

3 weeks in Germany (although this is often residential) to a maximum of 12 months in Austria (7). The frequency recommended by the American Association of Pulmonary and Cardiovascular Rehabilitation, as well as the European and Canadian Associations for Cardiovascular Rehabilitation and Prevention is a minimum of 3 sessions per week, whereas guidelines for Austria, Australia, Japan and the United Kingdom recommend 3 or fewer per week (7).

It appears that the total number of sessions in CR program is generally based on reimbursement policies (36) funding requirements and past practice (35). A number of studies in the literature found that the more CR sessions patients receive, the better their outcomes (37)(38)(6). A meta-analysis showed that patients exposed to longer CR duration, i.e. 3 or more months, had significantly lower CVD mortality by 36% and lower risk of recurrent myocardial infarction by 47% (24). A recent meta-analysis recommended a minimum of 12 sessions to reduce mortality and 36 sessions to reduce percutaneous coronary interventions among patients with coronary heart diseases (6).

In a systematic review and meta-analysis of the effect of cardiac rehabilitation dose on mortality and morbidity, it is demonstrated that a standard dose of 3 sessions / week over 12 weeks (i.e., 36 sessions),in the United States, is associated with reduction in risk of morbidity and mortality from CVD (7).

On the other hand in the United Kingdom where the dose is much lower at around 10 sessions, a multi-center randomized controlled trial in representative hospitals, in England and Wales, compared 1813 patients referred to comprehensive cardiac rehabilitation programs with those with ‘standard care’ (medication without referral to

cardiac rehabilitation) reported a lack of benefit (39). Programs generally use higher dose in North America than in Europe (7).

Findings from a number of studies suggest that CR as delivered in the United States (i.e., 36 sessions) (7) and Ontario, Canada (i.e., 40 sessions) (7) is sufficient to achieve the reduction in mortality and morbidity if patients adhere to their prescribed program (4). However, CR as delivered in parts of Europe and the United Kingdom may not be sufficiently intense (39). It is well established that the minimum duration of CR in the United Kingdom is 8 weeks (frequency is not specified)(39).

There is lack of studies on the recommended minimum dose of a CR program in terms of minutes. To the best of our knowledge, there is only one study that provided a minimum dose of CR programs and in specific diagnosis. This is a Cochrane systematic reviews, which showed that patients who had 1000 or more minutes had significantly lower CVD mortality of 25% and myocardial infarction (MI) of 26% (4). To the best of our knowledge, there are no evidence based recommendations on what dose should be offered to patients to achieve optimal clinical outcome. This variation significantly affects costs to deliver CR, capacity to serve patients, and outcomes achieved. Results also suggested that duration or frequency of sessions by themselves did not impact outcomes, but total dose was what mattered (7). Still, there is no study that describes and characterizes doses of CR globally. Additionally, there is lack of data on factors affecting CR dose. These factors can be either organizational (factors related to the program itself) or patient's factors (factors related to patient, e.g. diagnosis and level of risk). This variation in the dose of CR delivered significantly affects the clinical outcomes.

CHAPTER 3: RESEARCH QUESTIONS, HYPOTHESES, AND OBJECTIVES

Research Questions:

The main research questions of this study are:

1) What is the current dose of CR at country, WHO-region and global levels?

2) What are the potential factors that could affect CR dose globally?

Research Hypothesis:

The dose of Cardiac Rehabilitation program (number of sessions of exercise offered per week multiplied by number of weeks per program, multiplied by number of minutes per session) is associated with factors related to the CR program and with factors related to the patient.

Sub-hypotheses:

- The dose of cardiac rehabilitation program is positively associated with governmental funding of cardiac rehabilitation program.
- The dose of cardiac rehabilitation program is negatively associated with patient's level of risk, i.e patients with higher risk of developing another cardiac event have lower doses.
- The dose of cardiac rehabilitation program is positively associated with the number of staff in the CR team.

Theoretical Framework & Conceptual Framework:

Theoretical Framework:

Our study used the Andersen framework (40) as a conceptual framework to identify the factors that could affect the dose of cardiac rehabilitation program. The Anderson model was used by many investigators to investigate utilization of health care services. The model was developed in the 1960s, and since it has gone through four phases (40). The purpose of this model is to identify factors that either facilitate or inhibit utilization of health care services. The framework consists of four components: environmental factors, population characteristics, individual's health behavior, and health outcomes (Figure 1). According to this model, environmental factors affect the individual characteristics both directly and indirectly through the health care system.

Inclusion of the health care system emphasizes the importance of organization, health care policy and resources in the health care system as factors of the population's use of health care services (40). The two main components of health care system are the organization and resources, which together form the source of health care services to individuals. The resources of health care system consist of funds and labor, such as equipment, materials and medical staff, and the structures in which health care services are provided. Organization is the second dimension, describes the process of controlling resources while providing medical services. Organization consists of access and structure. The access represents the processes through which the patient can get access to health care services and obtain treatment. The structure represents characteristics of the

health care system responsible for the process after the patient gets access to the health care system, such as medical practices of medical professionals, referral process to other health care facilities, characteristics of hospital or health care facility, and the delivery of health care services after getting admission to health care facility.

The second component of this model is population characteristics, which describe the individual level. It consists of three elements: predisposing factors, need factors and enabling factors. Predisposing factors represent demographic factors, such as gender, age and social structure, such as ethnicity, occupation, social network and education. Enabling factors represent availability and accessibility of health care services, such as income and health insurance. Need factors represent how people perceive their own health in order to seek medical care. The third component of this model is health behaviors, such as exercise diet, self-care and smoking that influence the use of health care services and health outcomes. Finally, the fourth component is the health outcomes which represent the dynamic nature of the health care utilization model and the health outcomes (perceived health status, patient satisfaction, and health status evaluated by medical staff,) affects predisposing, enabling and need factors, in addition to health behavior.

Our thesis focused on the health care system because our purpose is to identify the organizational factors that might have an effect on the dose of CR program.

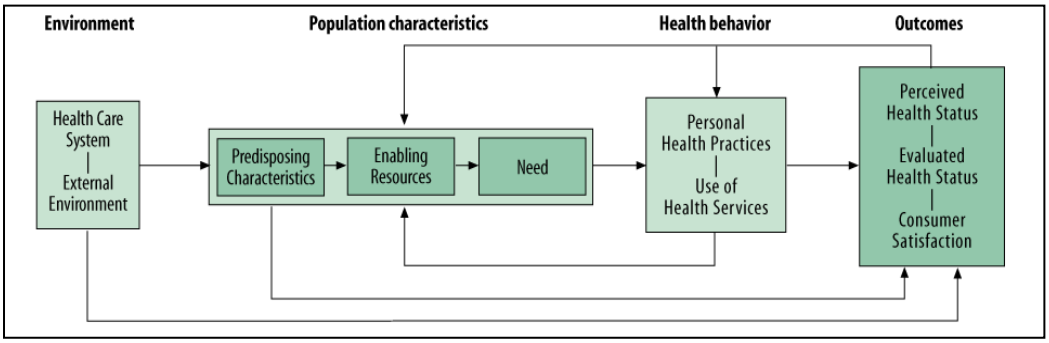

Figure (1): Andersen framework for utilization of healthcare(40)

Conceptual Framework:

Many factors affecting the dose of CR program, this study highlighted the health care system: processes and structure while controlling for population characteristics (figure 1). This study examined the organizational factors of CR and factors related to patient that might affect the dose of the CR offered to patients. It investigated the following organizational factors: presence of cardiologist on the CR team (yes/no); who pays for cardiac rehabilitation (combination / private / public); individual consultation with a physician during the program (yes / no); geographical location of CR program (rural area or countryside, i.e. a geographic area that is located outside towns and cities, or suburban, i.e. a residential district located on the outskirts of a city, or urban area, i.e. larger cities, towns, location of CR within hospital (yes / no); availability of another CR program within 20km (yes / no); CR program offer alternative models of program delivery than an on-site program (yes / no); number of patients in each exercise session; and number of staff on the CR team. , the factors related to the patient that might affect the dose of CR program include: type of diagnosis, level of risk.

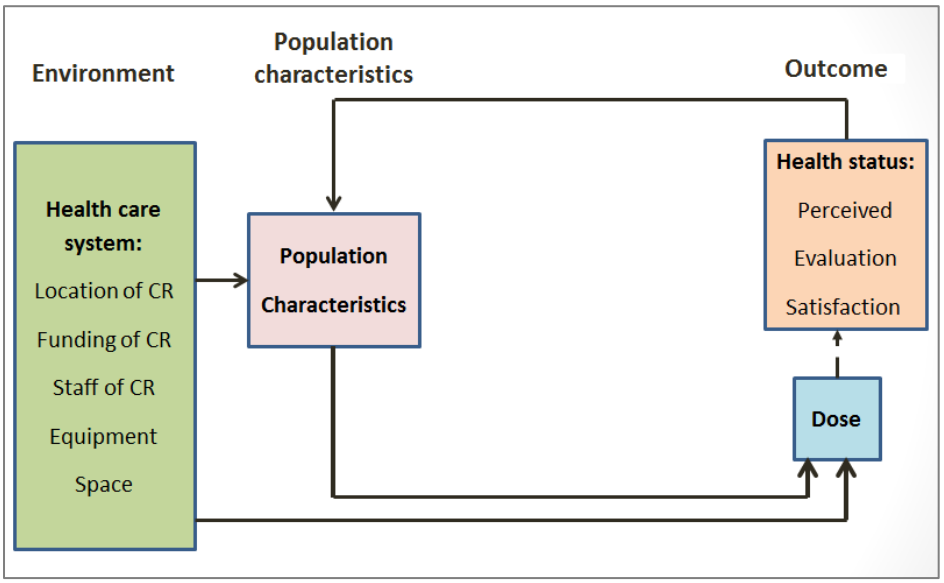

Figure (2) conceptual framework for cardiac rehabilitation

Objectives:

The objectives of the study are:

1. To describe the doses of CR programs at country level, WHO regional level, country income classification groups and globally.
2. To compare doses of CR program offered within the six WHO designated regions: African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region.
3. To compare the dose of CR program between high income, middle income and low income countries.
4. To identify potential factors that could affect the dose of CR programs worldwide.

CHAPTER 4: METHODOLOGY

Design & Procedure:

This is a cross sectional study based on secondary data collected using Cardiac Rehabilitation Program Questionnaire developed by the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR).

Ethical Consideration:

The study was approved by Qatar University Institutional Review Board, (IRB: QU-IRB 870-E/18).

