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Supplemental home-based exercise during cardiac rehabilitation

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SUPPLEMENTAL HOME-BASED EXERCISE DURING CARDIAC REHABILITATION

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ABSTRACT

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by Addison Pica

In this study, the effects of supplemental, home-based walking on resting systolic blood pressure, waist circumference, and quality of life (QoL) in cardiac rehabilitation (CR) patients were evaluated. Twelve patients wore pedometers during the last four weeks of their 12-week CR program. Resting systolic blood pressure, waist circumference, and QoL were measured at weeks 1, 8, and 12. After data collection, participants were categorized into low, moderate, and high volume groups based on their average number of steps taken per week. There was significant improvement in QoL during the 12-week CR program ($F(2,9) = 10.940$, $p < .001$). Participants rated their QoL better at weeks 8 ($p = .02$) and 12 ($p < .001$) than at week 1. However, the amount of supplemental walking during the final four weeks of the CR program did not affect QoL scores ($F(2,9) = .165$, $p > .05$). Although there were no significant differences in waist circumference across time or walking groups, the number of average weekly steps was significantly correlated with changes in waist circumference between weeks 1 and 12 ($r = -.592$, $p = .042$), and between weeks 8 and 12 ($r = -.645$, $p = .024$). Surprisingly, there was a statistically significant increase in resting systolic blood pressure across all groups during the CR program ($F(2,9) = 5.002$, $p = .019$). Thus participating in the CR program resulted in improved QoL; however, the small number of participants limited the power to detect differences in the outcome measures between walking groups.

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Chapter 1

Introduction

To regain strength, endurance, and functional independence, cardiac rehabilitation (CR) is critical for those who have experienced a cardiac event (Glassman, 2000). Over the past 20 years these rehabilitation programs have changed dramatically, going from prescribed bed rest for 1-2 weeks postcardiac event to starting a rehabilitation program as soon as 3-4 days after a cardiac event (Glassman, 2000; Keteyian, Pina, Hibner, & Fleg, 2010). The American Heart Association defines CR as a "medically supervised program to help heart patients recover quickly and improve their overall physical and mental functioning." According to the American Association of Cardiovascular and Pulmonary Rehabilitation, the following medical conditions are appropriate for CR: myocardial infarction (MI), stable angina, coronary artery bypass graft surgery (CABG), percutaneous transluminal coronary angioplasty (PTCA)/stent procedures, valve surgery, chronic stable heart failure (HF), ventricular assist devices, diabetes, cardiac transplantation, peripheral arterial disease, and high risk for coronary artery disease (Keteyian et al., 2010). The most common conditions seen in CR facilities today are MI, CABG, and stent implantation (Christensen & Jordan, 2008). Goals for CR include improving aerobic endurance and muscular strength, and modifying cardiovascular risk factors, including losing weight, lowering cholesterol, improving blood glucose, controlling blood pressure, and smoking cessation (Christensen & Jordan, 2008). New information is emerging from research about exercise prescription for people with heart failure and cardiac events; thus, there is a need to apply this information to CR programs.

Cardiac rehabilitation is a fairly new therapeutic modality within the medical community, and over the last 20 years significant advancements have been made in appropriate exercise modalities (Glassman, 2000; Keteyian et al., 2010). Recent research has shown that people who have experienced cardiac events can handle more frequent and intense exercise than originally thought (Kemi &Wisloff, 2010; Lee, Kilbreath, Singh, Zeman, & Davis, 2009; Marzolini, Oh, Thomas, & Goodman, 2008; Mezzani et al., 2010; Munkvik et al., 2010). Although advances have been made in exercise prescription for optimal CR, attendance and adherence is low (McGrady, McGinnis, Badenhop, Bentle, & Rajput, 2010; Zullo, Dolansky, & Jackson, 2010). Entry into CR programs ranges between 10-40%, with 40-80% of participants completing the program (McGrady et al., 2010). This could be due to psychological issues such as depression and anxiety, which have been linked to the development of heart disease (McGrady et al., 2010), social barriers such as notoriously low attendance rates for women (Sanderson, Shewchuk, & Bittner, 2010), or accessibility to training facilities (Keteyian et al., 2010). There are 7.9 million MI survivors in the United States, and 1.2 million will suffer a new or recurrent MI (Zullo et al., 2010). Zullo et al. call for "aggressive secondary prevention centering on behavior change and maintenance" (p. 28) to combat this deadly disease, which is claiming millions of lives each year.

Statement of the Problem

An issue within CR today is finding and implementing appropriate and optimal training strategies that promote patient adherence. To reduce the risk of recurrent cardiac events, patients must make lifestyle changes (Keteyian et al., 2010; McGrady et al., 2010; Mourot et al., 2010; Sanderson et al., 2010). Recent studies have called for more research on exercise prescription for this patient population. "Further studies, aimed at comparing the effects of high-intensity versus moderate-intensity continuous aerobic training on exercise capacity, safety, left ventricular remodeling, quality of life, and prognosis in CHF patients, are needed" (Mezzani et al., 2010, p. 638). A recent study by Keteyian et al. (2010) notes, "…long term adherence to exercise in patients with HF remains a challenge and requires additional research to determine strategies aimed at improving compliance. Areas of needed research include identifying which patient subgroup(s) benefits the most and determination of the optimal intensity, duration, and frequency of exercise needed to maximize clinical benefits and attenuate fatigue" (p. 67). Appealing to a person's motivation to exercise and achieve a higher level of health is critical for these patients, whose lifestyle habits likely contributed to their cardiac event (Keteyian et al., 2010). Clearly, there is a need for research on optimal exercise prescription for CR patients, and to determine exercise programs that promote adherence in this patient population.

Statement of Purpose

The purpose of this study was to evaluate the effects of supplemental, home-based exercise on resting systolic blood pressure (SBP), waist circumference, and quality of life in CR patients. During the last 4 weeks of their CR program, patients were given a pedometer that recorded the number of steps taken each day.

Hypotheses

This study tested three hypotheses. The first was that cardiac rehabilitation patients who engaged in higher amounts of supplemental walking each week during their clinical rehabilitation program would show a significant reduction in resting systolic blood pressure compared to patients who did not engage in supplemental walking exercise. The second was that cardiac rehabilitation patients who engaged in higher amounts of supplemental walking each week during their clinical rehabilitation program would show a significant reduction in waist circumference compared to patients who did not engage in supplemental walking exercise. Finally, the last hypothesis was that cardiac rehabilitation patients who engaged in higher amounts of supplemental walking each week during their clinical rehabilitation program would show significant improvement in quality of life scores compared to patients who did not engage in supplemental walking exercise. To test these three hypotheses, CR patients were categorized into low, moderate, and high walking groups based on the number of steps completed during the final 4 weeks of their CR program. Systolic blood pressure, waist circumference, and quality of life were measured at weeks 1, 8, and 12 of the CR program.

