Physical Activity, Physical Function and Quality of Life in Community-Based Maintenance Cardiac Rehabilitation

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Abstract

Cardiac rehabilitation (CR) is a comprehensive approach to recovery developed to help overcome the complications associated with cardiovascular disease. However, despite the reported advantages of CR, little is known of the benefits associated with long-term, maintenance CR, as many previous studies have focused on short-term CR. Furthermore, there remains a significant gap in evidence regarding the effects of CR in specific demographics, specifically women and elderly, due in part to the significant disparity in referral to CR and consequently, representation in CR research. Therefore, this study aimed to examine the physical activity (PA) habits, physical function as well as quality of life (QOL) perceptions of those elderly individuals participating in community-based, maintenance CR.

Thirty-nine elderly (71.8% female; age 70.5±5.5 years) individuals participating in community-based, maintenance CR were recruited from two local CR clubs in Dunedin, New Zealand. Participants were assigned to either the CAD group (defined as history of MI, coronary angioplasty or stent insertion, valve surgery or coronary artery bypass graft surgery, n=13) or the non-CAD group (no history of CAD, n=26) based on the history of cardiovascular disease. Self-report questionnaires on demographics, medical history, PA habits and QOL were completed. Participant physical function was assessed through a Short Physical Performance Battery (SPPB), 30-second chair-to-stand test, handgrip strength test, Six-Minute Walk Test and Ten-Meter Incremental Shuttle Walk Test. Objective PA was measured by seven-day accelerometer wear.
Overall, the CAD group performed significantly more moderate-to-vigorous physical activity (MVPA) per week (329.7±233.3 mins versus 160.6±149.5 mins, p=0.013). However, only 26.3% of all participants in the present study were categorised as being physically active by current PA guidelines (≥30 mins, ≥5 days/week). No differences were seen in self-reported PA habits except for moderate-intensity PA, which was statistically significantly higher in the CAD group. Body composition was the only significantly different anthropometric measure between the two groups, with the CAD group having less body fat percentage (27.5±8.4 versus 36.5±8.7, p=0.004) and higher muscle mass percentage (72.5±8.4 versus 63.0±9.8, p=0.022) compared to the non-CAD group. Significantly more of the CAD group was on various prescribed medications compared to the non-CAD group and self-reported significantly higher presence of chest pain with exertion (61.5% versus 3.8%, p=0.000) and shortness of breath (38.5% versus 7.7%, p=0.018). No significant differences were observed for any measures of physical function or QOL.

Elderly CAD patients who participate in community-based maintenance CR could perform enough PA to meet current PA guidelines, however, are not currently regularly active throughout the week. Furthermore, the CAD patients in the present study had similar physical function and QOL perceptions as their non-CAD peers. Therefore, it may be suggested continued participation in community-based, maintenance CR is effective in preserving the PA habits of elderly CAD patients and subsequently slowing the decline in physical function, and QOL saw with older age. The limitations of this study warrant further investigation to confirm these findings. Furthermore, the results of this present study highlight the need for increased referral of elderly CAD patients to CR.
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Introduction

Coronary artery disease (CAD) remains one of the leading causes of mortality worldwide, with an estimated 17.5 million attributable deaths in 2012 (1). The underlying causes of CAD have been shown to be numerous, including atherosclerosis, obesity, hypertension as well as lifestyle factors such as inadequate physical activity (PA) and poor diet (2). The most common health complications CAD patients experience are those that arise due to narrowed arteries, specifically arrhythmia, angina and myocardial infarction (MI), all of which can cause long-term health and lifestyle complications (3). Cardiac rehabilitation (CR) is a comprehensive and multifaceted approach to recovery developed to attenuate the many influential risk factors of CAD. Components of CR include exercise prescription, psychological counselling as well as cardiovascular risk factor management (4). Subsequently, participation in CR can improve multiple physiological as well as psychological aspects of a cardiac patient’s life (4-6). However, despite its well-documented benefits, few eligible patients attend CR or drop out within a year of enrollment (4, 7, 8). Furthermore, specific demographics in CR, specifically women and elderly have historically been under referred to CR, with elderly patients approximately 77% less likely to participate in CR compared to those patients under 65 years (9). Coupled with the high dropout rate and under referral, the relatively short duration of phase II CR has meant few cardiac patients adhere to the necessary level of PA to promote improved cardiovascular risk factors and reduce patient mortality risk (8). Initial research has shown that continued participation in maintenance CR programs, especially within a community setting, to be an effective method of promoting adherence to healthy exercise and dietary habits (10). However, only a few studies have examined the potential health benefits associated with participation in long-term, maintenance CR (11, 12), with many previous studies excluding cardiac patients over the age of 65 years (13). The limited inclusion of elderly patients in previous CR research
has meant a significant gap in knowledge regarding the benefits of CR exists for this elderly population. Therefore, further investigation into CR, specifically into elderly cardiac patients who are participating in maintenance CR, could provide essential findings that reinforce initial reports of the benefits associated with maintenance CR as well as promote increased referral of elderly cardiac patients to CR.

**Community-based CR Clubs Overview:**

Within the wider Dunedin area there are two community-based CR programs; The Otago Phoenix Club, based in central Dunedin and the Taieri Fit and Fun group based in Mosgiel. Both CR clubs offer weekly, hour-long exercise sessions involving a mixture of aerobic and resistance training for those individuals with a history of CAD that require long-term secondary prevention. However, despite both of these clubs being primarily involved in secondary prevention, they do allow individuals without a history of CAD to participate. The Otago Phoenix Club allows its members to bring their spouses as a support person while the Taieri Fit and Fun group, while also being a CR club, is a community exercise club. Therefore, those individuals at risk of any underlying CAD developing into a clinical endpoint such as myocardial infarction or those individuals who wish to maintain their physical function and PA habits may participate in the weekly exercise sessions.
Chapter One: Literature Review

1.0 Pathophysiology of Coronary Artery Disease

Coronary artery disease is a condition characterised by the progressive hardening and thickening of the coronary vasculature through a process known as coronary atherosclerosis (9). Atherosclerosis is a complex and chronic inflammatory process involving the infiltration of fats, cholesterol, calcium and other inflammatory markers and their accumulation together to form atheromatous plaques within the coronary arterial endothelium (9). The rate of development and extent of atherosclerotic plaque coverage varies widely by nature, with fatty streak development being reported to develop in individuals as early as their second decade (10). Conversely, atherosclerosis development can occur over a 30 – 40-year time span while remaining asymptomatic until the peak years of acute coronary syndrome incidence, typically within the 6th decade for men and seventh decade for women (11). However, those from countries of lower socioeconomic status experience CAD events early compared to those from more developed countries (11). The rate at which atherosclerosis develops has been reported to be heavily attributable to non-modifiable risk factors such as age, gender and family history (2). However, multiple modifiable risk factors including abdominal obesity, dyslipidemia, hypertension, diabetes, psychosocial health, diet, PA levels and tobacco smoking have been shown to increase the rate of plaque development dramatically (2). Furthermore, 80% of an individual’s risk of developing atherosclerosis and CAD can be attributed to only five risk factors; smoking, unfavourable lipid ratios, hypertension, abdominal obesity and diabetes (2).

Specifically, the increased vascular resistance, physical stress and susceptibility of the arterial wall to infiltration of fatty deposits associated with hypertension, oxidative stress from tobacco smoking and its relationship with increased lipid oxidation and retention, has
a strong influence on the development of atherosclerotic plaques (12, 13). In addition, despite these risk factors having a systemic effect on the body, lesion development is not uniformly distributed throughout the coronary vasculature (14). Instead, plaques have been found to commonly develop within the left coronary artery, with the greatest plaque clustering occurring in areas of highly susceptible to increased oscillatory stress, such as the left anterior descending artery, its bifurcations and regions near distal arterial branches (14, 15). Furthermore, experimental studies have shown these physiological stimuli greatly affect the vascular haemostasis of arterial endothelial cells, changing their permeability and allowing the entry of blood-borne lipids and other inflammatory markers into the arterial wall (16). The progressive accumulation of low-density lipoproteins (LDL-C) within the arterial intima and its subsequent modification and oxidisation by enzymes and proinflammatory cells are the initiating factors to the activation of the bodies innate inflammation responses and the beginning of atheroma development (17). This immune system reaction is mediated by the activation of endothelial cells causing adhesion molecule secretion and release of chemoattractants by smooth muscle cells, influencing monocyte, lymphocyte and other immune cell entry into the arterial intima (17). The transformation of monocytes to macrophages and later into foam cells through the internalisation of lipid particles is another significant step in the continued development of atherosclerotic plaques (17). This first physiological process of macrophage transformation is the cause of further release of inflammatory mediators and promotion of LDL-C to bind to the endothelial and smooth muscle cells of the intima, resulting in the pooling of necrotic debris and lipids, promoting a necrotic environment and further growth of the plaque (18).

Over time, the subtle physiological changes associated with CAD can result in the onset of multiple heart conditions. These changes are typically associated with the narrowing (i.e. stenosis) of the coronary vasculature leading to restricted blood flow to the myocardium,
the onset of ischemia and development of a hypoxic environment within the affected area of the heart (19). Clinically, this myocardial ischemia or ‘angina pectoris’, the result of an imbalance between oxygen demand and supply to the myocardium, is the reason many CAD patients commonly express feelings of chest discomfort CAD (20). Furthermore, some patients experiencing angina may show signs of referred pain or discomfort in the upper extremities, dyspnoea, fatigue, dizziness or nausea (21). However, the onset of symptoms associated with angina can vary greatly depending on the type of angina present. ‘Stable’ angina, often presents with symptoms common to myocardial ischemia and is exacerbated by physical exertion or emotional stress but can be relieved by rest (19, 21). ‘Silent’ angina, however, is asymptomatic and defined as the presence of myocardial ischemia in the absence of any symptoms related to chest discomfort and is also the most common form of angina, accounting for more than 75 percent of all angina cases (22, 23).

While stable angina is physiologically associated with coronary stenosis, complete blockage (i.e. occlusion) of coronary arteries is often life-threatening. Termed ‘acute coronary syndromes’ (ACS) and presenting as either ‘unstable’ angina or a myocardial infarction (commonly referred to as a ‘heart attack’) either with or without ST-elevation (an abnormality detected by 12-lead ECG machine), ACS is the result of a ‘vulnerable’ atherosclerotic plaque rupture and initiation of coronary blood clotting (i.e. thrombosis). This mechanism of occlusion results in irreversible damage to the myocardial tissue due to necrosis and hypoxia. The process of necrosis is a result of the prolonged ischemia due to the little to no blood supply within the coronary vasculature (24). Atherosclerotic plaque rupture can be influenced by multiple physical, mental and chemical ‘triggers’ such as shear stress injuries, immune infections, large meals as well as emotional stress and cold weather (25-28). Clinically, unstable angina is distinguished from stable angina by onset at rest for longer than 20 minutes, new onset of angina without a history of angina or increased
frequency and duration of angina with less exertion than previous anginal onset (29). Myocardial infarction itself is the endpoint of unstable angina and is differentiated by electrocardiogram changes and an elevated presence of cardiac biomarkers, such as troponin I (30). Both unstable angina and MI patients can present with symptoms typical of ischemia, (i.e. chest pains, referred pain down the left arm, diaphoresis (sweating), fatigue and anxiety fainting (31). Treatment options for both angina and ACS range from lifestyle changes (i.e. diet changes and increased exercise) to pharmacological (i.e. nitro-glycerin and beta-blockers) and invasive procedures, such as angioplasty, stent insertion and heart bypass surgeries (32).

Coronary artery disease is a leading cause of mortality worldwide (1). The numerous, often asymptomatic co-morbidities that underpin the development of atherosclerosis such as hypertension and obesity present a problematic situation for health organisations around the world. However, with greater emphasis on educating the public, improvements in medical technologies and medications including angioplasties and drug-eluting stents, the survival rate for CAD patients has steadily improved. Future endeavours by health care systems, especially within third-world countries must continue to focus on primary prevention strategies. Specifically, by targeting cardiovascular risk factors that influence the development of CAD such as abdominal obesity, diabetes and hypertension, the expected rise in the worldwide burden of CAD may be attenuated.

1.1 Cardiac Rehabilitation

Once limited to the services available to patients following a cardiac event, continued research into the pathophysiology and cardiology of CAD as well as vast improvements in medical technology has seen greater rates of survivability following acute cardiac events (33, 34). However, as the population of CAD survivors increases, secondary prevention and risk-factor management services are crucial for stemming the growing rate of morbidity
associated with living with CAD as well as improving the long-term prognosis of CAD patients (35).

Aimed at providing multidisciplinary and comprehensive rehabilitation services, traditional CR has been developed over the past 40 years in response to the need for reducing the mortality and morbidity associated with cardiovascular disease (33). Although primarily for those with some CAD, individuals with other heart conditions such as heart failure, peripheral vascular disease and patients who have undergone cardiac surgeries such as coronary angioplasty or bypass surgery can also be referred onto CR by their physician (6). Services commonly found in CR include patient assessment, exercise counselling, lifestyle and behavioural modification such as psychosocial therapy, disease education, pharmacological treatment, smoking cessation as well as nutritional counselling (6). These services are implemented with the aim of achieving three primary goals, reduce mortality and morbidity rates by preventing secondary cardiovascular events, improve patient QOL and facilitate a patients recovery towards a fully active lifestyle (33).

1.1.1 Phases of Cardiac Rehabilitation

Although no single, globally recognised guideline exists for CR, many societies and associations recommend the delivery of CR through multiple distinct phases (36, 37). Phase I CR (the inpatient phase) includes an early introduction to remobilisation, as an attempt to negate the effects of bed rest, following acute cardiac events such as heart attacks or surgical interventions (33). Core components of Phase I CR involve the preliminary medical evaluation of the patient, risk factor assessment such as smoking and body composition, as well as patient/partner education about cardiovascular disease (4). Phase II CR (the outpatient phase) is an essential period of transition from the hospital to home, with a duration of approximately 4-8 weeks (38). The primary focus of this phase revolves around
providing a safe and supportive environment for early supervised exercise training in a clinical setting such as a hospital. In addition, monitoring of the patient’s cardiovascular risk factor profile and education on the importance of lifestyle modifications such as dietary changes, smoking cessation as well as teaching patients to self-monitor their disease symptoms are all synergistic components that can provide adequate rehabilitation during phase II CR (39). Phase III CR (the long-term phase) is traditionally the beginning of a ‘maintenance phase’ of recovery through the initiation of home or community-based exercise programs. Phase III aims to refine healthy behaviours such as lifelong PA and cardiovascular disease risk factor reduction such as smoking cessation and diet modifications that have been developed during the earlier phases of CR, to ensure the risk of any further cardiovascular events are reduced (37).