Source of Data:

As per ICCPR team, data were collected from June 2016 to July 2017 through REDCap by the ICCPR team using Cardiac Rehabilitation Program Questionnaire. Items of the questionnaire were based on previous national CR program surveys. The investigative team underwent a process of integration and cleaning of overlapping content. The questionnaire was pilot-tested in the Arab world and Canada. It was then revised based on responses; i.e. some questions have been slightly revised to improve clarity. The final questionnaire was translated to Portuguese, Spanish, and Mandarin. The translated questionnaire was reviewed by a national champion with the corresponding first language. The translations underwent several review process including back translation to English to verify its linguistic validation or accuracy of concepts in the translated questionnaire(41).

Countries where CR services were available were identified first through previous reviews and search of: MEDLINE, EMBASE and Google Scholar for articles or abstracts on CR. For countries where no CR program was in evidence, the ICCPR team used the following strategies: (a) searched for term "cardiac rehabilitation and country" using internet via Google, (b) searched Google for hospitals within these countries, which were then searched for CR programs, (c) a snowball sampling strategy was used by the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR) members and key informants in the field (including European Society of Cardiology national CVD prevention coordinators), as well as (d) attended international conferences of relevant societies to approach experts in the given countries. Finally, before any country was designated as having no CR, international societies (e.g., International Society of Physical Medicine and Rehabilitation, European Association of Preventive Cardiology, African Heart Network) were contacted to ascertain whether there were any CR programs in countries where we lacked confirmation of availability(41).

For each country identified to offer CR, first, available CR or cardiac societies leadership were contacted to ascertain number of CR programs in their country and to facilitate administration of the survey. If there was no society available, senor leaders for the CR were identified from the peer-reviewed, or secondly, grey literature / the web. Identified leaders were sent an e-mail requesting their assistance administering the survey to each program in their country. The identified senior leader at each CR program was emailed requesting their completion of the survey. Informed consent was secured through an online form(41).

To improve response rate, leaders were sent two e-mail reminders at two-week interval. The national contact was provided with the response rate after four weeks following the initial administration. If the response rate was <40%, they were invited to suggest other approaches to improve the response rate; this often involved personally calling programs to ascertain whether they were aware of the survey, and to request completion if they had not done so already(41).

To verify the responses, collected data were cleaned by members of the ICCPR before being disseminated to any party. The ICCPR members also checked variables for outliers. Where implausible entries were suspected, representatives of relevant countries were contacted to verify such suspicious measures(41).

Target Population:

The sample consisted of all CR programs identified in countries worldwide that offer services to patients following an acute cardiac event or hospitalization.

Sample Size:

Number of CR programs participated=1082 from 93 countries out of the 111 countries implementing CR programs.

Measures:

There are two measures:

1. Dependent Variable: The dose in minutes that offered by the CR program which is the number of sessions of exercise per week multiplied by number of weeks per program multiplied by number of minutes per session in each program.

2. The independent variables included both organizational and patient-level variables. Factors related to the organization (program) were: presence of cardiologist on the CR team (yes/no); who pays for cardiac rehabilitation (combination / private / public); individual consultation with a physician during the program (yes / no); geographical location of CR program (rural area or countryside, i.e. a geographic area that is located outside towns and cities, or suburban, i.e. a residential district located on the outskirts of a city, or urban area, i.e. larger cities, towns, location of CR within hospital (yes / no); availability of another CR program within 20km (yes / no); CR program offer alternative models of program delivery than an on-site program (yes / no); number of patients in each exercise session; and number of staff on the CR team. The patient-related factors included mainly patient diagnosis accepted in the CR program, i.e. post-myocardial infarction/acute coronary syndrome (yes / no), stable coronary artery disease (yes / no), post percutaneous coronary intervention (PCI) (yes / no), post coronary artery bypass graft surgery (CABG) (yes / no), heart failure (yes / no), heart transplant (yes / no), arrhythmias (hemodynamically-stable) (yes / no), cardiomyopathy (yes / no), patients at high-risk of cardiovascular disease (primary prevention) (yes / no), level of cardiac risk accepted in the CR program (high / moderate / low).

Data Analysis:

SPSS 24 were used for data analysis. To achieve the first objective (describe the dose at different levels: country level, WHO region level and global level), descriptive analysis was carried out, i.e. count, percentage, mean, standard deviation (SD), median, and interquartile range (IQR). The mean was used to describe CR dose at country level,

and the median was used to describe the dose at regional and global level due to large variation among countries within the same region.

For the second objective (comparison of dose by the WHO-region and by income country group), differences in dose among different WHO regions and among different income groups were examined via, generalized linear model by applying the Generalized Estimating Equations (GEE) and pairwise comparison. We conducted GEE to account for clustering of countries within WHO regions and within income country groups because the within region intra-class correlation coefficient was 0.059, the dose of CR program in minutes was the dependent variable and the region was the independent variable. The dependent variable (dose of CR program) was continuous positively skewed as shown in figure 3, the mean of the dose was 2227.42 minutes and the variance was 10252751.95 minutes, therefore we used gamma distribution with log link function which is suitable for positively skewed outcome.

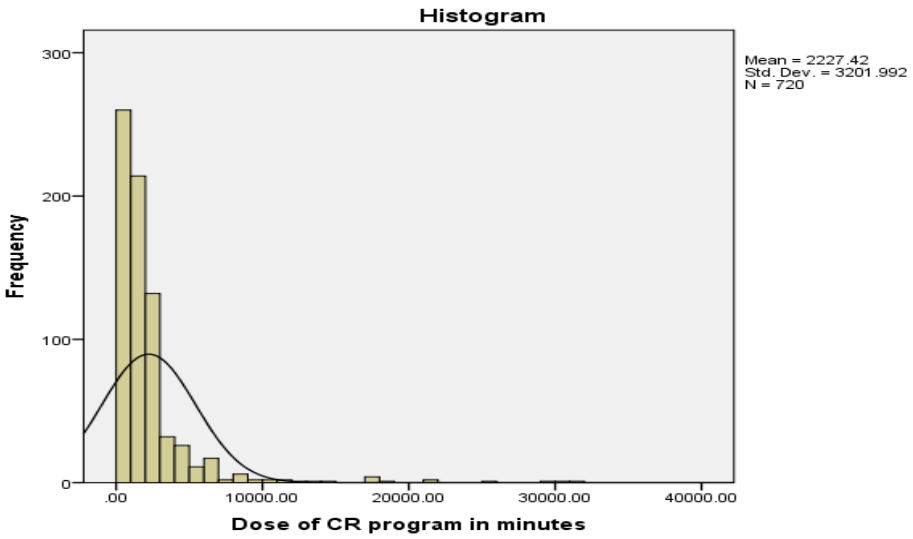

Figure (3) Distribution of the dependent variable (dose of CR program in minutes)

We used the independence working correlation matrix in the GEE analysis the quasi-likelihood under independence model criterion (QIC) of the comparison model using this correlation matrix was 556.582, which is equal to (QIC) of the same model using exchangeable correlation matrix, therefore we used the independence correlation matrix to assume that countries within the same region are independence.

To achieve the third objective (factors affecting the dose), we conducted GEE procedure to account for clustering of CR programs within countries because the within country intraclass correlation coefficient (ICC) indicated clustering issues (ICC= 0.115), and we used manual stepwise backward variable selection to find the parsimonious model, which kept only significant predictors of the outcome, i.e. dose. QICC was used as measure of goodness of fit to choose the best model with significant predictors during the manual stepwise backward variable selection procedure, QICC of model was

compared with the QICC of the nested model after dropping the non-significant predictor one at a time, the model with lower QICC being better fit. In addition to that goodness of fit was assessed by the distribution of residual via histogram and scatterplot of Pearson residual against the predicted values of the dependent variable (dose of CR program). The GEE procedure provides estimates of regression coefficients and their standard errors. We reported the multiplicative effect on the mean (MEM) because we used gamma distribution with log link function as the dose, dependent variable, was a continuous positively skewed variable as shown in figure 3 (42)(43).

For the model with the significant predictors we used the independence working correlation matrix in the GEE analysis, the corrected quasi-likelihood under independence model criterion (QICC) of the comparison model using this correlation matrix was 437.206, which is equal to (QICC) of the same model using exchangeable correlation matrix, therefore we used independence correlation matrix to assume that CR programs within the same country are independence.

The independent variables included both organizational and patient-level variables. Factors related to the organization (program) were: presence of cardiologist on the CR team (yes/no); who pays for cardiac rehabilitation (combination / private / public); individual consultation with a physician during the program (yes / no); geographical location of CR program (rural area or countryside, i.e. a geographic area that is located outside towns and cities, or suburban, i.e. a residential district located on the outskirts of a city, or urban area, i.e. larger cities, towns, location of CR within hospital (yes / no); availability of another CR program within 20km (yes / no); CR

program offer alternative models of program delivery than an on-site program (yes / no); number of patients in each exercise session; and number of staff on the CR team.

The patient-related factors included mainly patient diagnosis accepted in the CR program, i.e. post-myocardial infarction/acute coronary syndrome (yes / no), stable coronary artery disease (yes / no), post percutaneous coronary intervention (PCI) (yes / no), post coronary artery bypass graft surgery (CABG) (yes / no), heart failure (yes / no), heart transplant (yes / no), arrhythmias (hemodynamically-stable) (yes / no), cardiomyopathy (yes / no), patients at high-risk of cardiovascular disease (primary prevention) (yes / no), level of cardiac risk accepted in the CR program (high / moderate / low).

CHAPTER 5: RESULTS

Dose Globally and by Country Income Groups:

As shown in Table 1 the global median (interquartile range) duration of CR program in terms of minutes was 1440 (interquartile range (IQR) of 1028.7 – 2778.6) minutes. As shown in Figure 3, high income countries, the median duration in minutes of CR program was 1508.7 (IQR: 1190 -2844.3) minutes which is higher than that for middle income countries 1230 (IQR: 648.5 - 2561.7) minutes per CR program , there were no data available for the dose of CR program for low income countries.

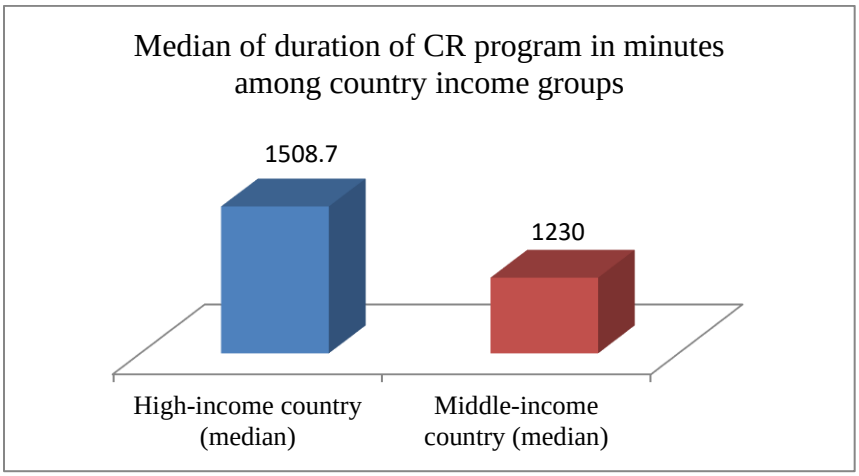

Figure (3) Median duration of CR program in minutes among country income groups

In terms of week, the global median of duration of CR programs was 9.2 (IQR: 6.0-13.8) weeks. As shown in Figure 4, the median number of weeks per CR program in high income countries 9.6 (IQR: 7.9 - 13.1) weeks was higher than the median number of weeks in middle income countries 7.8 (5.2 - 15.8) weeks which was higher than the

median number of weeks in low income countries (6 weeks per CR program). Globally, 24.4% of the countries had a program length of <1000 minutes.