Delimitations

Participants for this study were delimited to patients enrolled and participating in the Phase II CR program at Salinas Valley Memorial Hospital. Phase II of CR is an outpatient program, with exercise monitored by cardiac nurses and exercise physiologists. Exclusion criteria included a life expectancy of <6 months, or an inability to walk unassisted or exercise outside of the rehabilitation clinic. All eligible participants were included regardless of age, gender, or ethnicity. The outcome measures of this study were delimited to resting systolic blood pressure (Nishijima et al., 2007; Pullen et al., 2010), waist circumference (Nishijima et al., 2007; Pullen et al., 2010; Vainiopaa et al., 2007), and quality of life scores based on the Dartmouth Quality of Life Index (Feiereisen, Delagardelle, Vaillant, Lasar, & Beissel, 2007; McGrady et al., 2010; Nishijima et al., 2007; Pullen et al., 2010).

Limitations

The limitations included participant adherence, accuracy of instrumentation, and medication effects. Participants wore a pedometer and were required to record daily steps; some patients may not have complied with this requirement. The accuracy of steps recorded was dependent on the pedometer measurement. Participants decided the amount of additional walking they did; they did not receive extra encouragement or incentives for a home-based walking program. Therefore, the number of steps taken each week was determined by the participant and could have been influenced by medication use, health status, or weather, if the participant chose to walk outside.

Dependent Variables

In this study, dependent variables were resting systolic blood pressure, waist circumference, and the Dartmouth Quality of Life Index score. Systolic blood pressure is the highest arterial pressure during a cardiac cycle and occurs after ventricular systole (Blumenthal et al., 2010). Waist circumference is a measurement around the belly button of an individual (Young et al., 1998), which is the measurement site used at Salinas Valley Memorial Hospital. A large waist circumference is harmful to overall health and a risk factor for cardiovascular disease (Nishijima et al., 2007; Vainiopaa et al., 2007). The Dartmouth Quality of Life Index is a questionnaire that measures daily activities, social activities, pain, overall health, quality of life, change in health, feelings, physical fitness, and social support. For the purpose of this study, the three clinical outcome measures were resting systolic blood pressure, waist circumference, and quality of life.

Independent Variable

The independent variable was the amount of supplemental walking performed outside the CR facility. Participants wore a pedometer that measured the number of steps completed each week during the last 4 weeks of their CR program. The pedometer was worn throughout the day, but not while exercising at the CR facility.

Summary

Cardiac rehabilitation is an important step in the process of recovering from major cardiac events such as myocardial infarctions, coronary artery bypass graft surgery, or a stent implantation (Glassman, 2000). The goals of a CR program are to regain strength, endurance, and functional independence. Patients can start the rehabilitation process as soon as 3-4 days after a cardiac event (Glassman, 2000). This is a dramatic change from 20 years ago when cardiac patients were prescribed bed rest for 1-2 weeks following a cardiac event (Glassman, 2000; Keteyian et al., 2010). Today, CR patients work on improving aerobic endurance and muscular strength, and modifying cardiovascular risk factors (e.g., body weight, diet, blood cholesterol, blood glucose, blood pressure, and smoking). Because this is a relatively new area of rehabilitation, information is emerging from research about the best ways to prescribe exercise; this information needs to be applied to the rehabilitation setting (Keteyian et al., 2010; Mezzani et al., 2010; Scharhag, George, Shave, Urhausen, & Kindermann, 2008). Recent studies have shown that people who have experienced cardiac events can handle more frequent and intense exercise than originally thought (Kemi & Wisloff, 2010; Lee et al., 2009; Marzolini et al., 2008; Mezzani et al., 2010; Munkvik et al., 2010). A main concern among CR professionals today is not only providing an optimal exercise prescription for their patients, but also finding appropriate and feasible means for patients to complete their rehabilitation and adhere to a long-term program (Keteyian et al., 2010; McGrady et al., 2010; Mourot et al., 2010; Sanderson et al., 2010; Zullo et al., 2010). The purpose of this study was to examine the effects of supplemental, home-based exercise on clinical cardiac outcomes. This was done by measuring resting systolic blood pressure, waist circumference, and quality of life scores of patients before, during, and at the completion of their Phase II CR program at Salinas Valley Memorial Hospital.

Chapter 2

Review of Literature

Introduction

The purpose of this study was to evaluate the effects of supplemental, home-based walking on clinical cardiac outcomes: resting systolic blood pressure, waist circumference, and quality of life. Chronic heart failure (CHF) is one of the most prevalent diseases today, and is a major cause of premature death and morbidity (Nishijima et al., 2007; Pullen et al., 2010; Sanderson et al., 2010; Zullo et al., 2010). A reduced aerobic exercise capacity is a main debilitating factor in patients with CHF and, as a result, patients perform activities of daily living at a higher percentage of their peak oxygen consumption (VO_2) compared with healthy people (Mezzani, 2010). Numerous studies have shown significant benefits of exercise on VO_2 max and other physiological mechanisms that limit performance in patients with CHF (Brassard et al., 2007; Mezzani et al., 2010; Nishijima et al., 2007; Vainiopaa et al., 2007).

Exercise is an ideal therapeutic modality for patients with chronic heart problems, and can help improve not only one, but multiple risk factors for CHF and cardiovascular disease (CVD) (Nishijima et al., 2007). CVD is a term used for a number of cardiovascular irregularities that affect the heart, including many of those seen in CR. According to the American College of Sports Medicine (2007), regular physical activity is highly recommended for delaying the development of atherosclerosis and reducing risk of cardiovascular events. Nevertheless, high intensity physical activity can increase the risk for an acute myocardial infarction or sudden cardiac death in some individuals. Habitual physical activity is critical; however, designing an appropriate exercise program for a person with multiple risk factors and/or disease is difficult (Vainiopaa et al., 2007). Recent research has recommended strength training to maintain muscle mass, strength, power, and endurance of CVD patients (Feiereisen et al., 2007; Marzolini et al., 2008). The purpose of this chapter is to review the literature on exercise prescription for patients with cardiovascular disease, who very often have multiple risk factors and multiple diseases (Brassard et al., 2007). These patients have low rates of attendance and adherence to clinical exercise prescriptions (Keteyian et al., 2010; McGrady et al., 2010; Mourot et al., 2010; Sanderson et al., 2010; Zullo et al., 2010). This chapter will present specific information on cardiac diseases and CR programs today, followed by research on aerobic and strength exercise programming for CR patients, issues with patient attendance and adherence, quality of life, and use of pedometers in research studies.

Cardiac Diseases

One of the most prevalent chronic illnesses of modern days is coronary heart disease (Pullen et al., 2010; Zullo et al., 2010). Sanderson et al. (2010) state, "Coronary heart disease (CHD) is the major cause of death and disability in the nation, with more than 16 million individuals living with CHD, including more than 7 million women" (p. 12). "In the United States, there are 7.9 million survivors of myocardial infarction (MI), and every year 1.2 million Americans have a new or recurrent MI"

(Zullo et al., 2010, p. 28). According to the Centers for Disease Control and Prevention (CDC), the most common cause of heart disease is coronary artery disease (CAD), which is a hardening and narrowing of the arteries, called atherosclerosis, due to a build up of plaque. Over time, CAD weakens the myocardium and limits blood flow to the heart, reducing oxygen to the myocardium. This can lead to a myocardial infarction. A myocardial infarction occurs when a portion of the myocardium dies or sustains damage due to a lack of oxygen. Atherosclerosis can also lead to angina, which is the most common symptom of CAD (Zullo et al., 2010). Angina is chest pain and discomfort due to the reduced blood flow to the heart. Risk factors for heart disease include diabetes, high cholesterol, high blood pressure, metabolic syndrome, being overweight and obese, physical inactivity, and tobacco use (Pullen et al., 2010; Zullo et al., 2010). The CDC reports that after the age of 65, the incidence of heart disease approaches 10 per 1,000 in the population (Christensen & Jordan, 2008).