Overall, CR is a crucial part of recovery for individuals with cardiovascular disease. The multifaceted and comprehensive approach to rehabilitation means that each phase of CR can be explicitly tailored to the patients’ needs. This method allows patients to attenuate both the physiological and psychological impacts CAD has on their lives while progressively returning to their usual activities of daily living.

1.2 Benefits of Cardiac Rehabilitation

The multifaceted approach to CR can benefit numerous aspects of a cardiac patients’ life (40). These benefits can range from improved functional capacity and cardiovascular risk factors to psychosocial benefits, such as improved self-perceptions of health and QOL (4, 33, 37, 41, 42).

1.2.1 Improved Physical Activity Habits

As PA counselling has long been a core component of CR programs, many studies have investigated how exercise prescription as part of CR, can benefit CAD patients exercise
capacity (33). Furthermore, the current guidelines recommend CAD patients to perform at least 30 minutes of moderate-intensity PA, five to seven days per week (43). In addition, previous studies have recommended a minimum PA energy expenditure of 1500 kcal/week for CAD patients participating in maintenance CR programs, with higher energy expenditure (~2200 kcal/week) known to lower cardiovascular mortality rate (44). Regarding long-term PA habits, previous research comparing long-term participation in maintenance CR versus those CAD patients that had completed or never attended maintenance CR, found individuals who participated in CR to have engaged in more PA per week, were more likely to reach minimum PA guidelines as well as sustain their PA habits following CR graduation (45). A study by Giannuzzi et al. (46) examining a long-term CR intervention in recent MI patients who were randomised to either CR or a usual care group, found greater long-term PA habits as well as decreased nonfatal MI and mortality rates in those patients assigned to CR compared to those patients assigned to the usual care group. In addition, a subanalysis of two randomised controlled trials using new MI patients who were assigned to an eight-week aerobic exercise-based CR program saw a significant increase in the patient's frequency of moderate-vigorous PA as well as their cardiorespiratory fitness (VO$_{2\text{peak}}$) levels (47). Further studies are needed to determine if participation in exercise-based CR over the long-term, especially in community-based settings, can produce sustained increases in CAD patients PA habits as seen in previous research.

### 1.2.2 Improving Cardiovascular Risk Factors

Multiple studies have reported the ability of CR programs to attenuate and reduce the presence of cardiovascular risk factors in CAD patients (39, 48, 49). A study examining the effects of a comprehensive CR program on elderly CAD patient’s physical status and cardiovascular risk factors over a six-month period found no worsening of clinical CAD symptoms in either the intervention or control group (50). However, the intervention group
reported significantly reduced waist circumference and body composition while also reporting significantly lower triglyceride and fasting blood glucose levels compared to the control group (50). In addition, a previous study comparing the effects of short- versus long-term (3- vs. 12-months) CR found significant improvements in lipoprotein-lipid profiles, smoking cessation and participant exercise capacities, with more pronounced improvements in those participants that were part of the twelve-month CR intervention compared to the three-month CR intervention (51). Previous studies have also shown that participation in exercise-based CR post- MI, to be effective in lowering blood pressure after just two months of regular attendance (52).

1.2.3 Quality of Life and Psychosocial Health

The experiences CAD patients go through during a cardiovascular event can put them at a much higher risk of developing psychological conditions such as anxiety and depression compared to the general population (53). Therefore, a focus point of previous literature has been the effects CR programs have on improving the psychological health of CAD patients. These studies have shown CAD patients commonly report improved perceptions of QOL (54) including reduced subjective feelings of depression, anxiety, stress and hostility towards others after regularly attending CR (55). Furthermore, a recent systematic review has suggested there to be a bi-directional relationship between increased PA habits and QOL improvements, with significantly greater QOL reported in those CAD patients who exercised more frequently than those non-exercising CAD patients (56). Furthermore, previous research had reported significant improvements in multiple psychological factors such as general mental health, depression, anxiety, vitality as well as overall QOL, even when participants who partook in exercise-based CR saw no improvements in their exercise capacity (55).
The mental health services often provided by CR programs are an essential tool in the rehabilitation process and have been shown to be an effective method of improving psychosocial health. Furthermore, current indications of bi-directional health benefits extending from performing both exercise and mental health counselling give strength to the use of the comprehensive and multifactorial services that make up CR.

1.2.4 Mortality

Despite its comprehensive services, research into the benefits of CR on reducing mortality risk for CAD patients has produced mixed results risk (57, 58). A Cochrane review involving 10,974 CAD patients from 47 randomised trials, demonstrated a reduction in cardiovascular and overall mortality as well as reduced hospital admissions in those individuals that participated in CR for longer than 12 months (59). Furthermore, a recent systematic review of 34 randomised control trials involving 6111 MI patients, found that those patients who attended CR had a lower risk of secondary MI, cardiovascular mortality as well as all-cause mortality compared to those non-attenders (60). However, in contrast, a randomised controlled trial by West et al. (58) that examined 1813 participants who were part of either a comprehensive CR program involving exercise training, health education and counselling for secondary prevention or a usual care group, found at two years post-referral, there was no significant differences in all-cause mortality between those CR participants and usual care group attendees.

Overall, current evidence suggests that participation in CR has multiple benefits for CAD patients. The multidisciplinary nature of CR enables its many services to provide comprehensive care that has been reported to provide significant short-term benefits for those that attend CR. However, in the context of today’s CR programs and their multidisciplinary approach to rehabilitation, little is currently understood about the long-
term benefits these programs have for CAD patients. Therefore, further investigation into the effects of long-term CR is warranted.

**1.3 Barriers to Cardiac Rehabilitation**

Despite the known benefits of CR, previous studies have identified various barriers that impact on current CR attendance including individual, demographic and socioeconomic/environmental factors. (61-65).

Being the first point of contact for most CAD patients, lack of physician referral on to CR has been reported to be the strongest predictor of enrollment into CR programs (66). Furthermore, younger and healthier male CAD patients are more likely to be referred on to CR compared to their female and older patient counterparts (66-68). This disparity between referrals, specifically for older patients may be due to age indirectly presenting itself as a barrier to CR, as older CAD patients (>65 years old) have expressed more overall barriers to participation compared to younger CAD patients (69). Specifically, elderly CAD patients have reported exercise to be tiring as well as expressed beliefs that CR would not improve their health or that they had confidence in their own abilities to manage their disease (67, 69). Furthermore, elderly CAD patients have reported their health status to influence their attendance to CR programs (69). Particularly, it has been proposed that physical health can influence the participation of elderly CAD patients in CR, due to the higher presence of debilitating conditions such as angina or heart failure and the associated pain, as elderly CAD patients have commonly reported it to be too painful for them to regularly participate in CR (69). Geographical and socioeconomic factors such as lower socioeconomic status, long travel distances as well as issues relating to the cost of CR and involvement of insurance coverage have also been reported to influence CAD patients attendance to CR (63, 66, 68, 70, 71). Psychosocial issues such as depression and anxiety, perceptions of poor control.
over patient illness as well as inadequate social support have also been shown to impact the participation rate of CAD patients to CR (70).

Regardless of its benefits, it is evident that initial participation and long-term adherence to CR is often poor, of which can lead to the worsening of a CAD patient’s condition as well as the loss of health benefits gained from earlier participation in CR. Therefore, future studies should examine factors that influence long-term adherence to maintenance CR such as poor physician referral, gender and age with particular focus towards women and elderly individuals with CAD, who are currently mostly underrepresented and under referred.

1.4 Cardiac Rehabilitation and Physical Function

The decline in muscle strength associated with the presence of cardiovascular disease and the aging process can significantly impact an individual’s ability to live independently (72, 73). Therefore, current research has begun to investigate the benefits CR has regarding preserving muscle strength in CAD patients, particularly in the elderly population (74, 75).

Mandic et al. (76) examined the long-term changes in the physical function and body composition of 46 (69.7±8.9 years, 79% male) elderly CAD patients during a 1.6-year follow-up. Irrespective of CR attendance and self-reported PA habits, participants saw an increase in lower-body muscle strength and a decline in handgrip strength after the 1.6 years. Furthermore, increases in body weight and fat percentage were observed in the follow-up period. No significant changes in exercise capacity or physical function were seen. These findings suggest that although there were no significant improvements in exercise capacity, long-term maintenance CR may slow the decline in physical function and body strength seen with aging. The limitations of this study were its 26% participant drop out and subsequent small sample size. Furthermore, the use of self-report PA measures can be subject to recall
bias, where elderly individuals can find it challenging to recall PA details over an extended period (77).

A study by Asbury et al. (78) explored the impact an eight-week phase III CR program had on cardiovascular risk factors, physical function, QOL, and psychological health in individuals with refractory angina. Forty-four patients (65±7.3 years; 83% male) were randomly assigned to either the eight-week CR or symptom monitoring control group. Following CR, patients showed a significant improvement in their progressive shuttle walk level and distance reached compared to the control group. In addition, the CR group reported improved health anxiety reassurance and lower angina threat versus the control group. Both the frequency and severity of angina remained unchanged in both groups, while the control group reported increased pain on the SF-36 questionnaire pain scale. This study demonstrates that CR can improve physical function without increasing the prevalence of angina episodes in elderly individuals with CAD. The limitations of this study included its pilot study design and small sample size.

Although limited research currently exists regarding later phases of CR and physical function, initial evidence suggests long-term CR may slow the loss of physical function associated with the presence of CAD, especially at an older age (76). However, as with most CR research, many of the participants used for studies in this area have been low-risk stratified males aged ≤70 years of age who had normal or near-normal exercise capacities. Therefore, future studies should continue to investigate the relationship between CR and physical function with older and less physically able CAD patients to observe if the current benefits of CR for physical function can be found in other populations.
1.5 Outpatient Cardiac Rehabilitation and Quality of Life

Outpatient CR programs are a vital part of the rehabilitative process for CAD patients. With a dose-response relationship between the number of attended sessions and positive long-term health outcomes, the greatest benefits can be seen when there is minimal time between a patient's cardiac event and enrollment into a CR program (57, 79).

Janssen et al. (80) identified a positive relationship between patients’ illness perceptions and their QOL after participating in a three-month outpatient CR program in 158 middle-aged individuals with CAD (58±9.2 years; 80.4% male). Upon completion of the outpatient CR program, patients reported fewer perceived consequences of their illness on daily functioning in the context of physical, emotional and social areas of life. Furthermore, patients reported fewer disease symptoms including dizziness, the stiffness of joints, post-exercise fatigue and reduced emotional impact. These perceived psychological and physiological improvements also had a positive influence on improving QOL upon completion of the outpatient CR program. Due to the lack of a control group in this study, it is not possible to determine whether the changes in QOL were directly due to participation in CR or a general adaptation to illness over time.

A study by Niebauer et al. (81) examined the short and long-term effect of CR in 1432 outpatient (58.4±11.2 years; 83.9% male) and 1390 maintenance phase CAD patients (58.5±10.6 years; 84.5% male). Participation in Phase II outpatient CR improved risk factors for cardiovascular disease including a reduction in systolic and diastolic blood pressure, LDL-C and body mass index (BMI). Outpatient CR also led to clinically significant improvements in social, emotional and physical components of QOL. Furthermore, improvements achieved during phase II CR were more likely to be maintained or even increased if patients participated in phase III CR. The findings from this study provide compelling evidence for the benefits of both short- and long-term CR. Additionally, the
benefits were seen following a transition into long-term CR, offering support for the continued adherence to maintenance (Phase III) CR, a phase historically associated with low referral rates (4).

The benefits of early enrollment into CR can also be seen in a study by Hirano et al. (82). This study involving 47 Japanese CAD patients (59.4±12.6 years; 69% male) recovering from cardiac surgery, had participants take part in an eight-week exercise-based CR program involving both aerobic and resistance training. Outcome measures were VO$_{2\text{peak}}$, handgrip and knee grip strength as well as health-related QOL improvements at both one- and the three-month mark of CR attendance. After three months, all participants showed significant improvements in VO$_{2\text{peak}}$ as well as muscular strength testing compared to after one month. Furthermore, significant improvements were seen in QOL as reported in seven subscales of the SF-36 health-related QOL survey, however only physical function and mental health scores reached a level close to the average healthy Japanese adults. VO$_{2\text{peak}}$ was the only physiological measure to be significantly associated with the SF-36 physical function QOL score. The findings of this study reinforce previously reported evidence regarding the positive relationship between PA and improvements in psychological mood and QOL (56). However, the limitation of this study was its small sample size, where stronger associations between outcome measures may have been found using a larger sample size.

From the reviewed literature it is clear cardiac patients who participate in comprehensive outpatient CR can see many favourable improvements in health in as little as six months. However, there is currently an inadequate initial uptake of CR. Future research needs to examine current barriers to participation and reduce the current lack of inclusion of specific populations, specifically women and elderly to both outpatient CR
programs and research. Furthermore, a stronger base of evidence could compel health care systems to provide greater support to patients moving into maintenance CR programs, given the initial reports of consolidated benefits seen when patients continue into long-term CR following outpatient CR (20).

1.6 Maintenance Cardiac Rehabilitation Programs and Quality of life

Short-term participation in CR has been shown to produce many health benefits, both physiologically and psychologically (80, 81). However, compliance to CR in the long-term remains low, despite evidence reporting maintenance CR to have similar beneficial effects on health as outpatient CR (49).

Johnson et al. (83) examined the effects a 12-week post-outpatient, home walking CR intervention had on QOL and the maintenance of PA in 144 women with CAD under 75 years of age. Contrary to other studies (25), PA declined in both the intervention group and the usual care group over a one-year period. However, a significantly smaller reduction in PA was observed in the intervention group compared to the usual care group. QOL improved earlier in the intervention vs. usual care group although no overall differences at 12 months could be detected. This study highlights the effectiveness a long-term home-based CR program can have on helping CAD patients transition from a supervised to independent maintenance (phase III) CR. In addition, despite the overall outcome, this study provides evidence for the benefit CR has in the underrepresented female population.