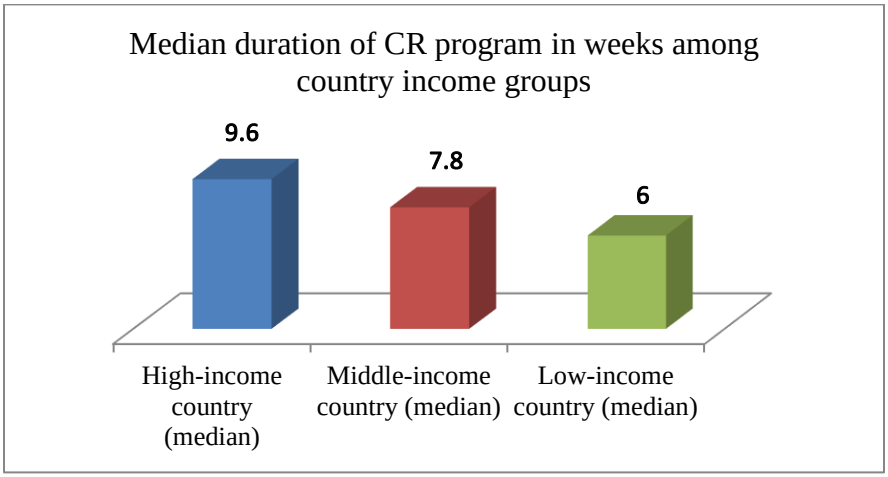

Figure (4) Median duration of CR program in weeks among country income groups

Dose at WHO Regional Level:

Comparing number of minutes per CR program among the six WHO regions the median number of minutes per program as shown in Table 1 and Figure 5 was higher for Americas 2941 (IQR: 1352.6 -4086.9) minutes , followed by Europe 1440 (IQR: 1042.8 - 2471.7) minutes and Eastern Mediterranean 1440 (IQR: 815 -1828.8) minutes , then Africa 1320 (IQR: 1020 -1620) minutes , followed by Western Pacific 1077 (IQR: 976 - 1200) minutes , then South-East Asia with the shortest 696.7 (IQR: 650 -1293.3) minutes per CR program.

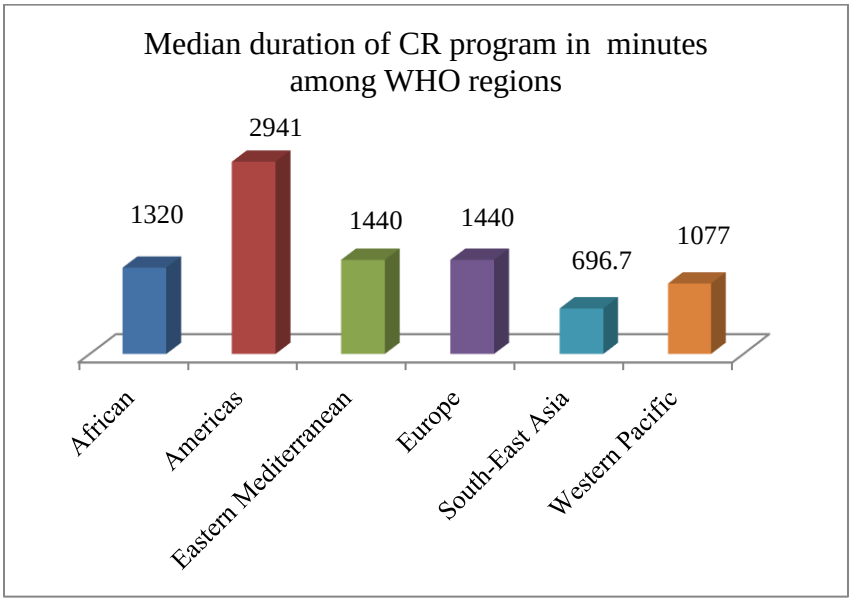

Figure (5) Median duration of CR program in minutes among WHO regions

Comparing number of weeks per program among the six WHO regions, as shown in Figure 6 the median number of weeks was higher in Americas with 14.1 (IQR: 12-20.8) weeks followed by Africa 11 (IQR: 8.5-13.5) weeks, Europe 8.9 (IQR: 5.5-10) weeks, Eastern Mediterranean 8 (IQR: 6.5-8.9) weeks, Western Pacific 7.9 (IQR: 6.8-12) weeks and South-East Asia 6.8 (IQR: 5.8-8.3) weeks.

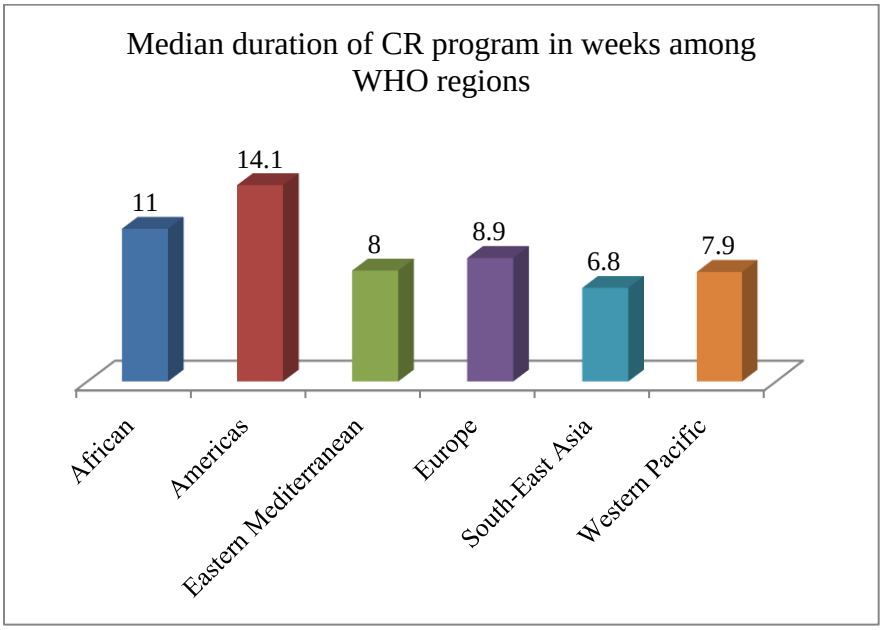

Figure (6) Median duration of CR program in weeks among WHO regions

Dose at Country Level:

The mean number of minutes per CR program was lowest in Bosnia and Herzegovina with 90 minutes per CR program, while Peru had the highest mean number of minutes 11073.9 minutes per CR program. Bangladesh had the least program duration in weeks, with one week per CR program, while Israel had the largest program duration in weeks with 42 weeks per CR program.

In African regions, two countries participated only; the highest dose of CR program among these two countries was in Nigeria with 1920 minutes. In Americas, 21 countries participated; the highest dose was in Peru with 11073.9 minutes per CR program. In Eastern Mediterranean region, 6 countries participated; the highest dose was in Tunisia with 2400 minutes per CR program. In Europe, 35 countries participated; the

highest dose was in Slovenia with 10560 minutes per CR program. In South-East Asia, five countries participated; the highest dose was in India with 1535.2 minutes per CR program. In Western Pacific region, 9 countries participated; the highest dose was in Taiwan with 1577.4 minutes per CR program.

Table 1

Dose of available cardiac rehabilitation program by country, WHO regions and country income classification

Region Country	Income Classification	number of program in countries	Number of responses	Average Duration in Weeks	Total Duration in Minutes	Rank (1 is greatest)
African (8 countries)						
Algeria	MIC	1	1 (100%)	NA	NA	NA
Benin	LIC	1	0	NA	NA	NA
Kenya	MIC	3	1(33.3%)	6	720	65
Mauritius	MIC	1	1 (100.0%)	NA	NA	NA
Nigeria	MIC	1	1 (100.0%)	16	1920	28
South Africa	MIC	23	14 (60.7%)	NA	NA	NA
Tanzania	LIC	1	0	NA	NA	NA
Uganda	LIC	1	0	NA	NA	NA
Mean ± SD			2.0 ± 5	11 ± 7.1	1320 ± 848.5	
Median (IQR)			1 (0-1)	11 (8.5-13.5)	1320 (1020-1620)	
n (%)countries < 1000 minutes	1(50.0%)				1(50.0%)	
n (%)countries ≥12*sessions*	1 (50.0%)					
Americas (28 countries)						
Argentina	MIC	23	3 (13.0%)	25	8750.0	3
Aruba	HIC	1	0	NA	NA	NA
Barbados	HIC	1	1 (100.0%)	12	2880.0	19
Bermuda	HIC	1	1 (100.0%)	24	4320.0	10

Table 1 ……continue

Region Country	Income Classification	number of program in countries	Number of responses	Average Duration in Weeks	Total Duration in Minutes	Rank (1 is greatest)
Brazil	MIC	75	30 (40.0%)	20.8	3444.4	14
Canada	HIC	170	57 (33.5%)	17.4	3091.6	16
Chile	HIC	10	1 (10.0%)	12	1440.0	37
Colombia	MIC	50	48 (96.0%)	14.1	2941.5	17
Costa Rica	MIC	6	6 (100.0%)	15	2615.6	21
Cuba	MIC	8	8 (100.0%)	20.8	4616.3	8
Curacao	HIC	2	1 (50.0%)	12	1260.0	47
Dominican Republic	MIC	2	1 (50.0%)	8	1200.0	50
Ecuador	MIC	5	2 (40.0%)	7.5	1603.1	33
El Salvador	MIC	2	0	NA	NA	NA
Grenada	MIC	1	0	NA	NA	NA
Guam	HIC	1	0	NA	NA	NA
Guatemala	MIC	2	2 (100.0%)	32	520.0	72
Honduras	MIC	2	1 (50.0%)	5	400.0	74
Jamaica	MIC	3	1 (33.3%)	NA	NA	NA
Mexico	MIC	24	9 (37.5%)	4.3	1352.6	43
Panama	MIC	1	1 (100.0%)	8	1260.0	47
Paraguay	MIC	3	3 (100.0%)	20	3200.0	15
Peru	MIC	10	7 (70.0%)	20.3	11073.9	1
Puerto Rico	HIC	1	0	NA	NA	NA
Trinidad and Tobago	HIC	2	0	NA	NA	NA
United States of America	HIC	2632	65 (2.5%)	13.7	4086.9	11
Uruguay	HIC	12	5 (41.7%)	28.4	5538.0	5
Venezuela	MIC	9	8 (88.9%)	12.2	2941.1	18
Mean ± SD			9.3 ± 17.8	15.8 ± 7.6	3263.0 ± 2631.4	
Median (IQR)			1.5 (1-7.3)	14.1(12-20.8)	2941.0 (1352.6-4086.9)	
n (%)countries < 1000 minutes	2 (9.5%)				2 (9.5%)	
n (%)countries ≥ 12 sessions	20 (95.0%)					
Eastern Mediterranean (12 countries)						
Afghanistan	LIC	1	1 (100.0%)	NA	NA	NA
Bahrain	HIC	1	1 (100.0%)	8	1440.0	37
Egypt	MIC	2	2 (100.0%)	NA	NA	NA
Iran	MIC	34	14 (41%)	9.2	1958.4	27