According to the American College of Sports Medicine (2007), CHD patients are at risk of plaque disruption, ischemia-induced ventricular fibrillation, myocardial ischemia, malignant cardiac arrhythmias, and decreased venous return. These abnormalities, along with acute myocardial infarction and sudden death, are seen in the least physically active adults with CHD. Coronary artery disease is the most common cause of death in adults who die during exertion, most likely from acute coronary artery plaque disruption or rupture and/or acute thrombotic occlusion (Pullen et al., 2010). Evidence suggests this mortality is triggered by mechanisms including increased wall stress from increased heart rate, increased blood pressure, decreased flexibility of atherosclerotic epicardial coronary arteries, and/or exercise-induced coronary artery spasm (Scharhag et al., 2008; Scott & Warburton, 2008). Physical activity increases the demand for oxygen. To meet this demand, the heart beats faster, shortening diastole and coronary perfusion time; thus, there is less time for oxygen exchange (Scharhag et al., 2008; Scott & Warburton, 2008). Because of the demands of exercise, a thorough and careful evaluation is made on CHD patients before they are allowed to exercise (Nishijima et al., 2007; Vainiopaa et al., 2007). Furthermore, an individually designed exercise protocol is necessary to reduce the risk of cardiac events (Nishijima et al., 2007).

Cardiac Rehabilitation Today

Cardiac rehabilitation is a safe and effective way to treat patients who have experienced cardiac events (Christensen & Jordan, 2008; Glassman, 2000; Kemi & Wisloff, 2010; Zullo et al., 2010). "Cardiac rehabilitation services are comprehensive, long-term programs involving medical evaluation, prescribed exercise, cardiac risk factor modification, education, and counseling. These programs are designed to limit the physiological and psychological effects of cardiac illness, reduce the risk for sudden death or re-infarction, control cardiac symptoms, stabilize or reverse the atherosclerotic process, and enhance the psychosocial and vocational status of selected patients" (Mitka, 2007, p. 2127). Cardiac rehabilitation is traditionally divided into four phases. Phase I is an inpatient program. This is an acute stage, and the patient may still be in a coronary care unit with continuous monitoring of heart rhythm and rate. Phase II is an outpatient stage that can last anywhere from 3 to 6 months, depending on the health and rate of recovery of the patient. During this time, cardiac nurses and exercise physiologists monitor patients' blood pressure and electrocardiograms (EKG) during exercise. Phase III is a maintenance stage, which consists of supervised exercise and education from cardiac nurses and exercise physiologists. The length of this period can be indefinite, and patients will undergo heart rate and blood pressure checks before and after exercise. Phase IV is unsupervised, continued maintenance in which patients may become clients for personal trainers because there is no longer a need for medical supervision. These patients should still follow exercise guidelines set up by their rehabilitation staff. Outpatient cardiac rehabilitation facilities treat Phase II and III patients, and provide a wide range of services from patient assessment, exercise training, education, and counseling. The education portion consists of physical activity and nutritional counseling; smoking cessation; and lipid, blood pressure, weight, diabetes, and psychosocial management (Christensen & Jordan, 2008). These programs employ a team of cardiologists, nurses, exercise physiologists, and social workers who support patients in the program to reduce the risk of further cardiovascular disease, and improve functional capacity and quality of life.

Although CR has been around for decades, less than 40% of eligible patients participate, and of those participating, only 40-80% complete the program (Mitka, 2007; Zullo et al., 2010). Professionals in the field are hoping that new clinical outcome measures will be evaluated to ensure that physicians and hospitals utilize CR most effectively. Studies have shown that CR reduces the risk of new cardiovascular events at similar rates as prescribed medical therapies for patients who have cardiac disease (Mitka, 2007).

Aerobic Exercise

Recent studies have shown that people who have sustained a cardiac event can handle more intense exercise than originally thought (Eder et al., 2010; Kemi & Wisloff, 2010; Lee et al., 2009; Marzolini et al., 2008; Mezzani et al., 2010; Munkvik et al., 2010). Eder et al. (2010) assessed the effect of additional exercise during a standard clinical CR program. Sixty participants who had undergone heart surgery were randomized into a control group that participated in the standard CR program only, or intervention groups where participants were selected for either walking or cycling exercise. Participants (32 men and 28 women) were included if they were >65 years-of-age, could walk and cycle on their own, and had a baseline functional capacity of <75 watts. All 60 participants completed a standard CR program that consisted of 30 min of calisthenic exercise and 30 min of walking 3 days a week for 4 weeks. The cycling intervention group exercised on ergometers for 12 min each day in the first week, with a 2-min increase each subsequent week. The walking intervention group walked on a flat surface for the same duration as the cycling group. Exercise intensities for both intervention groups were initially based on 50% of maximal power output, determined from a cardiopulmonary exercise test. Results showed significant differences between the control and intervention groups on peak VO_2, the 6-min walk test, and quality of life, with no differences between the cycling and walking interventions.

Mezzani et al. (2010) looked at the upper intensity limit for prolonged aerobic exercise in CHF. In this study, 15 untrained CHF patients were age matched with 5 untrained and 5 trained healthy participants. Critical power, or the highest power output that could be sustained under steady-state oxygen consumption and blood lactate conditions, was determined. Critical power was 66 ± 6% of peak power for the CHF patients and untrained healthy participants. In contrast, critical power was 74 ± 3% of peak power for the trained healthy participants. These workloads corresponded to 81 ± 26%, 91 ± 11%, and 83 ± 9% of heart rate reserve for the CHF, untrained, and trained healthy participants, respectively. These workloads were significantly higher than ventilatory anaerobic threshold, indicating that CHF patients with stable left ventricular dysfunction can safely participate in high-intensity, continuous aerobic training at intensities up to 65% of peak power.

Two clinical investigations in 2007 showed that additional exercise is beneficial for people with risk factors for CVD (Brassard et al., 2007; Nishijima et al., 2007; Vainiopaa et al., 2007). It is difficult to design exercise programs for people with multiple conditions, which is often true of CR patients. Vainiopaa et al. (2007) investigated the effect of impact exercise on osteoporosis and cardiovascular risk factors. They hypothesized that impact exercise would increase VO_2 and isometric leg strength, and would also have a positive effect on lipoprotein levels and glucose metabolism. The study consisted of 120 female participants between the ages of 35 to 40 with osteoporosis and risk factors for cardiovascular disease. Half of the participants completed a 12-month training program that consisted of 2 to 3 days per week of supervised, progressive, high impact aerobic exercise and a daily supplemental home exercise routine. Participants wore an accelerometer during all waking hours to quantify daily physical activity. Total cholesterol and low-density lipoprotein (LDL-C) decreased significantly more in participants who were in the highest quartile for physical activity. There also appeared to be a dose-response relationship between the quantity and intensity of exercise and risk factor reduction. Participants who exercised at higher intensities and more frequently had greater reductions in waist and hip circumferences, and serum lipids. The difference in LDL-C between the most active and the least active was clinically significant and further demonstrated the importance of exercise for reducing risk factors. The exercise program also improved cardiorespiratory fitness, with a 12% improvement in VO_2max, contributing to a lower risk of CVD. The exercise program was more beneficial for participants who were at the highest risk of impaired glucose metabolism. Lipoprotein improvements were seen even when exercise intensity was very light, such as slow aerobic stepping, as long as the repetition number was high. For people who need to improve lipoprotein profiles and insulin sensitivity, the quantity of exercise is more important than the intensity as long as they are physically active on a daily basis. However, an increase in the quantity or intensity of exercise may contribute to additional benefits. Finally, this study demonstrated that physical fitness changes were associated with compliance to the supervised training sessions. Although this study examined the effect of exercise on CVD risk factors in women without known cardiac disease, a goal of CR programs is to decrease CVD risk factors.