Dugmore et al. (84) examined the changes in cardiorespiratory fitness as well as QOL in 124 middle-aged individuals with a history of MI that was randomly allocated to either an exercise-based CR program or control group. After 12 months, the exercise treatment group had made significant improvements in VO2peak, psychological wellbeing and QOL. Furthermore, the CR participants showed strong trends for reduced symptoms related to
angina as well as fewer hospital readmissions and fewer medications taken compared to the control group. Regarding work status, a significantly more substantial portion of the treatment group returned to full-time work earlier compared to their matched controls. The results of this study emphasise the benefits of long-term exercise CR. The strength of this study was its use of a randomised control design, as casual conclusions between PA levels and associated health benefits can be accurately established.

To determine the effects of long-term participation in maintenance CR on health-related outcomes, Izawa et al. (85) studied 109 acute post-MI patients (63.5±10.1 years; 87% male) over an 18-month period. This observational study assessed physiological outcomes (VO$_{2peak}$, knee-extension and handgrip-strength) at the one- and six-month, post-MI period. Exercise maintenance, leisure-time objective PA and QOL were measured 12-months following completion of a five-month CR program. At 18 months, three-quarters of participants continued to perform regular PA. Total leisure-time objective PA as measured by daily step count and caloric expenditure, was significantly higher in long-term exercisers compared to non-exercisers. Furthermore, seven of the eight SF-36 QOL subscales were reported to be significantly higher in the long-term exercise group compared to the non-exercising group after 18-months. Both groups saw significant improvements in all physiological outcome measures at six-months following CR, compared to after one-month of CR participation. The results of this study suggest a relationship between long-term exercise maintenance following initial CR participation and sustained improvements in both physiologically and QOL outcome measures. The strength of this study is its long-term data collection. The limitation of this study was its use of a cross-sectional design. Therefore future studies should aim to use randomised, control trial designs with larger sample sizes to find evidence that strengthens the known associations between long-term PA and health.
With the main focus of research having been to investigate early CR programs and their benefits for CAD patients, little emphasis has been placed on maintenance CR and the long-term benefits for those individuals with CAD. To further emphasise and justify the uptake of maintenance CR following early CR, future studies should continue to examine the health benefits associated with long-term (>1-2 years) participation in maintenance CR programs.

1.7 Cardiac Rehabilitation in Older Adults and Quality of Life

Although previous studies have indicated improvements in QOL following CR in younger and middle-aged individuals, the effects of CR in elderly individuals remain mostly unknown, as elderly patients with CAD have often been excluded from previous research (67, 69). Because of this exclusion, only a few previous studies have investigated the relationship between elderly CR participants and QOL (86-88).

Stahle et al. (55) examined changes in PA and QOL following a three-month CR program in 101 elderly patients (71 years; 80% male) who were randomly allocated to either a three-month, supervised outpatient CR group involving 50 minutes of exercise, three times a week or a control group. In the treatment group, exercise capacity significantly increased at three months with further increases seen at 12 months compared to the control group who achieved only slight improvements. The treatment group also reported significant improvements in multiple dimensions of QOL, including depression and self-perceived health, with a higher number of daily activities performed after the intervention compared to the baseline. A strength of this study was its use of a randomised controlled study design. These findings suggest that elderly CAD patients benefit both physically as well as psychologically the longer they attend CR.

Marchionni et al. (89) assessed total work capacity and QOL in 270 patients of three age groups (middle aged (45-65-year-olds), old (66-75-year-olds) and (very old >75 years
old)) who were randomised into either a hospital-based involving exercise training and stretching, a home-based outpatient CR involving instructional sessions and training at home or a control group for 14 months. Health-related QOL improved significantly over all three age brackets regardless of treatment group, except in very old patients where it improved regardless of treatment, but not when assigned to the control group. For hospital-based CR participants, total work capacity significantly improved in all three age groups, however only remained higher than baseline in the middle-aged patients, with old and very old patients returning to a level like that of baseline at the 12-month follow-up. Conversely, for home-based CR, total work capacity remained higher than baseline for the entire study period in all three age groups. The QOL improvements seen in the very old only when participating in CR reinforces the current need for higher participation of elderly CAD patients in maintenance CR. A limitation of this study was its high exclusion and dropout rate which may have limited its generalizability. However, a strength of this study was its use of multiple age groups and their randomisation into multiple treatment groups, as it examined the needs of different age groups in CR. In addition, it included a range of elderly individuals, an age bracket that has been previously excluded from research (66, 68).

Tolmie et al. (90) investigated a phase III CR program to see if CR was meeting the rehabilitative needs of elderly CAD patients. Involving 31 participants (74.5±6.2 years; 52% male) who were either non-, partial- or full-attenders to a CR program, this study examined QOL, anxiety/depression, CAD risk factor presence as well as central themes for CR attendance. Results showed non-attenders had lower QOL scores in all dimensions as well as poorer depression scores compared to partial- and full-attenders of CR. Blood pressure and waist circumference were statistically significant between all groups, with non-attenders reporting lower blood pressure compared to both attender groups and males of the full-attender group reporting greater mean waist circumference compared to non- and partial-
attendees. Primary reasons for attendance included ‘it is the sensible thing to do’, ‘CR being too great of an impact on daily life’ and ‘Individuals believing there was nothing to gain from attending CR’. A larger sample size and additional measurements of cardiovascular risk factors would have strengthened this study’s results. Strengths of this study were its older mean participant age, use of different attendance levels as treatment groups and examination of a phase III CR group as there is little research to date that has investigated these variables.

It is apparent from previous investigations that comprehensive CR is crucial in helping elderly CAD patients improve their QOL. Furthermore, it is apparent that improvements in QOL have a bi-directional relationship with increased exercise training. Therefore, future studies should continue to explore this relationship between exercise and QOL, especially in the elderly CAD patient population, as current evidence suggests improvements in QOL are dependent on PA improvements.

1.8 Accelerometers and Physical Activity Habits of Cardiac Rehabilitation Patients

Due to the significant impact sedentarism can have on both the development of CAD and onset of secondary CAD events, previous studies have investigated the relationship between CR and its effect on attenuating the drop in habitual PA caused by CAD (91).

1.8.1 Accelerometers

Motion sensors such as accelerometers have recently emerged as both a viable and popular tool in CR research. When used to assess PA, energy expenditure and body motion capture, accelerometers are valid and reliable (92). Furthermore, objective measures of PA such as accelerometers are not prone to the overestimation of habitual PA or recall bias that is common when using self-report PA questionnaires, especially in elderly individuals (77,
The basis for accelerometer use when measuring PA is that acceleration is proportional to net force (muscular force) and therefore, can directly reflect energy expenditure, allowing the documentation of both duration and intensity of PA (94). Accelerometers can detect acceleration in multiple planes of movement (e.g. vertical, horizontal or lateral), and are known as either uniaxial, biaxial or triaxial depending on the sensitivity of the accelerometer for detecting acceleration in different axes (95). Newer accelerometers can store large periods of data at once, often multiple weeks at a time and can be analysed using specific computer programs (95). Despite their benefits over questionnaires, accelerometers do have limitations, specifically accelerometers cannot measure water-based activities such as swimming and have been shown to be inaccurate when assessing upper body movements or during stationary exercise such as cycling, which may impact the final measure of PA (95). However, the ability for objective methods such as accelerometers to accurately measure all levels of PA intensity reinforces the need for their use in future studies to collect accurate data on CAD patients habitual PA. By improving the quality of data collected on CAD patients PA habits, intervention programs may be more appropriately tailored to the needs of CAD patients.

1.8.2 Objectively Measured Physical Activity Habits

Harris et al. (96) investigated the factors associated with PA in older, community-dwelling individuals using accelerometry (ActiGraph GT1M). This cross-sectional study involving 238 participants (age ≥65 years, 52.1% male) examined the average daily step count and time spent in different PA levels of participants and its association with health, disability, anthropometric and psychosocial measures. The results showed that the PA habits of elderly individuals differ considerably from younger individuals. The mean accelerometer step count was 6443 steps/day, with almost all participants remaining sedentary throughout the day and only 2.5% of participants achieving recommended PA guidelines. Self-reported

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levels of PA were borderline significantly higher than participants objectively measured PA levels. Independent predictors of low step count included: low PA, older age, poor general health, disability, high BMI and lower perceived control over exercise. The strength of this study was recording step counts as the primary outcome measure, as many elderly individuals solely perform low-intensity PA such as walking. Due to its cross-sectional design, causality between PA associations cannot be entirely inferred. A limitation of this study was its use of only one practice in a semi-rural, middle-income area with less than half of potential participants responding which limited the overall generalizability to other settings.

Trumeaux et al. (97) examined the long-term PA habits of CR participants using objective measures. Eighty cardiac patients (age 56±11.6 years, 83% male), wore an accelerometer (MyWellness Key actimeter) at either the 2- or 12-month period following discharge from a phase II CR to assess the PA habits and adherence to reaching minimum PA guidelines of 150 minutes per week. A graded cardiopulmonary exercise stress test was used to assess peak power output following completion of CR. The results showed approximately only half of all participants in both the 2- and 12-month assessment groups, were classified as performing PA for the recommended 150 minutes per week, with most participants being active for only 120 and 90 minutes each week. There was no significant difference in total weekly energy expenditure between the two groups. There was a weak yet significant association between total weekly energy expenditure and peak power output for both groups. This study highlights the current trend of participant drop off associated with completion of outpatient CR, with only half of all participants continuing to be physically active in the long-term. The limitation of this study was its demographic recruitment, as most participants were men, which reduced the studies generalisability to the whole CR
participant population. However, its use of an objective measure of PA in both the short- and long-term provides insight into the PA habits of cardiac patients.

Ayabe et al. (98) also used accelerometry to assess the PA habits of 77 CR participants (age 68.1±9.2 years, 69% male) on both CR and non-CR days. The CR program involved three sessions a week for >3 months. Each participant wore a uniaxial accelerometer (Life-Corder) on their wrist continuously for ten days. Accelerometry was used to determine the time participants spent in light, moderate and vigorous PA levels based on metabolic equivalents (METs) as well as overall PA duration. On CR days, almost all participants reached recommended daily PA levels (30 minutes/day), however on non-CR session days, less than a third of participants reached the recommended PA levels. Participants PA intensity rarely exceeded light intensities (<3 METs), except during their CR sessions. After adjustment for body weight, results showed no difference between genders for total PA level or time spent in specific PA intensities. By comparing CR and non-CR days, this study showed traditional CR programs (~3 sessions/ week) might not be enough to prompt CAD patients to reach the PA level necessary for health promotion. The limitation of this study was its use of uniaxial accelerometers, as those devices are prone to underestimating the intensity of large bouts of upper body exercise, which may have reduced the total MET values of each participant.

Similarly, Jones et al. (99) also examined the exercise habits of CR participants. Twenty-five men (age 60±8.3 years) who were part of a hospital-based, phase III CR, wore an accelerometer (ActiGraph GT1M) for seven consecutive days, where step count and energy expenditure served as the primary measures of PA. Subjects attended 3.0±1.0 sessions per week, averaged 6907 steps per day and expended 466 Kcal/ day in PA during the seven-day period. Participants achieved significantly more steps on their CR session days compared to their non-CR days. However only half of the participants reached the
recommended 10,000 steps/day on their CR days. Just over half of the participants also performed exercise at home at least once per week. Those participants that exercised at home in addition to CR accumulated on average, more steps than those that performed CR only, however still did not meet recommended step counts. Retired participants (n=9) took significantly fewer steps on non-CR days compared to employed participants and were classified as being sedentary on their non-CR days. There was a significant age difference between those that were employed and retired, suggesting that age may potentially play a role in the average step count/activity level reported in this study. This study was limited by its small numbers as well as having only male participants, limiting generalizability to the whole CR population.

Byun et al. (100) investigated the correlates of objectively measured PA in 65 pre-maintenance phase CR patients (58±10.6 years; 74% male). Physical activity habits, including total time spent in PA as well as MVPA, was measured by accelerometers (ActiGraph GT3X) for seven days before cardiac patients begun their maintenance CR program. In addition, demographic, clinical, psychosocial and behavioural correlates of PA were assessed using self-report questionnaire. The results from participant accelerometer data indicated that nearly all cardiac patients did not meet recommended PA guidelines (≥150 mins/ week MVPA)(101). Functional capacity, exercise history and PA readiness were all positively correlated with total PA. The results of this study highlight key factors that may help to improve the number of CR participants that transition into long-term CR. The limitations of this study were its lack of information on environmental factors of PA and its cross-sectional design. The strength of this study was the use of an objective measure of PA and investigation into the correlates of PA during the transition from phase II to phase III.
In summary, results from previous research have shown cardiovascular disease patients do not perform enough weekly PA to reach minimum PA guidelines. In addition, even when participating in regular CR sessions, the PA habits of cardiovascular disease patients, specifically in elderly individuals, is not enough to reach PA levels necessary to achieve the health benefits associated with exercise. Future studies should continue to examine the long-term PA habits of the elderly population using objective measures to gain a better understanding of the trends of PA patterns among elderly individuals with cardiovascular disease. Furthermore, objective measures of PA such as accelerometers can allow researchers to overcome the inaccuracies in PA recall associated with self-report methods of PA such as questionnaires. Understanding the PA habits of elderly CAD patients will allow CR programs to better tailor interventions to help elderly individuals reach minimum PA guidelines.