Table 1 ……continue

Region Country	Income Classification	number of program in countries	Number of responses	Average Duration in Weeks	Total Duration in Minutes	Rank (1 is greatest)
Lebanon	MIC	1	1 (100.0%)	20	300.0	75
Morocco	MIC	1	1(100.0%)	NA	NA	NA
Pakistan	MIC	4	2 (50.0%)	6	607.5	69
Qatar	HIC	1	1(100.0%)	8	1440.0	37
Saudi Arabia	HIC	1	0	NA	NA	NA
Tunisia	MIC	1	1(100.0%)	5	2400.0	24
United Arab Emirates	HIC	1	0	NA	NA	NA
Mean ± SD			2 ± 3.8	9.4 ± 5.4	1357.6 ± 792.7	
Median (IQR)			1 (0.8-1.3)	8 (6.5-8.9)	1440 (815-1828.8)	
n (%)countries < 1000 minutes	2 (33.3%)				2 (33.3%)	
n (%)countries ≥ 12 sessions	6 (100%)					
Europe (47 countries)						
Austria	HIC	26	5 (19.2%)	9.3	3548.9	13
Belarus	MIC	5	1 (20.0%)	6	648.0	68
Belgium	HIC	48	9 (18.8%)	16	3614.7	12
Bosnia and Herzegovina	MIC	1	1(100.0%)	2	90.0	78
Bulgaria	MIC	1	1(100.0%)	NA	NA	NA
Croatia	HIC	3	3(100%)	7.5	1603.1	33
Cyprus	HIC	1	0	NA	NA	NA
Czech Republic	HIC	15	6 (40%)	10	1617.2	31
Denmark	HIC	35	8 (22.9%)	9.6	2520.0	22
England	HIC	266	57 (21.4%)	9.9	1609.5	32
Estonia	HIC	2	2(100%)	12	2160.0	26
Finland	HIC	25	11 (44%)	2.5	2250.0	25
France	HIC	130	16 (12.3%)	5.5	1803.2	29
Georgia	MIC	17	13 (76.5%)	9.3	6881.6	4
Germany	HIC	120	34 (28.3%)	5.3	4441.2	9
Greece	HIC	4	4(100%)	15	2423.4	23
Hungary	HIC	33	20 (60.6%)	3.5	569.3	70
Iceland	HIC	4	4(100%)	9.6	1160.0	53
Ireland	HIC	37	7 (18.9%)	8.5	1232.5	49
Israel	HIC	22	6 (27.3%)	42	4872.0	7
Italy	HIC	221	70 (31%)	4.8	1296.6	45
Kazakhstan	MIC	1	1(100%)	NA	NA	NA
Kyrgyz Republic	MIC	1	0	NA	NA	NA
Latvia	HIC	2	1 (50%)	NA	NA	NA
Lithuania	HIC	25	9 (36%)	10	NA	NA
Luxembourg	HIC	4	0	NA	NA	NA
Malta	HIC	1	1(100%)	6	1080.0	55
Moldova	MIC	1	1(100%)	NA	NA	NA
Montenegro	MIC	1	0	NA	NA	NA

Table 1 ……continue

Region Country	Income Classification	number of program in countries	Number of responses	Average Duration in Weeks	Total Duration in Minutes	Rank (1 is greatest)
Northern Ireland	HIC	13	10 (76.9)	8.4	559.4	71
Norway	HIC	35	0	NA	NA	NA
Poland	HIC	56	21 (37.5%)	3.7	998.5	60
Portugal	HIC	23	21 (91.3%)	22.5	5057.0	6
Romania	MIC	3	2 (66.7%)	2	450.0	73
Russia	MIC	3	3(100%)	1.5	225.0	76
Scotland	HIC	69	24 (34.8%)	9.5	1035.5	58
Serbia	MIC	2	2(100%)	3	1050.0	57
Slovak Republic	HIC	7	1 (14.3%)	10	1200.0	50
Slovenia	HIC	2	2(100%)	32	10560.0	2
Spain	HIC	87	47 (54%)	9	2832.3	20
Sweden	HIC	69	1 (1.4%)	12	1440.0	37
Switzerland	HIC	51	4 (7.8%)	7.5	1350.0	44
Turkey	MIC	10	9 (90%)	7.6	1353.5	42
Wales	HIC	17	16 (94.1%)	8.8	790.2	63
Mean ± SD			10.5 ± 15.3	9.9 ± 8	2173.5 ± 2102.4	
Median (IQR)			4 (1-12.5)	8.9 (5.5-10)	1440 (1042.8-2471.7)	
n (%)countries < 1000 minutes	8 (22.9%)				8 (22.9%)	
n (%)countries ≥ 12sessions	31 (88.57%)					
South-East Asia (7 countries)						
Bangladesh	MIC	1	1(100%)	1	180.0	77
Dem• Republic of Korea	HIC	17	12 (70.6%)	8.6	1293.3	46
India	MIC	23	18 (78.3%)	7.5	1535.2	36
Indonesia	MIC	13	10 (76.9%)	5.7	696.7	66
Nepal	LIC	1	1(100%)	6	NA	NA
Sri Lanka	MIC	4	2 (50%)	20	650.0	67
Thailand	MIC	5	0	NA	NA	NA
Mean ± SD			6.28 ± 7	8.1 ± 6.4	871 ± 542.3	
Median (IQR)			2 (1-1)	6.75 (5.8-8.3)	696.7 (650-1293.3)	
n (%)countries < 1000 minutes	3 (60.0%)				3 (60.0%)	
n (%)countries ≥ 12 sessions	5 (83.33%)					
Western Pacific (9 countries)						
Australia	HIC	314	85 (27%)	6.8	976.0	61

Table 1 ……continue Region Country	Income Classification	number of program in countries	Number of responses	Average Duration in Weeks	Total Duration in Minutes	Rank (1 is greatest)
China	MIC	216	83 (38.4%)	9.2	1026.4	59
Japan	HIC	325	9 (2.8%)	15	756.3	64
Malaysia	MIC	6	4 (66.7%)	6	1200.0	50
Mongolia	MIC	1	1(100%)	NA	NA	NA
New Zealand	HIC	43	27 (62.8%)	7.9	1107.2	54
Philippines	MIC	10	10(100%)	5	951.0	62
Singapore	HIC	7	7(100%)	7	1077.1	56
Taiwan	HIC	35	23	13.1	1577.4	35
Mean ± SD			25.1 ± 32.2	9.1 ± 3.5	1123.5 ± 252.6	
Median (IQR)			9.5 (4.8-26)	7.9 (6.8-12)	1077 (976-1200)	
n (%)countries < 1000 minutes	3 (33.3%)				3 (33.3%)	
n (%)countries ≥ 12 sessions	9 (100%)					
Global Mean ± SD			9.8 ± 17.3	11.2 ± 7.6	2177.7 ± 2110.1	
Global Median (IQR)			2 (1-9.5)	9.2 (6-13.8)	1440 (1028.7-2778.6)	
High-income country mean (median)			13.3 (5)	11.8(9.6)	2252.3 (1508.7)	
Middle-income country mean (median)			6.7 (2)	10.6 (7.8)	2081.2 (1230)	
Low-income country mean (median)			0.4 (0)	6 (6)	NA	
Global :n (%)countries < 1000 minutes	19 (24.4%)				19 (24.4%)	
Global: n (%)countries ≥ 12 sessions	72 (77.4%)					

NA: not available; SD, standard deviation; IQR, interquartile range

Pairwise Comparison between the Six WHO Regions:

Using generalized estimating equations procedure and pairwise comparison, differences in the mean number of minutes across the six WHO regions was significant ($P<0.05$). As shown in Table 2, the Americas had significantly longer program in terms

of minutes than any other regions, Africa had significantly longer program in terms of minutes than Western-Pacific and South-East Asia, Europe had significantly longer program in term of minutes than Western-Pacific and South-East Asia and finally the Eastern Mediterranean region had longer program in terms of minutes than South-East Asia. There was no significant difference in means of minutes between Africa and Europe, between Africa and Eastern Mediterranean, between Europe and Eastern Mediterranean, between Eastern Mediterranean and Western Pacific, and finally between Western Pacific and South-East Asia.

Table 2

Pairwise comparisons of Dose (minutes) of Available Cardiac Rehabilitation programs by the WHO Region

WHO region (1)	WHO region (2)	Mean Difference ± Std. Error (Minutes)[1]	P-Value[2]
Africa	Western Pacific	844.21 ± 376.89	0.03
Africa	South-East Asia	1023.23 ± 394.97	0.01
Americas	Africa	1416.54 ± 476.3	0.003
Americas	Europe	1492.42 ± 348.3	< 0.001
Americas	Eastern Mediterranean	1770 ± 417.64	< 0.001
Americas	Western Pacific	2260.75 ± 330.25	< 0.001
Americas	South-East Asia	2439.77 ± 350.75	< 0.001
Europe	Western Pacific	768.33 ± 191.04	< 0.001
Europe	South-East Asia	947.35 ± 224.62	< 0.001
Eastern Mediterranean	South-East Asia	669.76 ± 321.82	< 0.001

[1]Mean difference = mean WHO region (1) – mean WHO region (2).
[2] Pairwise comparison using generalized estimating equations procedure.

Pairwise Comparison by Country Income Group:

The same generalized estimating equations procedure was used, differences in the mean number of minutes between high income country group and middle income country group was not significant (P-value: 0.335), as shown in Table 3, middle income country group has longer dose of CR program in terms of minutes than the high income country group, there is no comparison with low income country group because there were no data available for the dose of CR programs in terms of minutes for the low income countries.