Nishijima et al. (2007) also studied the effect of exercise on CVD risk factors. The participants in this study were overweight with at least two of the following three risk factors: hypertension, hyperlipidemia, glucose intolerance. Participants exercised 2 to 4 days a week for 6 months. Results showed reduced waist circumference, diastolic blood pressure, and triglycerides, and increased VO_2 peak. Overall, this study demonstrated an improvement in CVD risk factors and quality of life for sedentary, overweight participants with multiple risk factors. The authors hypothesized that their results could be found with any form of aerobic exercise due to the general consensus that exercise benefits are not limited to one particular mode of exercise. However, some studies have advocated the use of strength training to obtain similar risk reduction and improvement in patients with CVD.

Type 2 diabetes increases the risk of developing CHF. Brassard et al. (2007) examined the effect of aerobic exercise training on 23 participants with Type 2 diabetes and left ventricular diastolic dysfunction (LVDD). The 12 month training program consisted of 30-60 min of aerobic exercise 3 days a week; no strength training was performed. Results showed a 13% improvement in VO_2 max. Similar results were also found in a recent study that demonstrated beneficial effects of aerobic exercise 5 days a week on left ventricular remodeling after myocardial infarction (Xu et al., 2010). This improvement in left ventricular function is therapeutically relevant to patients with Type 2 diabetes, improving the ability to perform exercises and activities of daily living, and reducing the amount of diastolic wall stress.

Strength Training

CR facilities are increasingly incorporating strength training into their programs (Marzolini et al., 2008). Recent research has investigated strength training prescriptions for CR patients; however, the appropriate volume of strength training for patients with CAD is currently unknown. Marzolini et al. (2008) compared single and multiple set programs with aerobic only training programs. A total of 72 CAD patients participated in either 5 days per week of aerobic training, or 3 days per week of aerobic training with either 1 or 3 sets of resistance training. Similar changes in cardiovascular fitness (VO_2 peak) were found in the aerobic only training group and the resistance plus aerobic training groups. However, the multiple set group also demonstrated a greater increase in total body, arm, and leg lean mass when compared to the single set group. Overall, the resistance training was well tolerated in the CAD patients, and the authors advocated the use of resistance training (with three sets) in combination with aerobic training for more pronounced physiological adaptations.

An earlier study demonstrated similar benefits from resistance training. Feiereisen et al. (2007) examined training modalities for CHF patients. They noted that current guidelines on strength training for CHF patients are very cautious, even though strength training can reduce peripheral muscle dysfunction, which is responsible for key symptoms such as dyspnea, fatigue, and exercise intolerance. CHF patients in this study performed strength training, endurance training, or a combination for 45 min, 3 days a week for 40 sessions. All three training programs contributed equally to improvements in VO_2, workload, cardiac function, peripheral muscle mass, and quality of life. However, although a significant increase in peripheral muscle endurance was observed from all three programs, there was an even greater increase for patients in the endurance training group. The endurance training group also had greater improvements in left ventricular ejection fraction, a measure of cardiac function.

The next step in CR is to ensure that the exercise prescription reflects results from the latest research (Keteyian et al., 2010). A recent study by Pullen et al. (2010) examined benefits of yoga in African American heart failure patients. Forty heart failure outpatients in a cardiology clinic were randomly selected to participate in yoga for 8 weeks in addition to their home walk program, or to only do the home walking program. Both groups improved VO_2 peak, exercise capacity, and flexibility, and reduced inflammatory markers, but greater improvements were seen in the group that participated in yoga, in addition to the home walk program. The authors suggested a possible mechanism for these findings is that the yoga postures, combined with breathing exercises and meditation, attenuate sympathetic activation, which could lead to a decrease in ventricular filling pressures. Yoga was selected because of the breathing and meditation benefits, and yoga is a safe form of exercise that can be practiced by the elderly, disabled, and people with cardiac disease. This study also recommended the use of pedometers or accelerometers and an activity questionnaire to more objectively quantify physical activity done outside of the CR clinic.

Patient Attendance and Adherence

A growing issue within CR research is patient attendance and adherence (Keteyian et al., 2010; McGrady et al., 2010; Mourot et al., 2010; Sanderson et al., 2010; Zullo et al., 2010). Cardiac rehabilitation has changed drastically since the 1970s when patients who had a cardiac event were directed to rest as their primary recovery strategy (Keteyian et al., 2010). Cardiac rehabilitation is still fairly new. Only 10-40% of eligible patients enter a program, and 40-80% complete the program (McGrady et al., 2010). The effects of depression and anxiety were examined on 380 patients with MI, CABG, angina, or CHF who were enrolled in a CR program (McGrady et al., 2010). Depression, anxiety, and quality of life were assessed by standard questionnaires and a psychiatrist during the 12-week period when the patients were exercising 3 days a week. The study found that 20-30% of patients entering a CR program presented depressive symptoms, and patients with psychological distress had a more difficult time completing the program. However, the study demonstrated that even with psychological distress, a CR program is helpful to patients both psychologically and physically, and that completing a clinical program should be encouraged. The authors did note that taking more physiological measures would have been advantageous, and also called for more research to identify strategies to maintain anxious and depressed patients in the rehabilitation program.

Underutilization of CR is especially pertinent for women, who are even less likely than their male counterparts to participate in a rehabilitation program. Sanderson et al. (2010) examined 131 women who were eligible for CR over a period of 16 months. Interviews were conducted to obtain ideas on the women's perceptions about CR. Factors that contributed to positive perceptions about CR included having good education classes, learning to live with their respective disease without being afraid, having convenient program hours, wanting to be self-sufficient, and wanting to maintain a healthy lifestyle. Results showed that 59% of women were referred to CR, with no demographic or clinical factors contributing to this referral. Among the women referred, only 34% enrolled, and women who did not enroll had lower education levels (less than 12 years) than those who did enroll. Overall, the study noted that both CR referrals and enrollments rates were "disappointingly low" (p. 12). The authors called for future research to be done "at all levels to help bridge the gaps in knowledge and practice in providing effective secondary prevention to women with heart disease" (p. 19).

A study by Fontana, Kerns, Rosenberg, Marcus, and Colonese (1986) examined exercise adherence for 50 male cardiac rehabilitation patients. The study looked at patient adherence at three points in the program: recruitment into the program, participation in the training, and continuation of the exercise after the formal program was completed. Patients were followed for 1 year after hospitalization. Results showed that 50% of patients attempted the 12-week CR program, with exercise adherence declining by 50% after the completion of the program, decreasing to 30% 9 months after the program had ended. Factors that contributed to adherence were distance from the CR facility, feelings toward CR staff, severity of the cardiac incident, history of physical exercise, perception of barriers, and perception of vulnerability. The study called for future research on efficacy of exercise training, and patients' hopes and perceptions of personal control.