1.9 Summary

Existing literature suggests that CR can be a valid form of recovery for patients suffering from CAD-related illnesses, where each phase of CR can be comprehensively tailored to match the patients’ health needs. Furthermore, the early phases of CR have been shown to be effective in providing multiple benefits for both physical and mental health. However, most phase II CR programs are too short (e.g., 4–12 weeks) to promote long-term adoption of new healthy behaviours effectively. Initial research has shown community-based maintenance CR programs to be an effective way of supporting patients by bridging the period between the completion of a phase II CR program and full adoption of new health behaviours and exercise habits. Unfortunately, compared to the early phases of CR, little research has been conducted on the benefits associated with the long-term, maintenance phase of CR, especially within the elderly CAD patient population. Therefore, further investigation into community-based, maintenance CR is warranted, as further evidence of
the health benefits associated with participation in maintenance CR may consequently help to better educate healthcare professionals on the importance of cardiac patient referral to CR. In addition, a greater understanding of what makes a community-based CR program successful may help to improve the uptake of CR by elderly cardiac patients, whom the most need to preserve physical function and the ability to live independently.

The aim of the current study was to examine the PA, physical function and quality of life of CAD patients who participate in community-based, maintenance CR programs within Dunedin, compared to their similar aged, non-CAD peers who also participated in these community-based programs. Based off previous research (11, 12), it was hypothesised that the present study would find those elderly participants who had some form of CAD, to have lower weekly PA levels compared to their non-CAD peers. Consequently, as physical function and quality of life are known to be affected by PA levels, it was also hypothesised that those participants with CAD would have poorer physical function and quality of life compared to their non-CAD peers.

Chapter Two: Methodology

2.0 Participants

Eligibility criteria for this study were individuals of either gender, aged ≥65 years who lived within the wider Dunedin area (Dunedin and Mosgiel), were a part of a community-based CR program and had participated in at least one session within the past 12 months. Classification of CAD included a history of MI, coronary angioplasty or stent insertion, valve surgery or coronary artery bypass graft surgery. Participants were ineligible to participate in this study if they had a recent (less than 6 months) heart attack or admission
to hospital with chest pain, chest pain coming on at rest, significant symptoms of palpitations, symptoms related to severe narrowing of the aortic valve, significant breathlessness and fluid build-up or swelling, lung clots, recent heart inflammation or inflammation of the sac surrounding the heart. In addition, individuals with any implanted medical devices such as defibrillators or pacemakers could participate in all parts of the study apart from body composition assessment, due to safety concerns regarding electrical signal interference from the BioImpedance scale (InBody 230, BioSpace Co Ltd, Seoul, Korea).

2.1 Recruitment

The primary method of recruitment for this study involved advertisement of the study using the Active Living Laboratory website and through each community-based CR program’s monthly newsletter. In addition, brief presentations were given by a researcher to both community-based CR groups (The Otago Phoenix Club and the Taieri Fit and Fun group) over the course of 2 to 6 weeks. These presentations were used to discuss the overall aims and procedures of the study, as well as hand out study packages containing both information and consent forms for the overall study and the seven-day PA assessment. Participants who consented were then contacted by telephone to organise an appointment and emailed further information and instructions regarding their appointment.

2.2 Ethics Approval

Ethical approval was obtained from the University of Otago Ethics Committee (reference number H14/166, December 2016). All participants were offered both written and verbal information about this study and signed their consent for participation before any data collection took place (See Appendix A, B, C). At the end of the study, each participant received a $20 grocery voucher for reimbursement for travel and parking expenses and a summary of their PA levels and physical function scores.
2.3 Study Design

In this cross-sectional study, participants attended one appointment for exercise testing and performed a seven-day PA assessment. The appointments were conducted at either the Active Living Laboratory within the School of Physical Education, Sport and Exercise Sciences in Dunedin for members of The Otago Phoenix Club or Mosgiel Bowling Club for those members of the Taieri Fit and Fun group. Each appointment lasted approximately two-hours and involved the participant performing a series of physical function assessments and completing questionnaires about demographics, medical history, QOL and self-reported PA levels. In addition, each participant received an accelerometer and log book to objectively measure habitual PA levels over seven consecutive days. Participants completed their part in the study upon returning their accelerometer to the researchers.

2.4 Outcome Measures and Measurement Procedures

2.4.1 Outcome Measures

The outcome measures of the present study were objectively measured and self-reported measures of PA, as well as physical function, QOL and participant attendance rates for both CAD and non-CAD individuals.

2.4.2 Attendance

Attendance rates for all participants were obtained and used with verbal consent from both The Otago Phoenix Club and The Taieri Fit and Fun groups presidents and group committees. In addition, researchers were given consent to examine individual participants attendance records upon participants signing of the study’s overall consent forms. Attendance rates were determined by dividing the number of the CR sessions attended by a participant with the total number of available sessions within their CR program since January
2016 (or their start date as some participants joined their CR program within the last year),
and the date of assessment for this study.

2.4.3 Demographics

Participant demographics (age, gender, ethnicity, education) and medical history
including cardiovascular risk factors, comorbidities and current medications were collected
during the two-hour appointment using a questionnaire (See Appendix E). Participants home
addresses were used to determine the distance to their nearest community-based CR program
using Google Maps. A researcher (GH) was available to offer any assistance required when
completing the questionnaires, including an explanation of questions or reading questions to
alleviate any burden participants may have had due to any visual/hearing impairment.

2.4.4 Anthropometry

Height was measured to the nearest 0.01 cm using a stadiometer. Weight was
measured to the nearest 0.01 kg using an electronic scale (A&D scale UC321, A&D
Medical). Body mass index was calculated using the formula: weight in kg divided by height
squared (kg/m$^2$) and then categorised using standardised international age and gender-
specific points; normal (18.5 - 24.99), overweight (25.00 - 29.99), obese (≥40.00) (102).
Waist circumference was taken at the narrowest point of the waist and hip circumference
around the widest portion of the buttocks, both using a metal tape measure (103). Each
anthropometric measure was taken twice and averaged to produce the final value used in the
analysis. All anthropometric measures were taken by a researcher (GH) in a screened off and
private area. All anthropometric measurements were taken directly on the skin if given
verbal consent by the participant, or over minimal clothing if participants did not give
consent or felt uncomfortable getting direct measurements.
2.4.5 BioImpedance

The participants had their body composition measured using a validated BioImpedance Scale (InBody 230, Bioscape Co Ltd, Seoul, Korea) (103). Bioimpedance assessment was not performed on participants with implanted electrical devices such as defibrillators or pacemakers. The assessment required participants to be barefoot with their heels aligned with the foot electrodes and thumbs grasping the thumb electrodes at waist level to allow conductance of a low-level electrical current to test impedance. This impedance provided results on weight, BMI, fat-free mass (kg), body fat (kg) as well as body fat and fat-free mass percentages of which were all used in the final analysis.

2.4.6 Resting Hemodynamics

Resting hemodynamics (heart rate and blood pressure) were taken at the start of the appointment after a participant had rested for at least five minutes. In addition, participants reported coffee, tea, alcohol or food consumption before their appointment. Each participant was set up to wear a heart rate monitor (Polar FS1 heart rate monitor) around their chest for the duration of their appointment. Heart rate was taken after five minutes of rest and during different physical function tests (see section 2.7 for details). Blood pressure was measured using an automatic blood-pressure cuff (Omron HEM-712C Automatic Blood Pressure Monitor with IntelliSense).

2.5 Questionnaires

2.5.1 Quality of Life

Quality of life assessment allows examination of an individual’s experience in dealing with their condition, and the perceived effects the disease has on daily living. QOL was measured using the Short Form 36 version 2 (SF-36 v2) questionnaire (104). The SF-36 questionnaire is a valid and reliable tool when assessing health-related QOL and has been
previously used in CR research (105, 106). The SF-36 is a multidimensional self-report questionnaire consisting of 36 questions relating to the influence an individual’s conditions has on physical, mental and social status within eight broad health concepts: physical function, bodily pain and limitations, general health and vitality as well as social function and general emotional and mental health (104).

Scoring of the SF-36 was completed according to a two-stage standardised scoring protocol (107). The first phase involved individual questions being scored using a pre-coded value, with each question scored between a range of 0-100 (107). The second phase involved the individual scale scores summed and averaged to produce eight final subscale scores (107). Five of the subscales (physical function, role physical, bodily pain, social function and role emotional) were ‘unipolar’, meaning the greater the score, the greater the perceived absence of disability (107). For the remaining scales (general health, vitality and mental health), scoring was ‘bipolar’, covering both negative and positive aspects of health. Therefore, a maximum score of 100 indicated the absence of disability as well as the presence of positive health perceptions (107). Higher score values were representative of a more favourable health perception, relative to the subscale (0, least favourable to 100, most favourable). Blank questions were disregarded in the scoring process to reduce any misrepresentation of the participant's average scores (107). All scoring procedures were completed using a syntax provided by an SF-36 scoring software (QualityMetric Health Outcomes Scoring Software, version 4.0, Lincoln, R.I).

2.5.2 Perceptions of Physical Activity Habits

Habitual PA was measured using the International Physical Activity Questionnaire-Short Form (IPAQ- SF) (108). This survey included ten questions regarding time spent in light, moderate and vigorous levels of PA as well as the frequency of PA during the past
seven days. Further questions were added to the PA survey including the effect of illness or disability on a participant’s ability to perform PA, expectations of PA level within the next six months as well as sedentary behaviours of each participant to allow comparison with previous CR study data from this research team, as well as allow the collection of further data regarding participant sedentarism. Each question was answered on a Likert-scale, where the lower the number, the worse the participant’s perception was relative to the question. For example, question six “Overall, how physically active do you consider yourself to be?” allowed participants to answer between 1= Not physically active at all, and 5= Very physically active.

Physical activity data collected from the IPAQ was used to categorise participants weekly PA intensity; Inactive, minimally active or health-enhancing physical activity (HEPA). In addition, both the frequency (days/ week) and duration (minutes/ week) of individual PA intensities, as well as the time they spent being sedentary (hours/ day) over a seven-day period was calculated.

2.6 Objective Physical Activity

Each participant received an accelerometer (ActiGraph, GT3XPlus, Pensacola, FL, USA) that was initialised using ActiLife software and given to the participant at the end of their two-hour appointment. Each participant was required to achieve a minimum wear-time of at least 10 hours per day for a seven-day period. However, to ensure wear time compliance, participants were advised to wear their accelerometers for a minimum of 12 hours per day over the seven-day period. An eight-day log sheet was also given to each participant to facilitate compliance. Participants received verbal and written instructions to put the accelerometer on as soon as they woke up in the morning and remove it when they either went to bed or participated in any water-related activities, as the accelerometers were
not waterproof. Following completion of the seven days wear-time, participants either mailed the accelerometers back using a pre-paid courier bag supplied to them during their appointment or dropped-off their accelerometer to the School of Physical Education, Sport and Exercise Science main reception desk, where a researcher would then collect it for data analysis.

Accelerometer data were downloaded using the MeterPlus software (version 4.3). PA was recorded within user-defined activity counts, specifically 60-second “epochs”. Activity cut-points were also defined using the Freedson Adult cut points; non-wear (−999 to -999), sedentary (0 – 100), light (101 -1951), moderate (1952 – 5724), vigorous (5725 - 15000) (109). Participants accelerometer data was screened for valid wear-time using the MeterPlus computer program and if it was determined a participant had insufficient wear-time or invalid accelerometer data, an accelerometer was sent back to the participant for re-wear. The accelerometers collected data on participants bouts of activity, intensity and time spent in light, moderate and vigorous PA as well as time spent being sedentary.

From data collected by the accelerometers, multiple indicators of PA level were determined. Specifically, the frequency of PA (in minutes/day) performed over seven-days, time spent being sedentary and performing PA at light-, moderate- or vigorous intensity was calculated. With total time participants spent in PA, it was then possible to determine the total time participants spent performing moderate-to-vigorous intensity PA (MVPA) and the number of participants that met current minimal PA guidelines (≥ 30 minutes/ day, ≥5 days/week) (101).

2.7 Physical Function

Participants performed a series of physical function tests including the Short Physical Performance Battery, upper body strength test as well as shuttle walking tests (see Appendix F).
2.7.1 Short Physical Performance Battery

The Short Physical Performance Battery is a series of short tests that measure lower extremity muscle strength and function through the replication of activities of daily living (110). This battery examines physical function by performing three simple tasks: gait speed, static balance and ability to get in and out of a chair (110). Each test mimics essential functions of daily activity that elderly individuals need for independence and have been shown to be valid and reliable when assessing functional disabilities in patients with cardiovascular disease (110).

Participant’s balance was evaluated using (up to) three hierarchical standing positions. The first test started with participants feet touching together, with each successive test increasing in difficulty, progressing to a semi-tandem stance and finishing with a full tandem stance position (110). Each participant was required to maintain a foot position for 10 seconds before moving on to the next position of the test (110). If unable to perform any stage of the balance test, the participant did not continue to the next balance position (110). When assessing gait speed, participants walked four meters at their average walking speed while being timed. Timing began when the participant was instructed to begin and stopped once the participant had crossed over the finish line. Participants had no room to accelerate as the distance to cover was only four meters (110). Participants were allowed to use a walking device to support themselves if required (110). The final component of the physical function battery involved a standard chair-stand test. This test required the participant go from a sitting position in a chair, with feet shoulder width apart and flat on the floor as well as arms crossed over their chest, to an upright standing position without any upper extremity assistance (110, 111). Before testing, participants were asked to perform an initial one chair-stand test to determine if they felt safe to perform the subsequent test. The test involved
performing five chair-stands as quickly as possible while being timed by a researcher (110, 111).

Each test in this battery was scored on a subscale between 0-4, with 0 being “unable to complete the task” and 4 being “highest level of performance”. The subscale scores from all three tests were added to generate an overall score from 0-12. The summary score was then categorised, with 0-3 being “severe limitations”, 4-6 “moderate limitations”, 7-9 “mild limitations” and 10-12 “minimal limitations” (110).

2.7.2 Lower Body Muscle Strength

Lower body muscle strength was also assessed using a 30-second chair-stand test. Participants were given instructions to complete as many chair-stands as possible, in the same position as the physical performance battery chair-stand test within 30 seconds. Participants could stop the test if they felt any pain or discomfort or if they no longer felt safe performing multiple stands. Incorrectly performed stands were not counted in the results. Both the five-chair stand and 30-second chair stand test was performed twice, with the best result being used in the final analysis. Participants had a minimum of three minutes rest between each chair stand test.