Table 3

Pairwise Comparisons of Dose (minutes) of Available Cardiac Rehabilitation Programs by Country Income Group

Country income group	Country income group	Mean Difference ± Std. Error (minutes)	P-value
Middle-Income	High-Income	223.2084 ± 231.55098	0.335

Factors Associated with Dose of CR Program:

Table 4 presents the factors affecting dose of CR programs. Over three-forth (77.8%) of CR programs had cardiologist in the team; 73.8% of program had general physician, only 25.3% of the programs were funded by multiple sources, i.e. combination of private insurance and government, 12.6% of programs available in rural area, 31.1% of CR programs offering alternative models for delivery.

Table 4

Characteristics of cardiac rehabilitation programs

Factors	Categories	N	Percentage
Presence of Cardiologist in the CR Team	Yes	720	66.5
	No	206	19.0
Funding source	Combination	269	24.9
	Private	202	18.7
	Public	592	54.7
Individual consultation with general physician	Yes	697	64.4
	No	248	22.9
Geographical location of CR program	*Rural area	134	12.4
	Suburban	155	14.3
	Urban area	775	71.6
location of CR within Hospital	Yes	845	78.1
	No	205	18.9
Availability of another CR program within 20km	Yes	495	45.7
	No	516	47.7
Diagnosis: Post-Myocardial Infarction/acute coronary syndrome	Yes	833	77.0
	No	22	2.0
Diagnosis: Stable coronary artery disease, without a recent event or procedure	Yes	692	64.0
	No	161	14.9
Diagnosis: Post percutaneous coronary intervention	Yes	820	75.8
	No	33	3.0
Diagnosis: Post coronary artery bypass graft surgery (CABG)	Yes	817	75.5
	No	36	3.3
Diagnosis: Heart failure	Yes	757	70.0
	No	96	8.9
Diagnosis: Heart transplant	Yes	470	43.4
	No	383	35.4
Diagnosis: Arrhythmias (hemodynamically-stable)	Yes	566	52.3
	No	287	26.5

Table 4 ……. continue

Factors	Categories	N	Percentage
	No	212	19.6
Diagnosis: Patients at high-risk of cardiovascular disease (primary prevention)	Yes	493	45.6
	No	360	33.3
level of Cardiac Risk accepted in the CR program	high	595	55.0
	moderate	167	15.4
	low	22	2.0
CR program offer alternative models of program delivery than an on-site program	Yes	285	26.3
	No	630	58.2
		N	Mean ± SD
Number of patients in each exercise session		807	9.8 ± 8.3
Number of staff in the CR program		803	2.5 ± 2

*Rural area or countryside (a geographic area that is located outside towns and cities).
Suburban (a residential district located on the outskirts of a city).
Urban area (e.g. larger cities, towns).

The following organizational factors were significantly associated with dose (P-value <0.05) (Table 5): presence of cardiologist on the CR team was significantly associated with the dose of CR program with a multiplicative effect on the mean of the dose of the CR program (MEM): 1.29 (95% CI: 1.06 to 1.57), i.e., the dose was 29% longer in CR programs where the cardiologist is a member of the CR team, compared to CR programs where no cardiologist on the CR team. In addition to that CR programs that had general physician who provided individual consultation for patients had (60%) higher dose compared to CR programs which did not offer individual consultation with a general physician (MEM: 1.60, 95% CI: 1.35 to 1.91).

Further, the dose was significantly higher by 27% (MEM: 1.27, 95% CI: 1.03 to 1.57) when CR program was funded by a combination of governmental organizations and

private health insurance compared to fund from governmental organizations. Funding of the CR program by private health insurance only was not significantly associated with dose compared to funding by governmental organization alone (MEM: 1.04, 95% CI: 0.82 to 1.32).

Location of CR program was a significant predictor for the dose, CR programs located in the rural areas (a geographic area that is located outside towns and cities) had 35% higher dose compared to CR programs located in the urban areas (e.g. larger cities, towns) (MEM:1.35, 95% CI:1.01 to 1.804). Location of CR program in suburban (a residential district located on the outskirts of a city) areas was not significantly associated with dose compared to urban areas (MEM: 0.97, 95% CI: 0.78 to 1.19).

Number of patients per session of CR program was positively associated with dose of CR program; increasing the number of patients in each session by one patient is associated with 3% increase in the dose of the CR program (MEM: 1.03, (95% CI: 1.01 to 1.04). Similarly, number of staff in the CR program was positively associated with dose of CR program; increasing the number of staff of the CR program by one staff was associated with 17% increase in the dose of the CR program (MEM: 1.17, 95% CI: 1.01 to 1.36). If the CR program offer alternative models of program delivery other than an on-site program, it was associated with 17% increase in dose of CR (MEM: 1.17, 95% CI: 0.98 to 1.4) but it was not significantly associated with dose; however, it was supported by the literature that it increases the adherence to more CR sessions (44).

Patients' factors: The dose of CR program was significantly associated with the

following cardiac diseases: Heart Failure, Heart Transplant, and Cardiomyopathy. Patients with heart failure had higher dose by 64% compared to patient without heart failure (MEM: 1.64, 95% CI: 1.24 to 2.18). Additionally, patients with heart transplantation had higher dose of CR program by 22% compared to patient without heart transplantation (MEM: 1.22, 95% CI: 1.02 to 1.47). Patients diagnosed with cardiomyopathy had higher dose of CR by 38% compared to patient without cardiomyopathy (MEM: 1.38, 95% CI: 1.15 to 1.65).

The following predictors were not significantly associated with dose of CR program (p-value > 0.05): location of CR within hospital, availability of another CR program within 20 km, CR program offer alternative models of program delivery than an on-site program, level of cardiac risk accepted in the CR program, and the following diagnosis (post-myocardial infarction/acute coronary syndrome, post coronary artery bypass graft surgery, stable coronary artery disease, post percutaneous coronary intervention, arrhythmias (hemodynamically-stable), and patients at high-risk of cardiovascular disease.

Table 5

CR characteristics associated with dose of cardiac rehabilitation programs

Factors	Categories	MEM*	95% Confidence Interval		P-value
			Lower	Upper	
Presence of Cardiologist in the CR Team	Yes	1.29	1.06	1.57	0.013
	No	1	Reference group		
Funding source	Combination	1.27	1.03	1.57	0.027
	Private	1.04	0.82	1.32	0.777
	Public	1	Reference group		
Individual consultation with general physician	Yes	1.6	1.35	1.91	<0.001
	No	1	Reference group		
Geographical location of CR program	Rural area	1.35	1.01	1.8	0.047
	Suburban	0.97	0.78	1.19	0.753
	Urban area towns)	1	Reference group		
Diagnosis: Heart failure	Yes	1.64	1.24	2.18	0.001
	No	1	Reference group		
Diagnosis: Heart transplant	Yes	1.22	1.02	1.47	0.03
	No	1	Reference group		
Diagnosis: Cardiomyopathy	Yes	1.38	1.15	1.65	0.001
	No	1	Reference group		
CR program offer alternative models of program delivery than an on-site program	Yes	1.17	0.98	1.4	0.081
	No	1	Reference group		
Number of patients in each exercise session		1.03	1.01	1.04	<0.001
Number of staff in the CR program		1.17	1.01	1.36	0.045

* MEM: multiplicative effect on the mean

The final parsimonious model with significant predictors after backward stepwise elimination had the lowest QICC = 437.206, in addition to that the distribution of residuals via histogram and scatter plot of Pearson residuals against the predicted values of the outcome were used to assess the goodness of fit of the parsimonious model, as shown in the figure 7 the histogram for the residuals showed normal distribution, in addition to that the scatterplot of Pearson residuals in figure 8 showed that in general there aren't clear patterns for the distribution of the Pearson residuals which proof that the model provide good fit to the data.

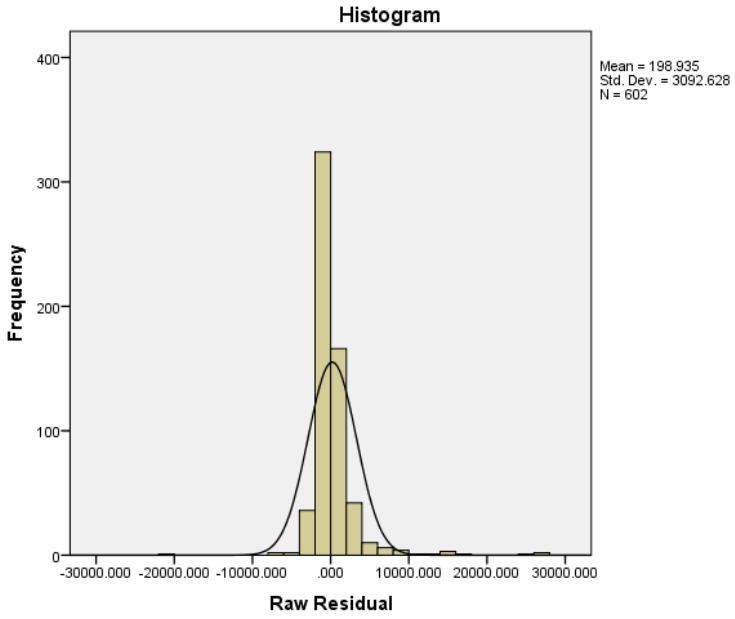

Figure 7: distribution of residuals of the parsimonious model with the significant predictors

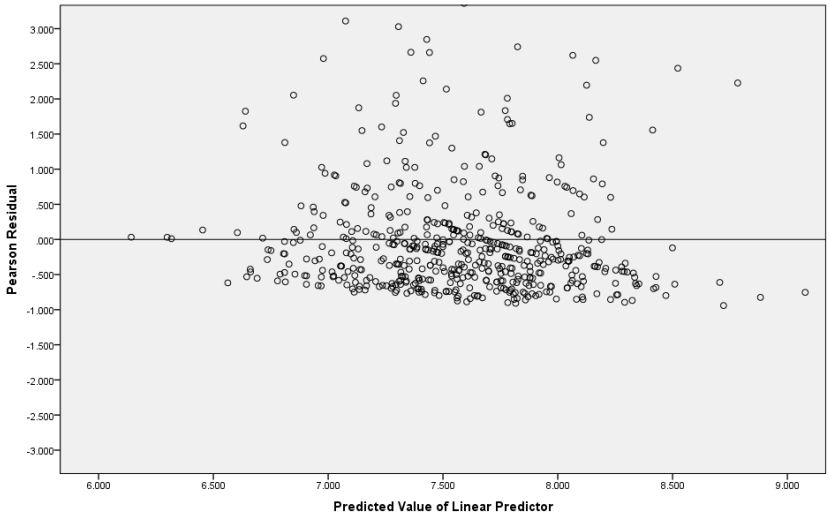

Figure 8: Scatterplot of Pearson residuals against the predicted values of the dependent variable (dose of CR program)

CHAPTER 6: DISCUSSION

This is the first study, to the best of our knowledge that described dose of CR program at global, regional and at country levels. It is also the first study that compared the dose of CR among the six regions of the WHO. Cardiac rehabilitation program was available in 111 (54.7%) of the 203 countries in the world (45). Data were collected in 93 (83.8%) of these countries with a total of 1082 CR programs completed the survey. This represents a response rate of 32.1% of the total 3373 CR programs, worldwide (41). The level of missingness was 30.8%, the effective sample size was 749 CR programs.