Bunker (2000) followed 697 CR patients, 70.4% male and 29.6% female, through their outpatient CR program. Overall, 69.2% of males and 54.9% of females attended at least one session. Factors positively associated with attendance were access to transport, shorter distance to travel, being married, higher level of education, and intention to attend. Factors associated with nonattendance were lack of motivation, distance and transport difficulties, and medical reasons/ill health. Other factors associated with CR, such as quality of life, were addressed in other studies.

Quality of Life

Improving quality of life (QoL) is a main focus of CR programs and is monitored by professionals during Phase II of the rehabilitation process. A patient's overall QoL is influenced by environmental constraints, coping mechanisms, and personal feelings (Shephard & Franklin, 2001). Among patients with cardiac disease, women had poorer QoL than men, and expressed more worry about overall health along with anxiety, depression, and self-esteem problems (Shephard & Franklin, 2001). Despite gender differences, cardiac patients exhibited concern about physical functionality, capacity for self-care, ability to play a meaningful role in the work place, and feelings of well being and comfort.

Marike et al. (1999) looked at aerobic exercise frequency and improvement in QoL. Phase II CR patients (N=130, 32-70 years-of-age) were randomly assigned to high-frequency (10 sessions per week) and low-frequency (2 sessions per week) training groups for a 6 week training program. A single exercise session included 30 min of stationary bicycling at 60-70% of max heart rate, and 60 min of sports, including ball sports, calisthenics, or swimming. A General Health Questionnaire was used to measure QoL. Subgroups within this questionnaire looked at perceptions of mental health, physical pain, social functioning, physical functioning, vitality, general health, and any perceived health changes since the cardiac event. Results showed that after the 6 weeks of training, the high-frequency patients reported significantly more positive changes in psychological distress, mental health, and health change compared to the low-frequency patients.

Kardis, Johnson, and Barnett (2005) examined the effect of age of cardiac rehabilitation patients on QoL measures. From 2001 to 2005, 556 Phase II CR patients were compared on their QoL measurements based on the Dartmouth Quality of Life Index. The Dartmouth QoL Index is a written questionnaire containing questions on daily activities, feelings, overall health, pain, physical fitness, and QoL. Lower scores indicate a higher overall QoL. Participants in the study were divided into three groups based on their age: 50 years-of-age or younger, 51-65 years, and over 65 years. A repeated measures ANOVA was used to determine differences between age groups and QoL measured before and after the 3 month CR program. Results showed statistically significant improvement ($p < 0.01$) across all age groups for daily activities, feelings, overall health, pain, physical fitness, and QoL. Older participants had greater improvements on the overall health and pain subscales.

Pedometer Use

The use of pedometers has been advocated to more precisely quantify the amount of physical activity being done outside of clinically supervised exercise (Nishijima et al., 2007; Pullen et al., 2010; Scharhag et al., 2008; Vainiopaa et al., 2007). In particular, Clemes and Parker (2009) studied reactions of adult participants to pedometer use during walking and activities of daily living. The study showed that significantly more steps were taken by participants who used a pedometer, along with keeping a written record of number of steps taken. There were no differences between men and women. These results have implications for any study looking at habitual, free-living activity.

Savage and Ades (2008) studied the daily step counts and cardiac risk factors of incoming Phase II CR patients. Over 107 CR patients wore a pedometer for the first 7 days of their clinical rehabilitation program, with CR and non-CR days analyzed separately. Results showed a significantly higher number of steps on the days patients were in CR. Total daily step count also correlated significantly with VO_2 peak, number of days from the cardiac event, physical function score, waist circumference, body mass index, and HDL-C. Overall, the study found that average daily steps during the first week of a CR program was very low, but after a cardiac event, a higher number of daily steps was associated with an improvement in the measured risk factors.

A study in 2006 looked at the effect of pedometers on exercise motivation of CR patients. Rosneck, Waechter, and Josephson randomly assigned 98 Phase II CR patients to either an open or closed pedometer group. The open group viewed pedometer readings and recorded daily steps; whereas, participants in the closed group did not see their steps. All participants were asked to increase their home-based walking. Exclusion criteria included participants who could not complete 20 CR sessions, record steps accurately, or wear pedometers. Results showed a nonsignificant increase in the mean number of steps taken per day in the open group compared to the closed group.

Leicht and Crowther (2007) found that walking over dry beach sand significantly reduced walking speed and the recorded number of steps compared to concrete and grass. Caution is advised when using pedometers to measure steps walked on the beach, especially in females whose exaggerated hip movements may affect pedometer measures. This further illustrates the importance of combining pedometer use with a daily journal entry of physical activity to see if participants are walking on surfaces that could cause measurement inaccuracies.

Abelt et al. (2005) used pedometers to measure daily steps taken by patients with systolic and diastolic heart failure. Twenty-seven heart failure patients were tested for VO_2 max and wore a pedometer for 7 days. Results showed that average daily steps significantly correlated with VO_2 ($r = 0.84$, $p < .001$). Additionally, the study found that average daily steps for diastolic heart failure patients were similar to healthy populations; whereas, steps for systolic heart failure patients were significantly lower.

Summary

Cardiovascular disease is the leading cause of death in the United States. Risk factors for CVD include high blood pressure, high cholesterol, metabolic syndrome/ diabetes, overweight/obesity, physical inactivity, and tobacco use (Pullen et al., 2010; Sanderson et al., 2010; Zullo et al., 2010). Cardiac rehabilitation is a service provided by clinical professionals to limit the physiological effects of cardiac disease, reduce the risk of death, control symptoms, and enhance quality of life (Christensen & Jordan, 2008; Glassman, 2000; Kemi & Wisloff, 2010; Zullo et al., 2010). These goals are achieved through methods that include physical activity and nutritional counseling; exercise training; smoking cessation; and lipid, blood pressure, weight, diabetes, and psychosocial management (Christensen & Jordan, 2008). Because many of these patients often have multiple risk factors, proper exercise prescription is crucial. Recent research has indicated that chronic heart failure patients can handle more exercise than originally thought (Kemi & Wisloff, 2010; Lee et al., 2009; Marzolini et al., 2008; Mezzani et al., 2010; Munkvik et al., 2010). Studies have found a relationship between quantity of aerobic exercise and reduction of CVD risk factors (Nishijima et al., 2007; Vainiopaa et al., 2007). Other studies (Brassard et al., 2007; Xu et al., 2010) have shown that aerobic exercise 5 days a week significantly improves left ventricular function. Strength training for cardiac patients has also been examined (Feiereisen et al., 2007; Marzolini et al., 2008). These studies have shown that while strength training was well tolerated in CHF patients, a combination of resistance and aerobic training should be employed 3 to 5 days a week to have significant beneficial effects on VO_2, workload, cardiac function, peripheral muscle mass and function, and quality of life. One of the next steps in CR is to find optimal strategies of exercise prescription to improve clinical outcomes. Additionally, these training strategies need to promote patient attendance and adherence (Sanderson et al., 2010).