2.7.3 Handgrip Strength Test

Handgrip strength testing is a valid method for assessing physical function limitations in elderly individuals (112, 113). Furthermore, weak handgrip strength has been shown to be a reliable indicator of both upper body muscle strength and predictor of all-cause mortality in older adults (114). Upper body strength was measured using a dynamometer (Lafayette Dynamometer Model 78010) to assess handgrip strength in force kilograms. Participants were seated on a chair with their feet flat on the floor, arm bent and holding a dynamometer parallel to the ground with their wrist in line with their elbow (76).
Starting with the participants’ dominant hand, a researcher instructed the participant to squeeze the dynamometer as hard as possible until they reached their maximum strength level. Each value was recorded, and then the test was performed on the opposite hand for a total of 3 tests per hand (76). Between each test was at least a 30-second rest to ensure proper recovery. Handgrip strength was determined by the average of the highest values from left and right hands (115).

2.7.4 Six-Minute Walk Test

Cardiorespiratory exercise testing is the current gold standard test for the determination of functional capacity, cardiovascular prognosis and when evaluating training progression (116-118). However, these expensive and sophisticated tests are not always available to the general practitioner. The Six-Minute Walk Test (6MWT) is a valid, reliable and straightforward alternative for estimating submaximal functional capacity of CAD patients (119). In addition, given the intensity of walking is determined by the participant, the 6MWT may be a safer test of functional capacity for elderly individuals who suffer from severe functional impairments compared to performing a maximal cardiorespiratory test (120).

During the 6MWT, participants were asked to walk around a rectangular loop while trying to cover as much distance as possible in six minutes (121). Due to assessment location size, a standard 60-meter loop could not be placed. Therefore a 30-meter rectangular loop was used for all 6MWT assessments. The total distance covered was calculated based on the number of laps completed by the participant. Participants received standardised encouragement (“well done” and “keep going”) once during the 6MWT. The rate of perceived exertion (Borg 10-point scale) and heart rate (Polar Electro Oy, Kempele, Finland) were recorded before, at every minute during the test and after one and two minutes of
recovery after the test. Each participant performed the 6MWT twice with a minimum 60-minute rest period in between to account for any learning effects and to allow for a full recovery. Reasons for early test cessation included: chest pains/angina, muscle fatigue, shortness of breath, technical difficulties, reached age-predicted maximum heart rate, desire to stop or completion of the six-minutes (121).

2.7.5 10 Meter Incremental Shuttle Walk Test

A Ten-Meter Incremental Shuttle Walk Test (10SWT) was performed to measure the exercise capacity of participants. In contrast to the self-paced nature of the 6MWT, in which distance walked could be influenced by participant’s motivation, the 10SWT has a more standardised protocol (122). For the 10SWT, participants walked between two cones placed nine meters apart (providing a 10-meter course when participants walked around the cones) for as long as was possible (up to 12 minutes) in synchronisation with an external auditory track that was played over a loudspeaker (122). The test began at level one with a speed of ~1.8 km/h and progressively increased in speed every minute until it reached the maximum speed of 8.5 km/h during the final minute at level 12 (122). Participants were required to walk for as long as they could until they were no longer able to keep up with the auditory cues, with one chance to catch back up to the cues before test cessation. Early termination of the test occurred if the participant felt the onset of symptoms related to exercise intolerance (including chest pains/angina, muscle fatigue, shortness of breath) or if they had reached their age-predicted maximum heart rate, wished to stop, or if any technical difficulties arose (76, 122). The total number of shuttles the participant achieved during the test was recorded along with the reason for terminating the test. Both heart rate and rate of perceived exertion were measured at the beginning of the test, at every new level and the one- and two-minute marks at the end of the test during the recovery phase.
2.8 Estimating VO_{2peak} From Functional Testing

Estimated VO_{2peak} was calculated from both the 6MWT distance and peak 10SWT walking speed using previously published formulas designed for elderly individuals with stable CAD (121). These equations used to estimate VO_{2peak} included values from an anthropometric assessment (body fat percentage) and physical function tests (30-second chair stand) to increase the accuracy of VO_{2peak} calculations (121).

VO_{2peak} based on 6MWT distance was calculated using the equation:

\[ \text{VO}_{2\text{peak}} = 0.015 \times \text{6MWT distance (m)} + 0.239 \times \text{30-second chair stand (n)} - 0.218 \times \text{body fat (\%)} + 12.258 \]

VO_{2peak} based on peak shuttle walk speed during the 10SWT was calculated using the equation:

\[ \text{VO}_{2\text{peak}} = 1.546 \times \text{shuttle speeds (km/h)} - 0.219 \times \text{body fat (\%)} + 0.296 \times \text{30-second chair stands (n)} + 11.399 \]

2.9 Data Analysis

For all objective measures of PA, MeterPlus software (Version 4.3) was used to screen, clean and analyse data. Statistical data analysis was performed using the IBM SPSS statistical software package version 24.0 (SPSS, Chicago, IL). P values of <0.05 were considered statistically significant.

Descriptive statistics were used to analyse the participant’s sociodemographic information, attendance rates, medical histories and current medications. Chi-square tests were used for any categorical variables such as demographic information to determine any
statistical significances in data between CAD and non-CAD study groups. Furthermore, for any continuous variables including age and anthropometry measures, independent t-tests were used to look for statistical significance between the two study groups.

Mean values of the SF-36 version 2.0 QOL questionnaire (Optum, Eden Prairie, MN) were analysed using the scoring program Health Outcomes Scoring Software version 5.0 (Optum, Eden Prairie, MN) with a further comparison of statistically significant differences within the eight individual health domains compared between study groups using Chi-square tests in the statistical software program SPSS.

### Chapter Three: Results

#### 3.0 Demographics and Medical History

A total of 39 participants were recruited for this study. Based on their history of CAD, participants were classified as those with CAD (n = 13) or without CAD (n = 26). There were no statistically significant differences between the two study groups regarding age, gender, ethnicity, education, marital or employment status (Table 1). Participants attended just over half of all available CR sessions within the past 12 months. In addition, there were no statistically significant differences between the two groups in CR session attendance or the distance participants had to travel to their respective clubs between the two groups (Table 1). However, the CAD group had participated in CR for a longer duration compared to the non-CAD group (Table 1).

There were no statistically significant differences in the prevalence of the CAD risk factors hypertension, diabetes, smoking status or family history of CAD between the two groups (Table 2). The CAD group had a statistically significant higher prevalence of dyslipidemia and the total number of CAD risk factors compared to the non-CAD group
However, the non-CAD group had a statistically significant higher proportion of participants that were classified as ‘obese’ by their BMI compared to the CAD group (Table 2). The most common indicator of cardiovascular disease within the CAD group was bypass surgery and angina followed by angioplasty and MI (Table 2). There were no statistically significant differences between the two groups in the presence of other health conditions such as asthma, chronic obstructive pulmonary disease or mental health issues (Figure 1).

The CAD group had a statistically significantly higher prevalence of symptoms of chest discomfort with exertion, shortness of breath, dizziness/fainting or blackouts and lower leg cramps with short walks compared to the non-CAD group (Table 3). In addition, there was no statistically significant difference between the study groups for the symptom of musculoskeletal problems (Figure 1). The most commonly prescribed medications for both groups were aspirin and lipid-lowering agents (Table 4). The CAD group also had a statistically significantly higher prevalence of taking beta-blockers, ACE-inhibitors, aspirin and lipid-lowering agents compared to the non-CAD group (Table 4).
Table 1. Sociodemographic characteristics and attendance rates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>70.7 ± 5.5</td>
<td>71.8 ± 7.1</td>
<td>70.1 ± 4.6</td>
<td>0.362</td>
</tr>
<tr>
<td>Gender [n(%)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>11 (28.2)</td>
<td>3 (23.1)</td>
<td>8 (30.8)</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>28 (71.8)</td>
<td>10 (76.9)</td>
<td>18 (69.2)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity [n(%)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>35 (89.7)</td>
<td>12 (92.3)</td>
<td>23 (88.5)</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (5.1)</td>
<td>0 (0.0)</td>
<td>2 (7.7)</td>
<td></td>
</tr>
<tr>
<td>Marital status [n(%)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Single</td>
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<td>0 (0.0)</td>
<td>2 (7.7)</td>
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</tr>
<tr>
<td>Married/living with a partner</td>
<td>30 (76.9)</td>
<td>9 (69.2)</td>
<td>21 (80.8)</td>
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</tr>
<tr>
<td>Divorced</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>6 (15.4)</td>
<td>4 (30.8)</td>
<td>2 (7.7)</td>
<td></td>
</tr>
<tr>
<td>Highest education [n(%)]*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Secondary-5th form</td>
<td>14 (35.9)</td>
<td>5 (38.5)</td>
<td>9 (34.6)</td>
<td></td>
</tr>
<tr>
<td>Secondary-6th form</td>
<td>3 (7.7)</td>
<td>1 (7.7)</td>
<td>2 (7.7)</td>
<td></td>
</tr>
<tr>
<td>Secondary-7th form</td>
<td>3 (7.7)</td>
<td>1 (7.7)</td>
<td>2 (7.7)</td>
<td></td>
</tr>
<tr>
<td>University degree</td>
<td>10 (25.6)</td>
<td>3 (23.1)</td>
<td>7 (26.9)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8 (20.5)</td>
<td>2 (15.4)</td>
<td>5 (19.2)</td>
<td></td>
</tr>
<tr>
<td>Employment status [n(%)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working - part time</td>
<td>6 (15.4)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Working - full time</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>5 (19.2)</td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>30 (76.9)</td>
<td>10 (76.9)</td>
<td>20 (76.9)</td>
<td></td>
</tr>
<tr>
<td>Sick/invalid</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Time since first cardiac event (years)</td>
<td>11.2 ± 10.1</td>
<td>11.2 ± 10.1</td>
<td>-</td>
<td>0.263</td>
</tr>
<tr>
<td>Time since last cardiac event (years)</td>
<td>7.4 ± 5.3</td>
<td>7.4 ± 5.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CR membership length (years)</td>
<td>5.6 ± 6.8</td>
<td>7.7 ± 9.9</td>
<td>4.5 ± 4.4</td>
<td>0.170</td>
</tr>
<tr>
<td>CR Attendance over previous 12 months (%)</td>
<td>49.9 ± 28.5</td>
<td>46.2 ± 28.4</td>
<td>51.8 ± 29.0</td>
<td>0.570</td>
</tr>
<tr>
<td>Distance from CR club</td>
<td>5.5 ± 5.9</td>
<td>7.2 ± 6.5</td>
<td>4.6 ± 5.5</td>
<td>0.192</td>
</tr>
</tbody>
</table>

CR= cardiac rehabilitation
Continuous data reported as mean ± SD
Categorical data are reported as n (%)
Table 2. Cardiovascular risk factors and conditions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk factors [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>24 (63.2)</td>
<td>10 (76.9)</td>
<td>14 (53.8)</td>
<td>0.163</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>21 (53.8)</td>
<td>10 (76.9)</td>
<td>11 (42.3)</td>
<td>0.041</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2 (5.1)</td>
<td>2 (5.1)</td>
<td>0 (0.0)</td>
<td>0.608</td>
</tr>
<tr>
<td>Obesity (based on BMI)</td>
<td>9 (23.1)</td>
<td>0 (0.0)</td>
<td>9 (34.6)</td>
<td>0.000</td>
</tr>
<tr>
<td>Smoking</td>
<td>4 (10.5)</td>
<td>1 (8.3)</td>
<td>3 (11.5)</td>
<td>0.709</td>
</tr>
<tr>
<td>Family history of CAD</td>
<td>14 (35.9)</td>
<td>4 (30.7)</td>
<td>10 (38.4)</td>
<td>0.337</td>
</tr>
<tr>
<td>Total number of risk factors (n)</td>
<td>1.7 ± 1.1</td>
<td>2.1 ± 1.1</td>
<td>1.5 ± 1.1</td>
<td>0.076</td>
</tr>
<tr>
<td><strong>Cardiovascular Disease [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>9 (23.7)</td>
<td>9 (69.2)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>6 (15.4)</td>
<td>6 (46.2)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Angioplasty/stent</td>
<td>5 (12.8)</td>
<td>5 (38.5)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Bypass surgery</td>
<td>11 (28.2)</td>
<td>11 (84.6)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Heart failure</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>1 (2.7)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>2 (5.1)</td>
<td>2 (15.4)</td>
<td>0 (0.0)</td>
<td>0.040</td>
</tr>
</tbody>
</table>

BMI= body mass index, CAD= coronary artery disease
Continuous data reported as mean ± SD
Categorical data are reported as n (%)
Table 3. History of other medical conditions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Other medical conditions [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>8 (20.5)</td>
<td>2 (15.4)</td>
<td>6 (23.1)</td>
<td>0.575</td>
</tr>
<tr>
<td>COPD</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td>0.474</td>
</tr>
<tr>
<td>Cancer</td>
<td>8 (20.5)</td>
<td>2 (15.4)</td>
<td>7 (26.9)</td>
<td>0.420</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>2 (5.1)</td>
<td>0 (0.0)</td>
<td>2 (7.7)</td>
<td>0.305</td>
</tr>
<tr>
<td>Other CVD</td>
<td>4 (10.3)</td>
<td>1 (7.7)</td>
<td>3 (12.0)</td>
<td>0.681</td>
</tr>
<tr>
<td><strong>Musculo-skeletal conditions [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis</td>
<td>18 (46.2)</td>
<td>5 (38.5)</td>
<td>13 (50.0)</td>
<td>0.496</td>
</tr>
<tr>
<td>Backpain</td>
<td>11 (28.2)</td>
<td>4 (30.8)</td>
<td>7 (26.9)</td>
<td>0.801</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>4 (10.3)</td>
<td>1 (7.7)</td>
<td>3 (11.5)</td>
<td>0.709</td>
</tr>
<tr>
<td>Other physical condition</td>
<td>9 (23.1)</td>
<td>4 (30.8)</td>
<td>5 (19.2)</td>
<td>0.420</td>
</tr>
<tr>
<td><strong>Psychological conditions [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td>0.474</td>
</tr>
<tr>
<td>Depression</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td>0.152</td>
</tr>
</tbody>
</table>

COPD=Chronic obstructive pulmonary disease, CVD=cardiovascular disease
Categorical data are reported as n (%)
Table 4. Medications

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medications [n(%)]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta blockers</td>
<td>9 (23.1)</td>
<td>8 (61.5)</td>
<td>1 (3.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>ACE-Inhibitors</td>
<td>15 (38.5)</td>
<td>9 (69.2)</td>
<td>6 (23.1)</td>
<td>0.005</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>3 (7.7)</td>
<td>2 (15.4)</td>
<td>1 (3.8)</td>
<td>0.202</td>
</tr>
<tr>
<td>Aspirin</td>
<td>12 (30.8)</td>
<td>10 (76.9)</td>
<td>2 (7.7)</td>
<td>0.000</td>
</tr>
<tr>
<td>Lipid lowering agent</td>
<td>19 (48.7)</td>
<td>10 (76.9)</td>
<td>9 (34.6)</td>
<td>0.013</td>
</tr>
<tr>
<td>Nitrates</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td>0.152</td>
</tr>
<tr>
<td>GTN Spray</td>
<td>1 (2.6)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td>0.152</td>
</tr>
<tr>
<td>Diuretics</td>
<td>2 (5.1)</td>
<td>1 (7.7)</td>
<td>1 (3.8)</td>
<td>0.608</td>
</tr>
<tr>
<td>Other</td>
<td>19 (48.7)</td>
<td>5 (38.5)</td>
<td>14 (53.8)</td>
<td>0.365</td>
</tr>
</tbody>
</table>

ACE=Angiotensin converting enzyme, GTN=Glyceryl Trinitrate
Categorical data are reported as n (%)
Figure 1. Presence of cardiovascular disease symptoms in CAD and non-CAD groups.
3.1 Anthropometry

The CAD and non-CAD groups were similar with respect to height, weight, waist circumference (including recommended gender cut point guidelines, ≥102 cm for males and ≥88 cm for females), hip circumference and waist-to-hip-ratio (Table 5). The CAD group had both statistically significant lower body fat percentage and higher muscle mass percentage compared to non-CAD group (Figure 2).