Dose of CR Program:

To examine the clinical effectiveness of dose, in the most recent Cochrane systematic reviews, patients who had 1000 or more minutes had significantly lower CV mortality of 25% and myocardial infarction (MI) of 26% (4). In our study, globally, 24.4% of the countries had a program length of <1000 minutes. Short CR programs could decrease effectiveness of the proram in mortality reduction. (4). Apparantly, countries and regions with high burden of CVD and low resources had short CR programs (i.e. less than 1000 minutes). Regionally, the South East Asia had the largest proportion of countries (60%) with programs less trhan 1000 minutes followed by Africa (50%) , then Eastern Mediterranean and Western pacific equally (33.3%). According to the WHO report on CVD (46), the deaths from non-communicable diseases have increased in the South-East Asia Region, from 6.7 million in 2000 to 8.5 million in 2012. It is also estimated that CVD mortality to increase by 2030 with the greatest increase in Africa

follwed by the Eastern Mediterranean (46). Further, 13 (38.2%) of MICs had a program length of <1000 minutes compared to 10.7% in HICs, while over 80% of CVD deaths occur in low-income and middle-income countries) (46).

High income countries had higher dose of CR in term of minutes with median 1508.72 (1190 -2844.25) minutes and longer duration, in terms of weeks per CR program with median (9.6 (7.9 - 13.1) weeks) compared to low-and middle-income countries.

In terms of number of sessions provided, a recent systematic review and meta analysis suggested that patients with CVD should be prescribed a minimum of 12 sessions to reduce all-cause mortality (7). However, the length of the session was not specified (7). Because of lack of research, we used the 12 sessions per program as the baseline value to explore the effectiveness of CR programs delivered in the present study. Globally, 72 (77.42%) of the countries provided an average of ≥ 12 sessions per CR program; all 9 (100%)) of the Western Pacific and the EMR 6 (100%) countries, 20 (95%) of the Americas, 31 (88.57%) of the Europe, 5 (83.33%) of the South East Asia and 1 (50%) of the Africa region provided ≥ 12 sessions per CR program. Still, there is uncertainity of the effectiveness of CR in terms of number of sessions provided per program because the length of the session varies across programs both in our study and the reference study (7).

Factors Associated with Dose:

Presence of cardiologist on the CR team had a significant positive association with the dose (in terms of minutes) of CR program. Initially, a patient should have a

physician referral to enroll in CR programs (47). Some studies found positive relationship between patient enrollment or complinace to CR programs and physician involvement (48) (49).

In addition to patients' perception of safe environment in the presence of a cardiologist in case of adverse affect, Cardiologist could play an inspirational role in motivating patients to continue in participating in the CR programs, therfore, more demand on service delivered. In fact, frequent motivation by health professionals and discussing progress was reported among the most important CR features that encourage patients to continue in CR programs (50).

Within the context of the inspirational and motivational role of physicians, providing individual consultation for patients by general physician was positively associated with CR dose. Patients were more likely to participate in CR if their general physicians explained CR benefits and motivated them to participate in CR porgram (48).

Considering the type of funding of cardiac rehabilitation program, a combination of public (government or social security) and private (health insurance, out of pocket payment) was a significant positive predictor for the CR dose. This is in line with the finding by British Heart Foundation on national CR audit in England, where many groups of patients who would benefit are not able to take part because of a lack of funding (51) (52). Other studies (53) (54) found that patient payment is a barrier to CR participation and adherence, which could lead to less demand on CR services; consequently, lower dose if patient is the one responsible for the payment of CR program, but if the CR

program is completely funded by governemnt and private health insurance all patients will receive a complete dose of CR program.

CR programs located in the rural area (a geographic area that is located outside towns and cities) offer more dose, this may be explained by the high prevelance of cardiac disease and risk factors of cardiac disease i in rural area (55) therfore the residents of these areas need more dose of CR program to reduce risk factors of cardiac disease and improve cardiac function.

Number of patients in each session of CR program and number of staff in the CR program had a significant positive association with the dose of CR program. CR programs usually accept more patients if they are resourceful, i.e. they have the capacity to offer higher dose, e.g. more sessions per program, due to availability of resources, such as space, equipment, and staff. With more number of staff, programs can offer more sessions per program and some programs could offer after work (evening) and during weekends sessions. Adequate resources, including number of staff, space and equipment were found to increase the adherence to CR program in one study, therefore patients received more sessions of CR program (49). On the other hand, in a qualitative study, lack of equipment and inadequate physical space have been identified as barriers to CR enrollment (56).

CR programs offer alternative model of delivery was not significantly associated with dose. A study showed that CR alternative model for delivery, i.e. home based increased the adherence to more sessions, especially for those with travel or cost barriers

if they want to attend the supervised program (44).

The dose of CR program was possitively associated with the following cardiac diseases: heart failure, heart transplant, and cardiomyopathy, these findings may be expalined by the severity of disease. Patients with severe diagnosis as the aforementioned diagnosis need longer CR duration, i.e more sessions, in USA, those patients are covered up to 72 sessions (57).

Limitations:

Our study has few limitations. First, the study based on secondary data and it has missing values. Imputation of missing data could assist in reducing this effect but it is out of the timeline of this study. Second, limitation on generalizability particularly due to possibility of self-selection bias and the low response rates within countries. The ICCPR Global Team documented that there were difficulties in identifying programs in LMIC (45). Respondents may have been inclined to respond in a socially desirable manner to reflect better provision of CR services in their programs or country. However, this limitation can be mitigated if the non-respondent programs were shown to be not significantly different from the participating programs on characteristics that affect the dose. However, we did not have access to non-respondents' information and we have time limit to reach out. Finally, the dose could be overestimated because most probably, those participated in the survey could be large resourceful programs. For example, some poor regions or countries, specifically Africa could not be well presented may be due to lack of resources.

Significance:

This is the first study to characterize dose globally. Cardiac rehabilitation program is a secondary prevention program, help the patient to recover and return to practice his daily life activities, although the evidence that the dose of cardiac rehabilitation program is very important to achieve the desired outcome for cardiac patient of improving their health and prevent subsequent cardiac complications, there is lack of research regarding the organizational factors that could affect the dose of cardiac rehabilitation, therefore, this is the first empirical study that described and characterized the dose of CR programs at country, WHO designated six regions, country income classification, and global levels, and this is first study examined the organizational factors and patient related factors that could affect the dose. Our results are expected to guide policy makers of CR programs in identifying gaps in CR dose to improve their programs to achieve the desired outcome and reduce the cost of CVD.

Strength:

The study uses global data from more than 90 countries and more than 1000 programs worldwide, and it is the first ever global study described and characterized dose of CR program at country, WHO region, country income classification, and global levels, and determined the significant factors that could affect dose of the CR program.

Conclusion:

In conclusion, despite guideline recommendations that CVD patients should access CR, it is only available in 111 (54.7%) countries around the world. Advocacy for

more programs, that each serve the maximal number of patients safely, is needed to ensure all indicated patients achieve the reductions in mortality and morbidity associated with CR participation.

The findings of this study have important implications for the directors of CR program; organizational factors influence the dose of CR program. Some modifiable organizational factors were identified including presence of cardiologist and general physician on the CR team, funding the CR program by a combination of governmental organizations and private health insurance, increase number of staff in the CR program, and offering alternative models of program delivery than an on-site, each of which may guide decision-makers improve the dose of CR programs to achieve reductions in both mortality and morbidity associated with cardiovascular diseases. The study recommends financial support of CR programs through multiple sources to encourage patients to uptake more CR doses, increase number of CR programs in rural areas and to provide alternative models for delivery than onsite like home-based, especially for patients who have difficulty to participate in CR programs due to distance or funding reasons.

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APPENDIX

CARDIAC REHABILITATION PROGRAM QUESTIONNAIRE

Instructions: Please answer the series of questions by: (1) checking (✓) the appropriate box (sometimes one box and other times you will be asked to check as many boxes as apply), (2) typing in an answer, or (3) entering a number, as indicated. The survey items for which you enter numbers are constrained to one value (i.e., you cannot enter a range. If you would like to enter a range, instead enter the midpoint) and will not accept text. You can report a number to up to 1 decimal place if desired. Enter zero (0) only if the answer is none.

Be sure to click the "Submit" button when you reach the end of the survey.

1. What is your Title/Position at the cardiac rehabilitation program? (check ✓one):

☐ Director

☐ Coordinator / Manager / Supervisor

☐ *Clinician*

Please specify_____

☐ *Other*

Please specify _____

Section A: General information

2. In what country is your cardiac rehabilitation program? _____

2.b. Please, specify your country_____

3. City / Region: _____(optional)

4. Your cardiac rehabilitation program is located in an/a:

    - Urban area (e.g.larger cities, towns)
    - Suburban (a residential district located on the outskirts of a city)
    - Rural area or countryside (a geographic area that is located outside towns and cities).

5. In what year was your cardiac rehabilitation program initiated? Please enter a valid four digit start year _____ (year)

6. Who pays for cardiac rehabilitation? (Check all that apply)

☐ Social security / government

☐ Hospital or clinical center where the cardiac rehab service is based

☐ *Patient*

☐ Private health insurance

☐ *Other*

Please specify _____

6.b. What is the average percent of the total program cost that patients pay, if they complete the program? (Please enter a numeric value only in the field) _____ %

6.c. What is the direct cost to patients to participate, if they complete the program? (Note: Please enter amount. Enter a numeric value) _____ Amount

6.c2. Please specify currency _____ Currency.

7. Is your cardiac rehabilitation program located within a hospital?

☐ Yes – it is in a referral / quarternary / tertiary facility and / or academic center

☐ Yes – it is in a community hospital

☐ *Yes - it is in a rehabilitation hospital/ residential facility*

☐ Yes – other

Please specify where your cardiac rehabilitation is located _____

☐ *No* (skip to question 10)

7b. Is your Phase II program a spa / residential?