Chapter 3

Methods

Introduction

The purpose of this study was to evaluate the effects of supplemental, home-based walking on resting systolic blood pressure, waist circumference, and quality of life of patients participating in a Phase II CR program. This chapter will provide detailed information on participants, instrumentation, research design, and statistical analysis.

Participants

The participants for this study were patients enrolled in and attending the CR program at Salinas Valley Memorial Hospital. There were 12 participants, 3 female and 9 male, with ages ranging from 53 to 84, and an average age of 69 years. Heights ranged from 61 to 70 in. (154.9 to 177.8 cm), with an average of 66.3 in. (168.4 cm). Weights ranged from 143 to 239 lbs (64.9 to 108.4 kg), with an average of 194.5 lbs (88.2 kg). This study was approved by the Institutional Review Board at San José State University and the director of the CR program at Salinas Valley Memorial Hospital. Participants read and signed a consent form to participate in the study. All patients were included unless they met one of the following exclusion criteria: (1) life expectancy <6 months, (2) unable to walk unassisted, or (3) unable to exercise outside of the rehabilitation clinic. No participants in the study were excluded based on these criteria. This patient selection was based on previous research on CR patients (Pullen et al., 2010). Additionally, all patients enrolled and participating in the CR program were included regardless of age, gender, or ethnicity.

Instrumentation

Resting systolic blood pressure, waist circumference, and quality of life were measured at the beginning (week 1), middle (week 8), and end (week 12) of the patients' 36 sessions in the clinical CR program. The measurements were taken before the participant had done any exercise that day and, based on a recent study by Pullen et al. (2010), participants were instructed to take medications as usual. A Philips Sure Signs VS3 Patient Monitor, number 989803144001, was used to measure resting systolic blood pressure. Resting blood pressure was measured at the left brachial artery after the participant had been seated for 5 min (Pullen et al., 2010) and prior to waist circumference measurements. Waist circumference was measured using an Advicor Niacin Extended-Release/Lovastatin Tablets measuring tape. Waist circumference was measured under the participants' clothes, starting at the umbilicus and going completely around the waist. Young (1998) found that compared to skinfolds, bioelectrical impedance, and hydrostatic weighing, measuring waist circumference at the level of the umbilicus was a better indicator of body composition for CR patients. Quality of life was measured using the Dartmouth Quality of Life Index (Appendix B), which uses Likert scale questions including daily activities, social activities, pain, overall health, quality of life, change in health, feelings, physical fitness, and social support (Beaufait et al., 1992; Feiereisen et al., 2007; McGrady et al., 2010; Nishijima et al., 2007; Pullen et al., 2010). OMRON pedometers were used to quantify the number of steps taken outside of the CR program.

Research Design

The research design was observational. Eligible participants received a pedometer to track number of steps taken during the last 4 weeks of their clinical rehabilitation period. The pedometers were worn at all times during the day except when participating in CR sessions. Participants were called weekly and asked for the number of steps recorded for the week. After the data were collected, participants were categorized into low, moderate, and high groups based on the number of steps taken per week. The effect of this supplemental, voluntary walking on resting systolic blood pressure (Nishijima et al., 2007; Pullen et al., 2010), waist circumference (Nishijima et al., 2007; Vainiopaa et al., 2007) and quality of life changes (Feiereisen et al., 2007; McGrady et al., 2010; Nishijima et al., 2007; Pullen et al., 2010) were examined.

Statistical Analysis

The low, moderate, and high volume groups were compared on changes in resting systolic blood pressure, waist circumference, and quality of life. Based on statistical analysis techniques used in similar studies (Mezzani et al., 2010; Pullen et al., 2010), a two-way, repeated measures ANOVA was used to determine differences between groups and across time. Additionally, a Pearson Product Moment Correlation was used to examine relationships between number of steps and changes in systolic blood pressure, waist circumference, and quality of life.

Summary

Twelve patients in Salinas Valley Memorial Hospital's Phase II CR program participated in the study. All CR patients were eligible to participate unless they had a life expectancy of <6 months, or were unable to walk unassisted or exercise outside of the rehabilitation clinic. All patients met the inclusion criteria and were asked to participate. Participants were given a pedometer and asked to track the number of steps taken each day for the final 4 weeks of their clinical rehabilitation program. Mean step scores were calculated after the data were collected, and participants were divided into low, moderate, and high volume walkers based on their mean scores. Resting systolic blood pressure, waist circumference, and quality of life were measured at the beginning, middle, and end of the participants' clinical rehabilitation program. To determine the effects of supplemental, home-based walking, a two-way repeated measures ANOVA was used to evaluate differences in systolic blood pressure, waist circumference, and quality of life among low, moderate, and high volume walking groups. Relationships between number of steps and changes in systolic blood pressure, waist circumference, and quality of life were also examined.

Chapter 4

Results

The purpose of this study was to evaluate the effects of supplemental, home-based walking on resting systolic blood pressure, waist circumference, and quality of life in CR patients. Twelve patients in a Phase II CR program volunteered to participate and wore pedometers for 4 weeks to track the number of steps they took each day outside of their CR time. After collecting the data, participants were categorized into low (n = 2), moderate (n = 6), and high (n = 4) volume walking groups based on their weekly steps. Average weekly steps (with standard deviations in parentheses) were 2,356 (735); 11,888 (2,461); and 47,503 (42,462) for the low, moderate, and high groups, respectively. Steps ranged from 1,040-2,876; 6,461-15,074; 22,448-111,054 for the low, moderate, and high groups, respectively.

To examine differences in quality of life, waist circumference, and resting systolic blood pressure between walking groups across the 12-week time period, a two-way, repeated measures ANOVA was run for each dependent variable. Quality of life was measured using the Dartmouth Quality of Life Index. Scores on this questionnaire can range from 9 to 45, with a lower score representing a higher QoL. There was a significant improvement in QoL during the 12-week CR program, $F(2,9) = 10.940$, $p < .001$. Post-hoc analysis using a Tukey test showed that compared to week 1, participants rated their QoL better at weeks 8 ($p = .02$) and 12 ($p < .001$). (See Table 1.) There was no significant change between weeks 8 and 12. Thus, one outcome of the 12-week CR program was an improvement in QoL, with the greatest change occurring during the first 8 weeks of the program. In contrast to the changes that occurred over time, the amount of supplemental walking during the final 4 weeks of the CR program did not affect QoL scores, $F(2,9) = .165$, $p > .05$. Similarly, there was no significant group-by-time interaction. With the small number of participants in each walking group, the power to detect a difference between groups was low (5%).

Table 1

Quality of Life Scores of Participants in Walking Groups During CR Program

	Walking Group		
	Low (n = 2)	Moderate (n = 6)	High (n = 4)
Week 1	28.5 (5.0)	20.7 (6.9)	25.5 (5.1)
Week 8	18.5 (2.1)	20.8 (6.9)	20.3 (3.9)
Week 12	17.0 (2.8)	17.5 (2.8)	17.0 (4.8)
Week 1 to Week 8 Change	-10.0 (2.8)	0.17 (4.7)	-5.25 (4.0)
Week 8 to Week 12 Change	-1.5 (0.7)	-3.33 (6.3)	-3.25 (3.0)
Week 1 to Week 12 Change	-11.5 (2.1)	-3.17 (7.0)	-8.5 (5.9)

Note. Mean (SD) scores on the Dartmouth Quality of Life Index. A low score indicates a higher quality of life. Negative change scores indicate improved quality of life scores.