3.2 Quality of Life

There were no statistically significant differences between the two groups for any of the eight subscales of the Short Form -36 QOL questionnaire including, physical functioning, role limitations due to physical problems, bodily pain, vitality, social function, role limitations due to emotional problems as well as both general and mental health (Table 6).

3.3 Physical Activity

3.3.1 Self-Reported Physical Activity

Self-reported PA data showed no statistically significant differences between the CAD and non-CAD group for low, moderate or high-intensity PA over seven days (Table 7). Most participants self-reported engaging in low-intensity PA and only a few participated in high-intensity PA (Table 7). The CAD group self-reported engaging in significantly more moderate-intensity PA compared to the non-CAD group (Table 7). Data on PA habits showed 79.5% of the total study population had been performing PA at the same level of intensity for the past 12 months. In addition, the same 79.5% of participants reported the level of PA intensity they partake in would not change over the next six months. The CAD group self-reported spending significantly less time being sedentary compared to the non-CAD group (Table 8). However, ‘watching TV’ was the only individual sedentary activity to be significantly different between...
the two groups, with the CAD group spending less time compared to the non-CAD group (Table 8).

3.3.2 Accelerometer-Assessed Physical Activity

The CAD group accumulated more MVPA throughout the week and spent less time being sedentary compared to the non-CAD group (Table 9, Figure 3). In addition, the CAD group achieved recommended PA guidelines (≥ 30 minutes MVPA) on more days per week compared to the non-CAD group (Table 9).

3.4 Physical Function

No significant differences were observed for any physical function test, including the Six-Minute Walk Test, 10-Meter Incremental shuttle Walk Test, 30-second balance and chair stand tests, or Short Physical Performance Battery (Table 10). In addition, no significant differences were observed for both the 6MWT or 10SWT (Table 10).
Table 5. Anthropometry, body composition and resting hemodynamics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anthropometry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.8 ± 8.4</td>
<td>165.2 ± 11.4</td>
<td>161.7 ± 6.3</td>
<td>0.315</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.4 ± 13.7</td>
<td>73.3 ± 13.5</td>
<td>72.0 ± 14.0</td>
<td>0.788</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>27.2 ± 4.7</td>
<td>26.5 ± 3.5</td>
<td>27.6 ± 5.2</td>
<td>0.493</td>
</tr>
<tr>
<td><strong>Weight status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal BMI</td>
<td>10 (25.6)</td>
<td>9 (69.2)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Overweight BMI</td>
<td>20 (51.3)</td>
<td>4 (30.8)</td>
<td>16 (61.5)</td>
<td></td>
</tr>
<tr>
<td>Obese BMI</td>
<td>9 (23.1)</td>
<td>0 (0.0)</td>
<td>9 (34.6)</td>
<td>0.194</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>89.7 ± 13.1</td>
<td>91.5 ± 13.2</td>
<td>88.7 ± 13.1</td>
<td>0.539</td>
</tr>
<tr>
<td>Healthy</td>
<td>18 (46.2)</td>
<td>4 (30.8)</td>
<td>14 (53.8)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>21 (53.8)</td>
<td>9 (69.2)</td>
<td>12 (46.2)</td>
<td>0.173</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>102.1 ± 12.3</td>
<td>98.3 ± 10.6</td>
<td>104.0 ± 12.8</td>
<td>0.177</td>
</tr>
<tr>
<td>Waist to hip ratio</td>
<td>0.87 ± 0.10</td>
<td>0.91 ± 0.13</td>
<td>0.86 ± 0.10</td>
<td>0.114</td>
</tr>
<tr>
<td><strong>Resting hemodynamics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>73.4 ± 23.8</td>
<td>63.9 ± 22.9</td>
<td>78.1 ± 23.2</td>
<td>0.079</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>147.2 ± 23.8</td>
<td>148.8 ± 23.8</td>
<td>146.5 ± 24.2</td>
<td>0.779</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>75.5 ± 18.7</td>
<td>76.2 ± 14.4</td>
<td>75.1 ± 20.8</td>
<td>0.863</td>
</tr>
</tbody>
</table>

BMI= Body mass index
‘High’ waist circumference= ≥102cm for males, ≥88cm for females.
Categorical data are reported as n (%) 
Continuous data are reported as mean ± SD
Figure 2. Mean body fat and muscle mass percentage in CAD and non-CAD groups.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality of life subscales</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical functioning</td>
<td>85.2 ± 14.4</td>
<td>87.3 ± 13.9</td>
<td>84.2 ± 14.8</td>
<td>0.537</td>
</tr>
<tr>
<td>Role limitations - Physical</td>
<td>88.1 ± 17.8</td>
<td>85.1 ± 22.3</td>
<td>89.7 ± 15.3</td>
<td>0.457</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>79.9 ± 22.3</td>
<td>84.8 ± 20.4</td>
<td>77.6 ± 23.2</td>
<td>0.937</td>
</tr>
<tr>
<td>General health</td>
<td>78.9 ± 14.4</td>
<td>73.1 ± 17.9</td>
<td>81.9 ± 11.6</td>
<td>0.071</td>
</tr>
<tr>
<td>Vitality</td>
<td>75.0 ± 11.2</td>
<td>74.5 ± 13.2</td>
<td>75.2 ± 10.5</td>
<td>0.371</td>
</tr>
<tr>
<td>Social function</td>
<td>94.1 ± 13.5</td>
<td>93.7 ± 12.5</td>
<td>94.2 ± 14.2</td>
<td>0.266</td>
</tr>
<tr>
<td>Role limitations - Emotional</td>
<td>95.1 ± 12.2</td>
<td>91.7 ± 14.8</td>
<td>96.8 ± 10.6</td>
<td>0.280</td>
</tr>
<tr>
<td>Mental health</td>
<td>87.2 ± 10.1</td>
<td>83.7 ± 12.1</td>
<td>88.8 ± 8.7</td>
<td>0.142</td>
</tr>
</tbody>
</table>

Continuous data are reported as mean ± SD
Table 7. Self-reported physical activity in total sample, CAD and non-CAD groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brisk walking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency (days/wk)</td>
<td>4.9 ± 2.2</td>
<td>5.1 ± 1.9</td>
<td>4.7 ± 2.4</td>
<td>0.585</td>
</tr>
<tr>
<td>Duration (mins/wk)</td>
<td>50.0 ± 44.6</td>
<td>53.3 ± 32.8</td>
<td>48.4 ± 49.8</td>
<td>0.758</td>
</tr>
<tr>
<td>Moderate-intensity activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency (days/wk)</td>
<td>3.8 ± 2.0</td>
<td>4.7 ± 2.3</td>
<td>3.3 ± 1.7</td>
<td>0.048</td>
</tr>
<tr>
<td>Duration (mins/wk)</td>
<td>75.3 ± 74.0</td>
<td>81.9 ± 78.2</td>
<td>72.0 ± 73.2</td>
<td>0.699</td>
</tr>
<tr>
<td>Vigorous-intensity activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency (days/wk)</td>
<td>2.3 ± 1.5</td>
<td>2.50 ± 1.6</td>
<td>2.3 ± 1.5</td>
<td>0.664</td>
</tr>
<tr>
<td>Duration (mins/wk)</td>
<td>42.1 ± 56.5</td>
<td>50.8 ± 75.7</td>
<td>37.6 ± 44.8</td>
<td>0.503</td>
</tr>
<tr>
<td>Physical activity category [n(%)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inactive</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Minimally active</td>
<td>20 (52.6)</td>
<td>6 (50.0)</td>
<td>14 (53.8)</td>
<td></td>
</tr>
<tr>
<td>HEPA active</td>
<td>17 (44.7)</td>
<td>6 (50.0)</td>
<td>11 (42.3)</td>
<td>0.743</td>
</tr>
</tbody>
</table>

HEPA= Health-Enhancing Physical Activity
Continuous data are reported as mean ± SD
Table 8. Self-reported sedentary activities in the total sample, CAD and non-CAD groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary time (hrs/day)</td>
<td>14.6 ± 8.4</td>
<td>10.7 ± 7.4</td>
<td>16.5 ± 8.3</td>
<td>0.042</td>
</tr>
<tr>
<td>Watching tv</td>
<td>2.8 ± 1.4</td>
<td>2.2 ± 1.5</td>
<td>3.2 ± 1.4</td>
<td>0.040</td>
</tr>
<tr>
<td>On Computer</td>
<td>1.5 ± 3.3</td>
<td>0.65 ± 1.1</td>
<td>1.9 ± 3.9</td>
<td>0.234</td>
</tr>
<tr>
<td>Driving</td>
<td>3.9 ± 14.5</td>
<td>7.6 ± 24.8</td>
<td>2.1 ± 3.0</td>
<td>0.444</td>
</tr>
<tr>
<td>Reading</td>
<td>2.3 ± 3.1</td>
<td>2.0 ± 3.2</td>
<td>2.5 ± 3.1</td>
<td>0.693</td>
</tr>
<tr>
<td>Sitting</td>
<td>1.4 ± 1.6</td>
<td>1.4 ± 1.5</td>
<td>1.4 ± 1.6</td>
<td>0.986</td>
</tr>
<tr>
<td>Sleeping</td>
<td>7.4 ± 1.7</td>
<td>7.3 ± 2.4</td>
<td>7.4 ± 1.7</td>
<td>0.848</td>
</tr>
</tbody>
</table>

Continuous data are reported as mean ± SD
Table 9. Objectively measured physical activity in the total sample, CAD and non-CAD groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n=38)</th>
<th>CAD (n=13)</th>
<th>Non-CAD (n=25)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total time spent in PA (mins/day)</td>
<td>320.1 ± 69.4</td>
<td>351.7 ± 61.9</td>
<td>303.9 ± 68.7</td>
<td>0.044</td>
</tr>
<tr>
<td>Sedentary</td>
<td>514.6 ± 82.5</td>
<td>478.9 ± 77.8</td>
<td>533.1 ± 80.1</td>
<td>0.054</td>
</tr>
<tr>
<td>Light</td>
<td>289.8 ± 56.1</td>
<td>306.7 ± 50.3</td>
<td>281.0 ± 57.9</td>
<td>0.184</td>
</tr>
<tr>
<td>Moderate</td>
<td>30.0 ± 27.9</td>
<td>44.0 ± 34.6</td>
<td>22.8 ± 21.2</td>
<td>0.024</td>
</tr>
<tr>
<td>Vigorous</td>
<td>0.26 ± 0.65</td>
<td>0.52 ± 0.88</td>
<td>0.12 ± 0.45</td>
<td>0.141</td>
</tr>
</tbody>
</table>

Meeting physical activity guidelines

<table>
<thead>
<tr>
<th></th>
<th>Total (n=38)</th>
<th>CAD (n=13)</th>
<th>Non-CAD (n=25)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inactive (&lt;5 days/week)</td>
<td>28 (73.7)</td>
<td>8 (61.5)</td>
<td>20 (80.0)</td>
<td>0.220</td>
</tr>
<tr>
<td>Active (≥5 days/week)</td>
<td>10 (26.3)</td>
<td>5 (38.5)</td>
<td>5 (20.0)</td>
<td>0.220</td>
</tr>
</tbody>
</table>

Average days per week classed as active (≥30 mins/day) | 2.7 ± 2.6 | 3.8 ± 2.2 | 2.1 ± 2.6 | 0.040   |