☐ *Yes*

☐ No

8. If Q7 was marked yes, does the hospital have an inpatient cardiology service? (Check one box):

   ☐ Yes, and these patients are referred to our cardiac rehabilitation program regularly

   ☐ Yes, and these patients are sometimes referred to our cardiac rehabilitation program

   ☐ Yes, and these patients are rarely referred to our cardiac rehabilitation program

   ☐ No

9. If Q7 and Q8 were marked yes, do they offer? (check all that apply)

   ☐ Revascularization via percutaneous coronary intervention (PCI)

   ☐ Coronary artery bypass graft surgery (CABG)

   ☐ Percutaneous valve implantation

- ☐ Implantable heart devices (pacemakers or defibrillators)
- ☐ Cardiac transplant
- ☐ None

10. In what department is the cardiac rehabilitation program situated administratively?
    - ☐ Cardiology department
    - ☐ Physical Medicine and Rehabilitation department
    - ☐ Internal Medicine department
    - ☐ Primary / general practice
    - ☐ It is in a community facility
    - ☐ None – it is stand-alone
    - ☐ *Other*

      Please specify_____
11. For patients referred following a cardiac hospitalization, on average how many weeks after discharge does a patient start your program? (i.e., initial assessment appointment) (Please enter a numeric value in the field _____ weeks
12. How many unique cardiac rehabilitation patients do you <u>provide service</u> to each year in your program? (Please enter a numeric value) _____ patients per year
13. How many patients do you have <u>capacity</u> to serve each year, in terms of staff and space? (Please enter a numeric value)_____ patients per year
14. What is the cost to your program to serve one (1) patient, if they complete the program? (Note: Please specify amount. Enter a numeric value in the field)

    _____ Amount

14.b. Please specify currency _____ Currency

15. Who can refer a patient to your program? (Check all that apply)

- ☐ Patients can self-refer
- ☐ Physicians
- ☐ Allied healthcare providers and / or nurses
- ☐ Community health care workers
- ☐ *Other*

  Please specify _____

16. Are there any other Cardiac Rehabilitation programs in your area? (Check only one box)

- ☐ Yes, within approximately a 20 km radius
- ☐ Yes, but more than 20 km away
- ☐ None
- ☐ I don't know

17. Please rate the degree to which each of the following are barriers to greater patient participation in your cardiac rehab program, from "this is definitely not an issue" to "this is a major issue": Check one per row.

	This is definitely not an issue	This is Not an issue	Neutral	This is a minor issue	This is major issue
Lack of patient referral	○	○	○	○	○
Lack of equipment	○	○	○	○	○
Lack of space	○	○	○	○	○
Lack of human resources	○	○	○	○	○
Lack of financial resources/ budget	○	○	○	○	○
Other barrier	○	○	○	○	○

Please specify the equipment you lack, if applicable_____

Please specify the other barrier, if applicable _____

SECTION B: DETAILS ABOUT YOUR CARDIAC REHABILITATION PROGRAM

18. Who has overall responsibility for cardiac rehabilitation at your program? (Please check one box)

☐ Cardiologist

☐ Physician specialist in internal medicine

☐ Physical medicine and rehabilitation (physiatrist)

☐ *Physician, other specialty*

If you selected "Physician, other specialty", please specify the specialty here _____

☐ Nurse

☐ Exercise physiologist

☐ Physiotherapist

☐ *Other*

If you checked "other", please specify the heath profession here _____

19. How expensive are the following aspects of delivering your cardiac rehab program? (check one box per row)

	Free	Only a minor cost	Costs a bit	Costs quite a bit	Very expensive	Not applicable as we do not have

this

Front-line personnel	☐	☐	☐	☐	☐	☐
Space	☐	☐	☐	☐	☐	☐
Exercise equipment	☐	☐	☐	☐	☐	☐
Equipment / supplies for cardiovascular risk assessment (not including exercise stress tests)	☐	☐	☐	☐	☐	☐
Exercise stress testing on a treadmill or cycle ergometer	☐	☐	☐	☐	☐	☐
Patient education materials	☐	☐	☐	☐	☐	☐
Blood pressure assessment device	☐	☐	☐	☐	☐	☐
Blood collection and lipid testing	☐	☐	☐	☐	☐	☐
Free weights etc. for resistance training	☐	☐	☐	☐	☐	☐

20. Which of the following components of cardiac rehabilitation are provided in your program? If they are provided, are they provided in all the models you deliver? (i.e., supervised and home-based programs)?

Please check one box per row. If you only offer one model of rehabilitation and you offer the listed component, please check "yes, in all models".

	Yes In all models	Yes For some models	No
Initial assessment	☐	☐	☐
Individual consultation with a physician	☐	☐	☐
Individual consultation with a nurse	☐	☐	☐
Exercise stress test	☐	☐	☐
Other functional capacity test	☐	☐	☐
Assessment of strength (e.g., handgrip)	☐	☐	☐
Assessment for comorbities / issues that could impact exercise (e.g., cognition, vision, musculoskeletal / mobility issues, frailty, and / or balance / falls risk)	☐	☐	☐
Exercise prescription	☐	☐	☐
Physical activity counseling	☐	☐	☐

Supervised exercise training	☐	☐	☐
Heart rate measurement training for patients	☐	☐	☐
Resistance training	☐	☐	☐
Management of cardiovascular risk factors	☐	☐	☐
Prescription and/or titration of secondary prevention medications	☐	☐	☐
Nutrition counseling	☐	☐	☐
Depression screening	☐	☐	☐
Psychological counseling	☐	☐	☐
Smoking cessation sessions/classes	☐	☐	☐
Vocational counseling / support for return-to-work	☐	☐	☐
Stress management / Relaxation techniques	☐	☐	☐
Alternative forms of exercise, such as yoga, dance, or tai chi	☐	☐	☐
Women-only classes	☐	☐	☐
End of program re-assessment	☐	☐	☐
Electronic patient charting	☐	☐	☐

Communication of patient assessment results with their primary care provider_	☐	☐	☐
Follow-up after oupatient program	☐	☐	☐
Other	☐	☐	☐

If applicable, please specify what other functional capacity test is used in your program _____

If applicable, please specify what other alternative forms of exercise are offered in your program _____

If applicable, please specify what components of cardiac rehabilitation are provided in your program _____

21. How many education sessions are provided to each patient in your program? (Please enter a numeric value) _____ sessions
22. How many minutes on average is each education session? (Please enter a numeric value)_____ minutes
23. In your program, do you assess the following risk factors? Please check one box per row.

	Yes	No
Time spent being sedentary	☐	☐
Tobacco use	☐	☐
Harmful use of alcohol	☐	☐
Blood pressure	☐	☐

Body mass Index	☐	☐
Waist circumference	☐	☐
Hip circumference	☐	☐
Body composition	☐	☐
Total Cholesterol	☐	☐
Cholesterol fractions (HDL-c, LDL-c)	☐	☐
Triglycerides	☐	☐
HbA1c for diabetic patients	☐	☐
Blood glucose for non-diabetic patients	☐	☐
Sleep apnea	☐	☐
Depression / Anxiety	☐	☐
Physical inactivity	☐	☐
Poor diet	☐	☐
Other factor(s)	☐	☐

Please specify which other factor(s) you assess in your program

24. Which types of personnel are part of your cardiovascular rehabilitation (CR) team? If they are part of your team, do they work in Cardiac Rehabilitation only, or do they have other department obligations? (Check one box in each row):

	Yes-Only CR	Yes-Partial	No

Cardiologist	☐	☐	☐
Physiatrist (Physical Medicine and Rehabilitation)	☐	☐	☐
Sports Medicine Physician	☐	☐	☐
Other Physician	☐	☐	☐
	☐	☐	☐
Physiotherapist			
Nurse	☐	☐	☐
Nurse practitioner	☐	☐	☐
Psychiatrist	☐	☐	☐
Psychologist	☐	☐	☐
Social worker	☐	☐	☐
Dietitian	☐	☐	☐

Kinesiologist	☐	☐	☐
Pharmacist	☐	☐	☐
Exercise specialist	☐	☐	☐
Community Health worker	☐	☐	☐
Administrative assistant/ Secretary	☐	☐	☐
Other	☐	☐	☐

Please specify what kind of other physician _____

Please specify which other type of personnel are part of your team _____

25. Do all your clinical staff supervising patients during exercise sessions have cardiopulmonary resuscitation (CPR) training / certification?

☐ *Yes*

☐ No (skip to question 26)

25b. If yes, are they required to renew their CPR training regularly?

☐ Yes

☐ No

25c. If yes, is the CPR certification advanced or basic? (check one box per row)

	Advanced CPR training	Basic CPR training
Physicians	☐	☐
Nurses	☐	☐
Other	☐	☐

26. Does your program have each of the following ítems, and if yes, is its' use dedicated to your program or shared with another group (check one option in each row)?

	DEDICATED	SHARED	NOT AVAILABLE
BICYCLE ERGOMETER	☐	☐	☐
TREADMILL ERGOMETER	☐	☐	☐
ARM CYCLOERGOMENTER	☐	☐	☐
DOPPLER ECHOCARDIOGRAPHY	☐	☐	☐
STRESS TEST (NO O_2)	☐	☐	☐
STRESS TEST WITH O2	☐	☐	☐

TELEMETRY	☐	☐	☐
GROUP EDUCATION ROOM	☐	☐	☐
GYM SPACE	☐	☐	☐
INDIVIDUAL ASSESSMENT/ COUNSELLING ROOM	☐	☐	☐
PATIENT CHANGE ROOM	☐	☐	☐
ADMINISTRATIVE OFFICE	☐	☐	☐
ELECTRONIC PATIENT CHARTS	☐	☐	☐
RESISTANCE TRAINING EQUIPMENT	☐	☐	☐
BODY COMPOSITION ANALYZER	☐	☐	☐
STAFF MEETING ROOM	☐	☐	☐

STAFF OFFICE SPACE	☐	☐	☐
OTHER	☐	☐	☐

Please specify what other items your program has _____

27. Does your site offer a supervised Cardiac Rehabilitation program?

☐ *Yes*

☐ No

SECTION C: CARDIAC REHABILITATION – Supervised Program

28. Which of the following cardiac diagnoses or indications do you accept for your supervised program? (Check all that apply)

☐ Post Myocardial Infarction / acute coronary syndrome

☐ Stable coronary artery disease, without a recent event or procedure

☐ Post percutaneous coronary intervention (PCI)

☐ Post coronary artery bypass graft surgery (CABG)

☐ Heart failure

☐ Patients who have had valve surgery/repair or transcatheter aortic valve implantation (TAVI)

☐ Heart transplant

☐ Patients with ventricular assist devices

☐ Arrhythmias (hemodynamically-stable)

☐ Patients with implanted devices for rhythm control (i.e., ICD / CRT, pacemaker)

☐ Congenital heart disease

☐ Cardiomyopathy

☐ Rheumatic heart disease

☐ Patients at high-risk of cardiovascular disease (primary prevention)

☐ Non-cardiac chronic diseases

☐ *Other*

Please specify _____

29. Which of the following non-cardiac diagnoses or indications do you accept for your on-site program? (Check all that apply)