Waist circumference, measured at the level of the umbilicus, was a second outcome measured during the 12-week CR program. As shown in Table 2, there were no significant changes in waist circumference across time ($F(2,9) = 1.908$, $p > .05$) or between walking groups ($F(2,9) = 1.173$, $p > .05$). Waist circumference is an indicator of abdominal obesity, a risk factor for CVD disease. These results indicate that this risk factor was not modified by the 12-week CR program.

Table 2

Waist Circumference of Participants in Walking Groups During CR Program

	Walking Group		
	Low (n = 2)	Moderate (n = 6)	High (n = 4)
Week 1	115.6 (10.8)	103.3 (10.8)	107.8 (11.6)
Week 8	118.4 (12.1)	105.1 (11.8)	110.0 (9.4)
Week 12	118.4 (12.1)	104.6 (11.1)	106.2 (6.9)
Week 1 to Week 8 Change	2.8 (1.3)	1.8 (4.6)	2.2 (2.9)
Week 8 to Week 12 Change	0 (0)	-0.5 (1.3)	-3.8 (2.9)
Week 1 to Week 12 Change	2.8 (1.3)	1.3 (5.0)	-1.6 (5.3)

Note. Values are mean (SD) in cm

The third outcome, resting systolic blood pressure, was measured at weeks 1, 8, and 12 of the CR program. As shown in Table 3, there was a significant increase in blood pressure across all groups $F(2,9) = 5.002$, $p = .019$. A post-hoc Tukey test was used to evaluate pairwise comparisons. Resting systolic blood pressure at week 12 was higher than week 1 ($p = .016$), with no difference in blood pressure between weeks 1 and 8, and weeks 8 and 12. There was no significant interaction between walking groups and time, and no difference between the three walking groups.

Table 3

Resting Systolic Blood Pressure of Participants in Walking Groups During CR Program

	Walking Group		
	Low (n = 2)	Moderate (n = 6)	High (n = 4)
Week 1	127 (4)	106 (9)	124 (26)
Week 8	137 (4)	123 (13)	113 (28)
Week 12	143 (4)	126 (18)	131 (12)
Week 1 to Week 8 Change	10 (8)	17 (14)	-11 (4)
Week 8 to Week 12 Change	6 (0)	3 (15)	18 (16)
Week 1 to Week 12 Change	16 (8)	20 (19)	7 (15)

Note. Values are mean (SD) in mm Hg

Relationships between weekly steps and resting systolic blood pressure, waist circumference, and quality of life were examined using a Pearson Product Moment Correlation matrix. There was a significant correlation between average weekly steps and the change in blood pressure from weeks 8 to 12, $r = .660$, $p < .019$. As shown in Table 3, participants who walked more outside of the CR program surprisingly increased their resting systolic blood pressure more than participants in the low and moderate walking groups. However, there was no statistically significant difference in resting systolic blood pressure between walking groups at the end of the 12-week CR program. Based on average systolic pressure, both participants in the low walking group were classified as hypertensive at the end of the 12-week CR program. In the moderate walking group, three participants had normal systolic pressure, two were categorized as prehypertensive, and one was hypertensive at the end of the 12-week program. Similarly, in the high walking group, one participant had normal systolic pressure, two were categorized as prehypertensive, and one was hypertensive at the end of the program.

Additionally, the number of average weekly steps was significantly correlated with changes in waist circumference over the 12-week CR program ($r = -.592$, $p = .042$), and changes in waist circumference from week 8 to week 12 ($r = -.645$, $p = .024$). As shown in Table 2, participants in the low and moderate walking groups increased waist circumference by 2.8 and 1.3 cm, respectively, compared to participants in the high walking group that reduced waist circumference by 1.6 cm over the 12-week CR program. Thus, participants who walked more steps had a greater reduction in waist circumference from week 1 to week 12.

Participants were consistent in their walking pattern over the 4 week intervention. As shown in Table 4, there were significant correlations between the number of steps taken each week that the participants wore pedometers. Thus, participants who walked more steps during week 1 of the intervention continued this pattern during the following 3 weeks, and participants who walked fewer steps were consistent with this exercise pattern.

Table 4

Correlations between Weekly Steps during the 4 Week Pedometer Intervention

Steps	Week 2	Week 3	Week 4	Average Weekly Steps
Week 1	.805*	.946**	.98**	.973**
Week 2		.860**	.813*	.874**
Week 3			.974**	.992**
Week 4				.990**

Note. $N = 12$. * $p < .01$. ** $p < .001$.

Chapter 5

Discussion

This study examined the impact of supplemental walking on clinical outcomes during a 12-week CR program. Participants typically attended the CR program 3 days a week for 12 weeks and were encouraged to engage in supplemental walking outside of the program. During the last 4 weeks of the program, participants were given a pedometer to record the number of steps taken outside of the rehabilitation exercise sessions. It was hypothesized that participants who walked more outside of the program would show greater improvements in three clinical outcome measures: resting systolic blood pressure, waist circumference, and quality of life scores. These three clinical outcomes were measured at the beginning of the 12-week CR program, at 8 weeks when participants were given their pedometers, and at 12 weeks, after recording supplemental walking steps for the final 4 weeks of the rehabilitation program. After reporting the weekly steps completed during the 4 week pedometer intervention, participants were categorized into low, moderate, and high walking groups.

Results did not support the hypothesis that participants who completed more weekly steps would have a greater reduction in systolic blood pressure. In fact, results showed a significant increase in resting systolic blood pressure across all walking groups when comparing measurements made at week 1 and week 12. One possible explanation is the effect of medication changes. After a patient has experienced a cardiac event, the cardiologist often prescribes blood pressure medication to regulate the system. As patients go through CR and their cardiovascular systems begin to adapt to exercise, the need for blood pressure medication may decrease, resulting in a lower dose or change in medication. Average systolic pressure at the beginning of CR was low: 127, 106, and 124 mm Hg for the low, moderate, and high walking groups, respectively. At the end of the 12-week program, systolic pressure was significantly higher: 143, 126, and 131 mm Hg. Hypertension is defined as a systolic pressure ≥ 140 mm Hg; thus, only the week 12 measurement for the low walking group reached this level. The moderate walking group went from an initial systolic pressure in the normal range to a final value categorized as prehypertension. Although the high walking group remained in the prehypertension range after 12 weeks, the increase in systolic pressure (7 mm Hg) was the smallest of the three groups.

During the 12-week rehabilitation program, waist circumference decreased in the high walking group (-1.6 cm), and increased in the moderate (+1.3 cm) and low (+2.8 cm) walking groups. Differences between these groups were not statistically significant. Because of the sample size of 12, statistical power was low (7%). However, there was a significant correlation between weekly steps and reduction in waist circumference between weeks 8 and 12, $r = -.645$, $p = .024$, and weeks 1 and 12, $r = -.592$, $p = .042$. Similarly, Savage and Ades (2008) reported a significant correlation between average number of steps per day and reduction in waist circumference in CR patients.