PA= Physical activity
Categorical data are reported as n (%)
Continuous data are reported as mean ± SD
Note: Accelerometer data from one non-CAD participant missing due to withdrawal from the objective PA assessment.
Figure 3. Objectively measured moderate-to-vigorous physical activity per week in CAD and non-CAD groups.
Table 10. Physical function results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total n=39</th>
<th>CAD n=13</th>
<th>Non-CAD n=26</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical functioning</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-second balance test (sec)</td>
<td>22.9 ± 8.7</td>
<td>23.9 ± 7.7</td>
<td>22.5 ± 9.3</td>
<td>0.646</td>
</tr>
<tr>
<td>30-second chair stand test (n)</td>
<td>14.8 ± 4.7</td>
<td>15.5 ± 4.3</td>
<td>14.5 ± 4.9</td>
<td>0.570</td>
</tr>
<tr>
<td>Handgrip strength index (kg/F)</td>
<td>28.2 ± 9.5</td>
<td>32.4 ± 12.2</td>
<td>26.1 ± 7.6</td>
<td>0.109</td>
</tr>
<tr>
<td>SPPB Physical function score (0-12)</td>
<td>11.2 ± 1.5</td>
<td>11.6 ± 0.8</td>
<td>11.0 ± 1.7</td>
<td>0.267</td>
</tr>
<tr>
<td><strong>Ten-meter shuttle walk test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shuttle walk test duration (min)</td>
<td>7.7 ± 1.5</td>
<td>7.5 ± 1.4</td>
<td>7.8 ± 1.6</td>
<td>0.685</td>
</tr>
<tr>
<td>Estimated VO$_{2peak}$ (mL/kg$^{-1}$/min$^{-1}$)</td>
<td>17.4 ± 4.0</td>
<td>19.3 ± 3.8</td>
<td>16.4 ± 3.8</td>
<td>0.300</td>
</tr>
<tr>
<td><strong>Six-minute shuttle walk test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-minute walk test distance (m)</td>
<td>452.9 ± 103.9</td>
<td>456.4 ± 73.8</td>
<td>457.6 ± 63.5</td>
<td>0.959</td>
</tr>
<tr>
<td>Estimated VO$_{2peak}$ (mL/kg$^{-1}$/min$^{-1}$)</td>
<td>14.8 ± 5.2</td>
<td>16.6 ± 5.5</td>
<td>13.8 ± 4.9</td>
<td>0.124</td>
</tr>
</tbody>
</table>

SPPB= Short physical performance battery, VO$_{2peak}$= Peak oxygen uptake.
Continuous data are reported as mean ± SD.
Chapter Four: Discussion

The present study compared the PA, physical function and QOL of elderly CAD patients compared to their age-matched non-CAD peers who participated in a community-based, maintenance CR program. The main finding of the present study was that when measured objectively, the CAD group performed significantly more MVPA per week compared to participants of the non-CAD group. However, despite the significant differences in PA duration, objectively measured PA results showed only approximately 26% of all participants met current PA guidelines of ≥30 minutes per day, ≥5 days a week (101). In comparison to objectively measured PA, no significant differences were observed between the two groups for any variable of the self-report IPAQ survey. Body composition measures such as body fat and muscle mass percentages were significantly more favourable in the CAD group compared to the non-CAD group. In addition, there were no differences between the CAD and non-CAD participants for any measure of QOL and physical function. The results of this study have added evidence to the currently limited knowledge regarding the benefits of long-term CR for elderly CAD patients. With a wider breadth of knowledge, the results of the present study along with other previous investigations are essential in the process of better informing healthcare professionals and subsequently reducing the current age bias seen with CR referrals, with particular emphasis on elderly CAD patients.

4.0 Objectively-Assessed Physical Activity

Previous investigations into the PA habits of CR participants have commonly incorporated self-report questionnaires to assess PA, most of which are prone to overestimation of actual PA levels (123). Furthermore, despite the increased access to reliable objective measures of PA such as accelerometers (92), only a few studies have used this technology to assess PA habits of elderly CR participants (98, 99). Current recommendations state that CAD
patients should perform 30-60 minutes of MVPA at least three to four times per week to prevent secondary MI and lower the risk of mortality, with maximum health benefits seen in those who perform five to six hours of MVPA per week (101, 124). Data from objectively-measured PA in the present study suggest community-based, maintenance CR participants on average perform sufficient among PA to reach recommended weekly levels adequately, with both groups performing over 150 minutes of MVPA over a week’s duration. However, the CAD group performed significantly more MVPA (specifically, moderate intensity PA) compared to the non-CAD group.” Despite weekly minutes of MVPA being high in both the CAD and non-CAD group, the number of days per week on which participants were classified as being active (≥30 minutes of MVPA/day) was less than recommended (101). Specifically, only 26.3% of all present study participants met the current PA recommendations of ≥30 minutes per day, ≥5 days a week (101, 124), with the CAD participants classified as active on only 3.8 days and the non-CAD participants active on 2.1 days of the week. Comparable findings were reported by Ayabe et al. (98) who used accelerometers to assess the weekly PA habits of middle- and older-aged CAD patients participating in CR. The researchers (98) observed on days CR exercise-sessions were held, participants achieved on average 92% of the recommended level of PA (≥30 minutes per day), compared to only 36% on those days CR exercise-sessions were not held. Interestingly, Ayabe et al. (98) also found when the amount of PA performed during CR was excluded from participants total daily PA, fewer participants achieved the recommended PA levels necessary for health-related benefits.

The influence of CR exercise sessions on total PA has also been observed in other previous studies investigating the training habits of elderly individuals (125, 126). An investigation by Jones et al. (99) into the PA patterns of CAD patients participating in a phase III CR program using accelerometry, also observed that significantly more participants achieved PA guidelines on days CR exercise sessions were held compared to those days they
were not. Furthermore, Jones et al. (99) reported those who did not perform exercise outside of CR or who were classified as retired were more likely to be categorised as ‘sedentary’ on days they did not participate in CR. However, step count was used as the primary outcome measure of PA in the study by Jones et al. (99) compared to time spent in PA as used in the present study. Therefore, it may be suggested that the low percentage of participants that were classified as active in the present study was due to their reliance on the weekly CR sessions delivered by their respective CR clubs, as each club offered two exercise sessions per week for ~50-60 minutes. This would be consistent with previous findings that have shown elderly maintenance CR participants were more likely to self-report higher energy expenditure during CR exercise sessions compared to leisure time PA (127). However, given the relatively high standard deviations within each group of the present study, with a range of 2.2 to 2.6 days per week for the CAD and non-CAD group, future studies that investigate the average weekly PA habits of elderly CR participants with a larger study cohort using accelerometers is warranted.

A unique aspect of this study was the objective assessment of MVPA in CAD patients compared to their non-CAD peers. Unexpectedly, the CAD group perform significantly more MVPA over a seven-day period compared to the non-CAD group, as the higher presence of CAD-related symptoms and known diagnosis of CAD has been shown to reduce PA levels in CAD patients (69, 128). This is the first study to compare objectively measured PA levels of CAD and non-CAD community-based, maintenance CR participants, therefore, no direct comparison can be made to other studies. However, a previous investigation by our research team into a comparable group of CR participants has reported similar findings from self-report measures of PA (87). Specifically, it was observed that CAD patients were more active than their non-CAD peers who also participated in maintenance CR (87). Based on previous research (88), it could be suggested that the more significant amount of MVPA performed by the CAD group was attributed to higher levels of motivation to perform PA and attend CR. This is evident
in the previous research of Horwood et al. (88), that investigated the motivators and barriers to participation in CR by CAD patients in a similar cohort of community-based, maintenance CR participants. Horwood et al. (88) found that those high attendees of CR were likely to be more physically active, had greater health concerns and perceived more significant benefits to regular participation in CR compared to their low or non-attender counterparts (88). Consequently, given the potential inclusion of highly motivated CR participants, caution is warranted when comparing differences in the objectively measured PA of the present study. Furthermore, although novel in its approach, these objective PA results may not be representative of the entire population of the two CR clubs the present study recruited from. Therefore, continued research into community-based CR using accelerometers is necessary to determine if similar motivations and PA levels found in this present study are relatable to the broader CAD population itself.

4.1 Self-Reported Physical Activity

Results from the present study’s self-reported PA habits showed approximately 97% of all participants were classed as being active based on current PA guidelines (101). Bock et al. (45) found CAD patients who either were currently participating or had participated in a maintenance CR program were more likely to self-report performing more PA per week as well as meet PA guidelines more regularly compared to those CAD patients who did not participate in maintenance CR. In contrast, Hansen et al. (8) reported a lack of long-term adherence to PA, with only 27% of 119 elderly CAD patients self-reporting enough PA to meet current PA guidelines at 18 months following graduation from phase II CR. The results of Hansen et al.’s (8) study are highly comparable to the present study, as similar moderate- and vigorous-intensity PA levels were reported by participants in Hansen et al.’s research using the IPAQ, however, different phases of CR were examined between Hansen and the present study. Subsequently, it could be suggested that continued participation in maintenance CR following outpatient CR appears to influence the PA habits of CR participants positively and may explain the contrasting results between Hansen et al. (8) and the results of other studies (46) including
the present study. However, due to the nature of self-reported PA caution must be warranted when interpreting results due to PA recall inaccuracies.

4.2 Community-based Cardiac Rehabilitation and Body Composition

Anthropometric and body composition results of the present study showed 51.3% of participants were categorised as having overweight BMI. The overweight and obese BMI categories accounted each for approximately 24% of the remaining participants. In addition, 53.8% of participants were categorised as having a waist circumference above the threshold for being a risk factor of CAD (129). These findings are similar to recent investigations into the adverse long-term changes in body composition associated with the aging process (76, 130). In the present study, the CAD group had more favourable body composition with lower body fat and higher muscle mass percentages compared to the non-CAD group. A possible explanation for this is the significantly higher amount of PA performed by the CAD group, as previous studies have found CAD patients who participated in long-term exercise training programs, were able to make greater changes to their body composition compared to their less active counterparts (131, 132). Brubaker et al. (49) also found extended-length CR (≥1 year) to be more beneficial for body composition compared to standard-length CR (3 months) (49). Furthermore, it has been shown that extended-length CR participants are better able to maintain their improved body composition over the long-term compared to the individuals attending standard-length CR (49). However, Brubaker et al. (49) examined younger male CAD patients. Therefore the effects of aging in elderly individuals may not have been as apparent. The findings of Brubaker et al. and the present study contrast findings from previous investigations (133, 134) as well as a previous report by our research team that found during a 1.6-year follow-up of a similar cohort of maintenance CR participants, unfavourable changes in body composition occurred regardless of attendance to CR and self-reported PA level (76). Due to the cross-sectional nature of this previous study, it cannot be concluded to what extent the
higher level of PA in the CAD group directly influenced their more favourable body compositions over the long-term. Given the controversial findings regarding the benefits of increased PA and its effect on elderly body composition, further research into the effects of CR on elderly body composition is warranted.

4.3 Community-based Cardiac Rehabilitation and Quality of Life

In contrast to previous studies (55, 135), no significant differences in QOL variables measured using SF-36 questionnaire were observed between the two groups of the present study. Seki et al. (136) reported the effectiveness of participation in a six-month phase III CR program had on elderly CAD patients QOL compared to age-matched controls, using the SF-36 questionnaire. The researchers (136) observed that after six months of CR, significant improvements in multiple domains of QOL had occurred compared to the controls. Furthermore, the lack of significant differences in QOL between the two groups of the present study may in part be related to the ability of CR to improve elderly CAD patients QOL to a level similar to their healthy, non-CAD peers. This is evident in findings by Izawa et al. (85) who reported that in elderly Japanese CAD patients who regularly performed PA for >18 months, including participation in a six-month CR program post-MI, were able to reach SF-36 QOL scores similar to the healthy elderly Japanese population. The findings of Izawa et al. (85) and the significantly higher PA levels of the present study’s CAD group suggests CR may influence increased PA levels and its long-term maintenance which in turn, may help to improve the QOL of CAD patients. The beneficial relationship between CR and QOL would agree with previous research that has found increased PA to generally have a positive, bi-directional effect on improving QOL in elderly individuals, both with and without CAD (56, 137). However, as improved physical function and more favourable anthropometric measures, two byproducts of increased PA are also known to improve QOL in elderly individuals (137), it cannot be concluded to what extent a direct relationship existed between increased PA as part of CR and improved QOL in CAD patients. Therefore, future randomised control studies using
accelerometers are warranted to examine what extent of PA is needed to make improvements in elderly CAD patient’s perceptions of QOL.

4.4 Community-based Cardiac Rehabilitation and Physical Function

In the present study, there were no significant differences in measures of muscle strength (30-second chair stand and handgrip tests), physical function (Short Physical Performance Battery and Six-Minute Walk Test) or exercise capacity (Ten-Meter Incremental Shuttle Walk Test). This lack of difference may be explained by the participants in the present study already having high baseline levels of physical function. The high baseline level is evident when physical function results are compared with previous findings by our research team who performed a 1.6-year follow-up in a cohort of maintenance CR patients highly comparable to the cohort of the present study (76). Similarly, Rengo et al. (138) who assessed elderly CAD patients participating in outpatient CR using the Short Physical Performance Battery, found those with lower baseline scores of physical function, made significant improvements in multiple measures of physical function following CR compared with those participants who had higher initial baseline scores in the Short Physical Performance Battery. In addition, it was also observed that those participants with higher baseline exercise capacities (≥5 METs, ~17.5 mL/kg/min) had higher total Short Physical Performance scores compared to those with exercise capacities <5 METs (138). Therefore, it can be suggested the lack of observed difference in physical function between the present study’s CAD and non-CAD groups was due to a previously proposed ‘ceiling effect’ (138), where little to no improvements can be seen in physical function as measured by the Short Physical Performance Battery for those with high baseline physical function. Furthermore, in the present study, there were no differences in physical function despite the CAD group performing more PA compared to the non-CAD group, a mediator known to be related to improvements in physical function (139). This finding is similar to reports by our research team who examined the same population of CR participants
as the present study a few years earlier (86). The researchers (86) observed elderly CAD patients who were participating in community-based maintenance CR had similar exercise capacities and physical function to those of their age- and gender-matched non-CAD ‘less active’ counterparts. However, as both studies recruited from only two local CR clubs, the similar physical function levels may be related to the nature of this population of CAD and non-CAD individuals and the CR clubs themselves, rather than the differences between CAD and non-CAD individuals over all. The results of the present study’s physical function and its similarity to research conducted in the same population a few years earlier suggest that the participation in long-term maintenance CR may slow the inevitable decline in physical function seen with aging (140). However, it cannot be concluded to what extent maintenance CR helped to improve physical function in these elderly individuals or just maintained the physical function of these participants. This highlights the need for future longitudinal studies to examine the physical function of CAD patients, especially elderly CAD patients from outpatient CR through the transition into maintenance CR, to observe at what point improvements in physical function change into its preservation.