☐ Stroke

☐ Intermittent claudication / peripheral vascular disease

☐ Cancer

☐ Diabetes

☐ Chronic lung disease

☐ None

☐ *Other*

Please, specify which other non-cardiac diagnosis is accepted in your program_____

30. Which of the following patient levels of cardiac risk do you accept for your supervised program? (Check all that apply)

- ☐ Low
- ☐ Moderate
- ☐ High
- ☐ Not applicable because we do not risk stratify at our program

31. Do patients have an individual consult with a physician during the program?

- ☐ *Yes*
- ☐ No

31b. If yes, Please specify the number of times in a full program the patients have an individual consult with a physician (Please enter a numeric value) _____ times

32. What is the standard <u>duration</u> of the on-site cardiac rehabilitation program that you provide to patients? (Please enter a numeric value.) _____ weeks

33. On average, for how many sessions does each patient come on-site each week? (i.e., frequency; Note: if you run a residential program, leave this question blank and instead answer the next question; do not report how many sessions your program runs in a week) _____ sessions per week

33b. At your spa/residential program: On average, how many CR sessions do offer patients each day? (Please enter a numeric value in the field.) _____ sessions / day (residential programs)

34. On average, how many patients are in each exercise session? (Please enter a numeric value) _____ patients / session
35. On average, how long is each exercise session (including warm up, aerobic exercise, strength training and/ or cool down)? (Please enter a numeric value) _____ minutes / session
36. What is the maximum number of patients that your program allows in the same exercise session? (Please enter a numeric value in the field.)_____ patients / session
37. What is the staff to patient ratio during supervised exercise at your program? (Note: if there are 6 staff persons per 14 patients, enter 6 in the first box and 14 in the second box) (Please enter a numeric value in the fields.)

37b. Insert here the staff number in the staff-to-patient ratio: _____

37c. Insert here the patient number in the staff-to-patient ratio: _____

38. Which healthcare professionals are usually present during exercise sessions? (Check one box in each row)

	Present	Not usually present
Cardiologist	☐	☐
Physiatrist (Physical Medicine and Rehabilitation)	☐	☐
Sports Medicine Physician	☐	☐

Other Physician	☐	☐
Physiotherapist	☐	☐
Nurse	☐	☐
Nurse practitioner	☐	☐
Psychiatrist	☐	☐
Psychologist	☐	☐
Social worker	☐	☐
Dietitian	☐	☐
Kinesiologist	☐	☐
Pharmacist	☐	☐
Exercise specialist	☐	☐
Community health worker	☐	☐

Other ☐ ☐

Please specify which other physician is usually present during exercise sessions_____

Please specify which other healthcare professionals are usually present during exercise sessions_____

39. Does the supervised program offer telemetry or another method of monitoring patients' clinical status while exercising? (check all that apply)

☐ Yes, telemetry

☐ *Yes, other method of monitoring*

☐ None

If other method of monitoring please specify:

☐ Borg scale (perceived exertion)

☐ Heart rate

☐ Other

If applicable, please specify what other method of monitoring is used in your program_____

SECTION D- ALTERNATIVE MODELS OF CARDIAC REHABILITATION DELIVERY

40. Are alternative cardiac rehabilitation models such as home-based, reimbursable by government or insurance companies in your region?

 Yes

Please specify which model are reimbursable by government or insurance companies_____

 No

41. Does your cardiac rehabilitation program offer alternative models of program delivery than an on-site program?

☐ *Yes*

☐ No

41b. If Q41 was marked: yes, please specify (check all that apply):

☐ Home-based (includes web or Smartphone-based)

☐ Community-based

☐ *Hybrid of supervised with home or community-based*

Please describe the nature of your hybrid model_____

☐ *Other*

Please, specify what other alternative model is offered_____

If Q41b was marked: home–based program, please answer the following questions:

42. When did the home-based program start? (Please enter a numeric value)

_____ year

43. What percentage of your patients are served in a home-based program? (Enter 'unknown' if you do not know) (Please enter a numeric value)_____ %

44. Do you perceive your program has sufficient capacity to meet need/demand in the home-based model?

☐ Yes

☐ *No*

44b. If NO, please specify why your program doesn't have sufficient capacity to meet/demand in the home-based model (check all that apply):

☐ Not enough funding

☐ Not enough staff

☐ Not enough other resources

☐ Patients' risk too high for unsupervised exercise

☐ *Other*

Please specify the other reason your program doesn't have sufficient capacity in the home-based program_____

45. What is the standard <u>duration</u> of the home-based cardiac rehabilitation program that you provide to patients? (specify in weeks) (Please enter a numeric value in the field)_____ weeks

46. On average, how many sessions (i.e., formal contact with the Cardiac Rehabilitation staff) does each patient complete in the home-based program each

month? (frequency; do not report how many sessions your program runs in a month for all home-based patients)____ sessions / month

47. On what basis are patients offered a home-based program? (check all that apply)

- Risk stratification
- Patient indication
- Distance to centre
- Time or work constraints during the Cardiac Rehabilitation centre hours
- Transportation barriers
- Patient choice
- Cost
- *Other*

Please, specify on what other basis are patients offered a home-based program_____

48. Does the home-based program offer telemetry or another method of monitoring patients' clinical status while exercising? (check all that apply)

- ☐ Yes telemetry
- ☐ *Yes other method of monitoring*
- ☐ None

If other method of monitoring please specify:

- ☐ Borg scale (perceived exertion)
- ☐ Heart rate

□ *Other*

Please specify what other method of monitoring is used in your program_____

49. Do participants in your home-based program receive any materials to support them in the program? (check all that apply)

☐ Yes they receive an activity tracker (e.g., pedometer, accelerometer, log book)

☐ Yes they receive resistance training materials (e.g., therabands, dumbbells)

☐ Yes they receive education materials (e.g., workbook)

☐ *Yes they receive other materials*

Please specify what other materials they receive_____

☐ *Sometimes*

Please describe under what instances participants receive materials, and type of material(s) provided_____

☐ No

50. Which of the following patient levels of cardiac risk do you accept for your home-based program? (Check all that apply)

☐ Low

☐ Moderate

☐ High

☐ Not applicable because we do not risk stratify at our program

51. What forms of communication are used with patients in your home-based program? (check one box per row, to report the frequency)

	Never	Daily	Several Times/week	Weekly	Several times / month	Monthly	Just once
Internet webpage	☐	☐	☐	☐	☐	☐	☐
Email	☐	☐	☐	☐	☐	☐	☐
Webcam	☐	☐	☐	☐	☐	☐	☐
Mobile phone	☐	☐	☐	☐	☐	☐	☐
Smartphone app	☐	☐	☐	☐	☐	☐	☐
Text messages	☐	☐	☐	☐	☐	☐	☐
Log or diary (paper)	☐	☐	☐	☐	☐	☐	☐
Telephone (landline)	☐	☐	☐	☐	☐	☐	☐
In-person /	☐	☐	☐	☐	☐	☐	☐

on-site visit

Other ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please specify what other form of communication is used in your home-based program_____

52. Did you perceive any barriers to using these communication tools?

☐ *Yes*

☐ No

Check all the barriers that apply:

☐ Logistical problems: i.e., connection

☐ Lack of patient access (i.e., patients do not have computer with email)

☐ Difficulty for the clinical staff

Please specify the difficulties for the clinical staff_____

☐ Difficulty for the patients

Please specify the difficulties for the patients_____

☐ *Other*

Please specify other perceived barriers to communicating with patients via technology_____

_____

53. Which providers interact directly with the patients in the home-based cardiac rehabilitation program? Please check all that apply:

- ☐ *Physician*

  Please specify the specialty of the physician who interacts directly with the patients in the home-based program _____

- ☐ Nurse
- ☐ Exercise physiologist
- ☐ Physiotherapist
- ☐ *Other*

  Please specify who interacts with the patient in the home-based program_____

54. What do you think you would need to be ready and able to significantly increase your program's capacity to provide home-based cardiac rehabilitation services to patients?

_____

_____

_____

_____

If Q41b was marked: Community-based program, please answer the following:

55. Where does the community-based program take place?

☐ Public center

☐ Private center

☐ Semi-private center

☐ *Other*

Please specify where the community-based program takes place_____

56. When did it start? (Please enter a numeric value)

_____ year

57. What proportion of your patients are served in the community-based program? (Please, enter a percentage; only a number) _____ %

58. On average, how many patients are in each exercise session? (Please enter a numeric value)_____ patients / session

59. How many classes do you offer in a week? (for all patients)_____ sessions per week

60. Which of the following patient levels of cardiac risk do you accept for your community-based program? (Check all that apply)

☐ Low

☐ Moderate

☐ High

☐ Not applicable because we do not risk stratify at our program

61. Which type of provider is most responsible to supervise the Community-based exercise sessions? Please check one box:

☐ *Physician type*

Please specify the specialty _____

☐ Nurse

☐ Exercise physiologist

☐ Physiotherapist

☐ *Other*

Please specify who is the most responsible to supervise the community-based program_____

62. What is the standard duration of the community-based cardiac rehabilitation program that you provide to patients? (Please enter a numeric value)

_____ weeks

63. On average, how many sessions does each patient complete in the community-based program each month? (i.e., frequency; do not report how many sessions your program runs in a month)_____ sessions per month

64. On what basis are patients offered a community-based program? (check all that apply)

☐ Risk stratification

☐ Patient indication

☐ Distance to main Cardiac Rehabilitation centre

☐ Time or work constraints during the Cardiac Rehabilitation centre hours

- Transportation barriers
- Patient choice
- Cost
- We do not have a main centre in a clinical setting
- *Other*

  Please specify on what other basis patients are offered a community-based program_____

65. Does the community-based program offer telemetry or another method of monitoring patients' clinical status while exercising? (check all that apply)

- ☐ Yes, telemetry
- ☐ *Yes, other method of monitoring*
- ☐ None

65.b. Please specify what other method of monitoring is used in your community-based program

- ☐ Borg scale (perceived exertion)
- ☐ Heart rate
- ☐ *Other*

  Please specify what other method of monitoring is used_____

66. What do you think you would need to be ready and able to significantly increase your program's capacity to provide community-based cardiac rehabilitation services to patients?

_____

_____

_____

_____

Thank you most sincerely on behalf of the International Council of Cardiovascular Prevention and Rehabilitation for the time and expertise you have committed to complete this important questionnaire.

In return for your participation, we would like to offer you some information describing the nature of cardiac rehabilitation as delivered in your country / region. This may be useful to your program.

Please note, we will not have the opportunity to compile this information and share it with you until we have finished collecting data from as many programs as possible.

If you would like to receive this information via email, please check this box

- ☐ Yes, I would like to receive information describing the nature of cardiac rehab delivered in my country / region