In contrast to the other two clinical outcomes, quality of life significantly improved during the 12-week CR program. Although there were no significant differences between walking groups, participating in a clinical CR program appears to increase QoL, as measured by the Dartmouth QoL Index. This is consistent with Kardis et al. (2005) who reported significant improvements in QoL for all groups (50 years-of-age or younger, 51-65 years, and over 65 years) in a 3 month, Phase II CR program.

Pedometers are increasingly being used to quantify physical activity in many populations. Although participants in CR programs are typically encouraged to incorporate more physical activity into their daily lives, there are limited reports of pedometers being used during CR programs. Pedometers provide a relatively simple way to monitor daily walking. Most participants reported wearing the pedometer correctly throughout the 4 week intervention, although several participants reported that the pedometer would detach from their pants while sitting down. One participant misplaced her pedometer for several hours during 1 day, while another participant lost his pedometer during the second week of wearing it and, subsequently, decided to withdraw from the study. There were no reports of participants failing to remember to wear the pedometer during the 4 week intervention. There were no self-reporting problems as all participants were easily able to read the number display on the pedometer and report it weekly by phone. No pedometer malfunctions were reported with the exception of one device that was immediately replaced. Two participants reported being inspired by wearing the pedometer, one of whom purchased his own after the study was completed. All participants reported no conscious increase in daily steps taken as a result of wearing the pedometer, and they felt the pedometers recorded their normal walking routine.

Throughout the 4 week pedometer intervention, participants reported that weather was the main factor that affected their walking. During a period of heavy rain, the number of steps reported was lower, but not significantly. Additionally, health status affected supplemental walking. Three participants reported feeling ill at various times during the pedometer intervention, and this affected their step count. One participant dropped out of the study; however, every participant in the study successfully completed his or her clinical CR program.

Recommendations for future research on supplemental walking during CR include monitoring participants' steps throughout the 12-week clinical period. Although walking is a preferred mode of exercise, patients in CR may also participate in other modes of exercise such as cycling or swimming. Future studies could incorporate measurements for alternate modes of exercise. Obviously, a larger sample size would increase statistical power to detect differences in clinical outcomes. Other clinical outcomes that could be measured include body mass index, body fat, HDL- and LDL-cholesterol, hemoglobin A1C, and peak VO_2. Additionally, tracking changes in medication may help to better control this confounding variable, particularly when measuring outcomes such as blood pressure.

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Appendix A

Raw Data

#	# Steps Week 1	# Steps Week 2	# Steps Week 3	# Steps Week 4	Average Steps
1	63174	50564	179383	151093	111053.5
2	11315	18833	14053	16095	15074
3	3317	4787	1105	2295	2876
4	30328	490	31594	54233	29161.25
5	12824	10938	18205	12207	13543.5
6	17635	19598	18592	33969	22448.5
7	6206	10866	8153	9228	8613.25
8	10294	10974	11968	11095	11082.75
9	4945	1117	17299	15904	9816.25
10	21911	18024	30089	39369	27348.25
11	14245	15859	13201	9497	13200.5
12	5353	1141	464	387	1836.25

#	Pre SBP	Pre Waist (in.)	Pre QoL
1	86	47.25	18
2	96	45.5	18
3	130	48.5	32
4	144	42.75	29
5	100	46	21
6	128	43.5	27
7	112	41	17
8	118	37.5	29
9	112	36	11
10	138	36.25	28
11	100	38	28
12	124	42.5	25

#	Mid SBP	Mid Waist (in.)	Mid QoL
1	74	46.5	16
2	130	45.5	17
3	134	50	20
4	138	44.25	18
5	118	46.25	17
6	112	44.5	24
7	144	45	15
8	124	37	25
9	118	37.5	18
10	126	38	23
11	104	37	33
12	140	43.25	17

#	Post SBP	Post Waist (in.)	Post QoL
1	114	44.25	14
2	114	45.5	16
3	140	50	19
4	140	43	14
5	128	45	18
6	130	42	24
7	160	45	19
8	112	37	14
9	118	37.5	16
10	138	38	16
11	124	37	22
12	146	43.25	15

Appendix B

Dartmouth Quality of Life Index

CRDARTMOUTH

Revised JAN 2010

Name ______________________

Dartmouth Quality of Life Index

During the past 4 weeks how much have you been bothered by emotional problems such as feeling anxious, depressed, irritable or downhearted?

FEELINGS	Session Number		
	1	18	36
Not at all	O	O	O
Slightly	O	O	O
Moderately	O	O	O
Quite a bit	O	O	O
Extremely	O	O	O

During the past 4 weeks what was the hardest physical activity you could do for at least 2 minutes?

PHYSICAL FITNESS	Session Number		
	1	18	36
Very Heavy: Run Fast, Carry Heavy Loads Uphill	O	O	O
Heavy: Jog, Climb Stairs or Hill	O	O	O
Moderate: Walk Medium, Carry Heavy Loads	O	O	O
Light: Walk Medium, Carry Light Loads	O	O	O
Very Light: Walk Slow, Wash Dishes	O	O	O

During the past 4 weeks was someone available to help you if you needed and wanted help?
For example, if you:

- Felt very nervous, lonely, or blue
- Got sick and had to stay in bed
- Needed someone to talk to
- Needed help with daily chores
- Needed help just taking care of yourself

SOCIAL SUPPORT	Session Number		
	1	18	36
Yes, as much as I wanted	O	O	O
Yes, quite a bit	O	O	O
Yes, some	O	O	O
Yes, a little	O	O	O
No, not at all	O	O	O

Revised JAN 2010

Name ____

Dartmouth Quality of Life Index

During the past 4 weeks how much difficulty have you had doing your usual activities or tasks, both inside and outside the house because of your physical and emotional health?

DAILY ACTIVITIES	Session Number 1	18	36
No difficulty at all	O	O	O
A little bit of difficulty	O	O	O
Some difficulty	O	O	O
Much difficulty	O	O	O
Could not do	O	O	O

During the past 4 weeks has your physical and emotional health limited your social activities with family, friends, neighbors or groups?

SOCIAL ACTIVITIES	Session Number 1	18	36
Not at all	O	O	O
Slightly	O	O	O
Moderately	O	O	O
Quite a bit	O	O	O
Extremely	O	O	O

During the past 4 weeks how much bodily pain have you generally had?

PAIN	Session Number 1	18	36
No pain	O	O	O
Very mild pain	O	O	O
Mild pain	O	O	O
Moderate pain	O	O	O
Severe pain	O	O	O

During the past 4 weeks how would you rate your health in general?

OVERALL HEALTH	Session Number 1	18	36
Excellent	O	O	O
Very Good	O	O	O
Good	O	O	O
Fair	O	O	O
Poor	O	O	O

How have things been going for you during the past 4 weeks?

QUALITY OF LIFE	Session Number 1	18	36
Very Well: Could hardly be better	O	O	O
Pretty Good	O	O	O
Good & bad parts are equal	O	O	O
Pretty bad	O	O	O
Very bad: Could hardly be worse	O	O	O

How would you rate your overall health now compared to 4 weeks ago?

CHANGE IN HEALTH	Session Number 1	18	36
Much better	O	O	O
A little better	O	O	O
About the same	O	O	O
A little worse	O	O	O
Much worse	O	O	O

SUMMARY	Session Number 1	18	36
SCORE:			