4.5 Implications of Findings

Given the comprehensiveness of CR, the relationship between PA and its effect on physical function and QOL is complex. In addition, the current breadth of knowledge regarding community-based, maintenance CR and its benefits for elderly CAD patients remains low. Therefore, the results of the present study along with other previous research on community-based CR (87, 88, 141) should be used to better inform health care providers on the benefits long-term participation in community-based CR has with regard to both the physical and mental status of elderly CAD patients. As physician referral remains one of the leading barriers to increased referral onto CR (66), raising awareness about the benefits of PA among physicians and medical students (142) while improving their ability to provide PA advice (143) is an essential step in improving the referral rates to CR programs, especially among elderly
individuals with CAD. In addition, better education of physicians about the physiological and psychosocial benefits of participation in CR programs in all eligible CAD patients, including the elderly, may lead to increased rates of referrals to CR programs in the future (143). There remain many additional barriers to long-term participation in CR including geographical distance to nearest CR program and subsequent travel time to and from CR. In addition, high costs may impact the long-term participation in CR within some, but not all areas of the world (64, 71). The close geographical location, self-governance and low-cost of CR programs examined in the present study (141) may be key factors in their long-term success and relatively high number of observed attendees in the two CR clubs the present study recruited from. Therefore, although the structure of CR programs varies greatly, by implementing strategies that address the needs of the community and the local participants of CR, including social and economic aspects as well as the evaluation of program proximity, it may promote increased participation in maintenance CR (141). Increasing long-term membership and participation in maintenance CR is crucial, as the multiple health benefits associated with CR are essential for the preservation of health benefits acquired during earlier stages of CR (6).

4.6 Study Limitations

Despite its use of objective PA measures, the present study did have several limitations, including the ability to recruit from only two CR clubs within the wider Dunedin area. Having limited access to potential participants meant that when we encountered problems with recruitment, primarily the low interest in participation, there were fewer additional CR participants to recruit from. Therefore, the final small sample size of this study may have reduced any statistical power for the relationship between PA, physical function and QOL. Furthermore, it is possible that those participants who were recruited and took part in all aspects of the study were a selection of highly motivated CR participants, of whom may be non-representative of the entire population of the two CR clubs the present study recruited from.
This selection of highly motivated individuals is evident in the fact that most participants, both CAD and non-CAD were performing PA long enough to meet most of the recommended weekly PA guidelines (101). Therefore, it cannot be determined to what extent results of this study regarding physical function and QOL would be seen in less motivated and physically active CR participants. Despite previous studies having validated the use of BioImpedance machines for infield body composition measurement (144), these machines have been reported to provide potentially inaccurate measures of body fat percentage and free fat mass, tending to underestimate the body fat percentage of those individuals classed as obese (145). Therefore, measuring body composition with a BioImpedance machine may have produced inaccurate final data of the present study’s body composition trends. However, the portability of the BIA machine and its relative acceptability as an alternative to current gold standard methods of body composition, such as DXA scans made it an appropriate alternative for the present study. The selection of highly motivated participants may have introduced problems with recall and social desirability bias when self-reporting PA habits (146). In this study, accelerometers were used to overcome the potential introduction of elderly recall bias when self-reporting PA habits. However, despite accelerometers being able to measure PA in multiple planes of movement, they are potentially insensitive to non-ambulatory exercises such as cycling, swimming or upper-extremity movement (95). This inability of accelerometers to detect such exercise may have misinformed the overall objectively measured PA habits of participants, as both CR clubs offered opportunities to use stationary exercise equipment and perform multiple seated exercises using the body’s upper extremities. Furthermore, The Otago Pheonix Club offered its members swimming sessions, therefore given the accelerometers were not waterproof it cannot be determined how much PA was performed during those swimming sessions and if it would have changed the observed results of the present study.
4.7 Future Study Recommendations

Given the proximity of the present study’s participants to their respective CR clubs and potential self-selection of highly motivated individuals, it is uncertain to what extent the impact of participation in these maintenance CR programs influence the measures of PA, physical function and QOL as well as how representative these results are of the entire population of the two CR clubs this study recruited from. Therefore, to reduce the potential bias of self-selection, future studies should aim to recruit from a larger population of community-based, maintenance CR programs from multiple regions. With a greater sample of elderly CAD patients, results may be more generalizable to the whole maintenance CR population and less subject to the influences of individuals CR clubs. Furthermore, a longitudinal (1-3 year) assessment of elderly CR participants PA habits using accelerometers at periodic intervals should be used to assess the influence CR has on preserving PA levels over the long-term.

Conclusions

The present study found elderly CAD patients who are participating in community-based, maintenance CR can perform adequate amounts of weekly PA to a level similar or higher than their non-CAD peers. In addition, the high PA and long-term participation in CR may be a positive influencer for improving body composition and QOL, as well as help to preserve elderly CR participants physical function. Evidently, modern CR is a comprehensive and practical approach to the secondary prevention of CAD. However, current lack of knowledge and subsequent poor referral rates, especially for specific populations such as the elderly, has meant few eligible CAD patients have attended CR or have dropped out within the first year. Results of this study back-up previous reports that continued participation in community-based, maintenance CR can have beneficial effects for an elderly CAD patient, including the ability to maintain PA levels like that of their non-CAD peers. Given physician referral remains at the forefront of potential barriers to participation in CR, the findings of the present study highlight
the importance of better-educating health care providers and medical students on the benefits of long-term participation in CR. By improving awareness and education of the health benefits associated with maintenance CR, it may consequently increase the referral of CAD patients, particularly those elderly CAD patients who the most need to preserve physical function and the ability to live independently. Encouraging closer proximity community-based CR programs that employ strategies of self-governance may also promote increased adherence to participation in community-based CR. Therefore, despite the limitations of self-selection and small sample size, the findings of the present study warrant continued research that investigates community-based, maintenance CR using a more extensive and broader population of CR participants over the long-term. By increasing the knowledge of the multiple phases and aspects of CR, it may prove to be an effective strategy for improved participation and incorporation of CR into secondary prevention programs worldwide.
References


42. Mendes M. [Cardiac rehabilitation after myocardial infarction: an invaluable intervention that is little used in Portugal]. Revista Portuguesa Cardiology. 2013;32(3):201-3.


133. Socha M, Wronecki K, Sobiech KA. Gender and age-dependent differences in body composition changes in response to cardiac rehabilitation exercise training in patients after


Appendix A Ethics Approval

Dr S Mandic
School of Physical Education, Sport and Exercise Sciences
Division of Sciences
46 Union Street West

Dear Dr Mandic,

I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled “Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants”.

As a result of that consideration, the current status of your proposal is:- Approved

For your future reference, the Ethics Committee’s reference code for this project is:- H16/144.

The standard conditions of approval for all human research projects reviewed and approved by the Committee are the following:

Conduct the research project strictly in accordance with the research proposal submitted and granted ethics approval, including any amendments required to be made to the proposal by the Human Research Ethics Committee.

Inform the Human Research Ethics Committee immediately of anything which may warrant review of ethics approval of the research project, including: serious or unexpected adverse effects on participants; unforeseen events that might affect continued ethical acceptability of the project; and a written report about these matters must be submitted to the Academic Committees Office by no later than the next working day after recognition of an adverse occurrence/event. Please note that in cases of adverse events an incident report should also be made to the Health and Safety Office:

http://www.otago.ac.nz/healthandsafety/index.html

Advise the Committee in writing as soon as practicable if the research project is discontinued.

Make no change to the project as approved in its entirety by the Committee, including any wording in any document approved as part of the project, without prior written approval of the Committee for any change. If you are applying for an amendment to your approved research, please email your request to the Academic Committees Office:
gary.witte@otago.ac.nz

jo.farrondediaz@otago.ac.nz

Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval or an extension of approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

The Human Ethics Committee (Health) asks for a Final Report to be provided upon completion of the study. The Final Report template can be found on the Human Ethics Web Page [http://www.otago.ac.nz/council-committees/committees/HumanEthicsCommittees.html](http://www.otago.ac.nz/council-committees/committees/HumanEthicsCommittees.html)

Yours sincerely,

[Signature]

Mr Gary Witte
Manager, Academic Committees
Tel: 479 6256
Email: gary.witte@otago.ac.nz

c.c. Professor D G Booth  Dean  School of Physical Education, Sport and Exercise Sciences
Appendix B Māori Consultation Approval

Tuesday, 06 December 2016.

Dr Sandra Mandic,
University of Otago,
DUNEDIN.

Tēnā Koe Dr Sandra Mandic,

Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

The Ngāi Tahu Research Consultation Committee (the committee) met on Tuesday, 06 December 2016 to discuss your research proposition.

By way of introduction, this response from The Committee is provided as part of the Memorandum of Understanding between Te Rūnanga o Ngāi Tahu and the University. In the statement of principles of the memorandum it states “Ngāi Tahu acknowledges that the consultation process outlined in this policy provides no power of veto by Ngāi Tahu to research undertaken at the University of Otago”. As such, this response is not "approval" or "mandate" for the research, rather it is a mandated response from a Ngāi Tahu appointed committee. This process is part of a number of requirements for researchers to undertake and does not cover other issues relating to ethics, including methodology they are separate requirements with other committees, for example the Human Ethics Committee, etc.

Within the context of the Policy for Research Consultation with Māori, the Committee base consultation on that defined by Justice McGechan:

"Consultation does not mean negotiation or agreement. It means: setting out a proposal not fully decided upon; adequately informing a party about relevant information upon which the proposal is based; listening to what the others have to say with an open mind (in that there is room to be persuaded against the proposal); undertaking that task in a genuine and not cosmetic manner. Reaching a decision that may or may not alter the original proposal."

The Committee considers the research to be of importance to Māori health.

The Committee notes and commends that ethnicity data is to be collected as part of the research project and recommends the use of the questions on self-identified ethnicity and descent, these questions are contained in the latest census.

The Committee suggests including in the research team a researcher with expertise in analysing and interpreting data by ethnicity.

The Committee suggests dissemination of the research findings to Māori health organisations.
regarding this study.

We wish you every success in your research and the committee also requests a copy of the research findings.

This letter of suggestion, recommendation and advice is current for an 18 month period from Tuesday, 06 December 2016 to 6 June 2018.

Nāhaku noa, nā

Mark Brunton
Kaiwhakahaere Rangahau Māori
Research Manager Māori
Research Division
Te Whare Wānanga o Otāgo
Ph: +64 3 479 8738
Email: mark.brunton@otago.ac.nz
Web: www.otago.ac.nz

The Ngāi Tahu Research Consultation Committee has membership from:
Te Rūnanga o Ōtākou Incorporated
Kāti Huirapa Rūnanga ki Puketeraki
Te Rūnanga o Moeraki
Appendix C Study Information and Consent Form

Reference number: H14/166; December 2016

INFORMATION SHEET

Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

You are invited to take part in this study examining physical activity habits, physical function and quality of life. Please read this information sheet carefully before deciding whether or not to take part. You have up to 3 months to consider whether to take part in the study. Your participation is entirely voluntary (your choice). You do not have to take part in this study, and if you choose not to take part this will not affect any future care or treatment. If you do agree to take part in the study, you are free to withdraw from the study at any time, without having to give a reason, and this will in no way affect your future health care. Participation in this study will be stopped should any harmful effects appear or if the investigators feel it is not in your best interests to continue.

Aim of the Study. Older age is associated with the progressive impairment of physical function, decreased exercise capacities, poor quality of life and higher prevalence of coronary artery disease (CAD). The effects of long-term exercise on these factors in CAD patients, particularly elderly remains relatively unknown. In particular, short outpatient (phase II) cardiac rehabilitation programs, low adherence to continued exercise programs outside of rehabilitation as well as the relatively low number of community-based (phase III) programs available represent a challenge to examine the long-term effects of exercise in CAD patients. The purpose of this study is to examine the correlations between physical activity levels, physical function and quality of life in elderly (>60 years of age) individuals with and without CAD participating in community-based cardiac rehabilitation.

Participants. We plan to approach 100 men and women aged 60 years and older, with heart disease and without heart disease. Participants will be recruited from community cardiac clubs and from the community. If you do not have a history of heart disease, you should also be free of diabetes, chronic obstructive pulmonary disease, and cancer. If you have a history of heart disease, your last cardiac event (heart attack, stent placement, or coronary artery bypass surgery) should be at least 6 months ago.

People who have one or more of the following conditions will not be able to participate in the project because, in the opinion of the researchers, participation may involve an unacceptable risk to them: A recent (less than 6 months) heart attack or admission to hospital with chest pain, chest pain coming on at rest, significant symptoms of palpitations, symptoms related to severe narrowing of the aortic valve, significant breathlessness and fluid build-up or swelling, lung clots, recent heart inflammation or inflammation of the sac surrounding the heart.

Participant’s Involvement. Should you agree to take part in this project, you will be asked to attend 1 visit to the Active Living Laboratory within 3 weeks.

Active Living Laboratory Visit (2 hours). School of Physical Education, University of Otago. During the first visit, we will ask you about your health and physical activity habits using questionnaires that may take you up to 1 hour to complete. We will also measure your height, weight, waist circumference, blood pressure, body composition and the strength of your muscles. You will also be requested to perform simple physical tasks and 3 short walking tests. In addition, we will give you instructions, an accelerometer and a log to record your physical activities for 7 days. Once completed, you will return the accelerometers and logs to us.

Benefits. As part of this study you will receive a copy of your physical function results as well as a certificate of participation in this study.
Inconvenience. You may experience temporary muscle soreness for a few days after the physical function testing.

Compensation. In the unlikely event of a physical injury as a result of your participation in this study, you will be covered by the accident compensation legislation within its limitations. If you have any questions about ACC, feel free to ask the researcher for more information before you agree to take place in this study. You are also advised to check whether participation in this study would affect any indemnity cover you have or are considering, such as medical insurance, life insurance and superannuation.

Collected Information and Its Use. The data collected from you will include demographic information, results of your physical assessments, your physical activity habits and perceptions of your quality of life and general health. If you belong to the Phoenix Club, The Larks or Taieri Fit and Fun Club, we will collect information on your attendance of the club exercise sessions for up to 10 previous years from the club attendance records.

We are collecting your contact information to be able to contact you for future follow-up studies. There are no consequences to you for not supplying the requested information. It may only limit the quality of research data. The information you provide will be used to develop future projects.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand). No material that could personally identify you will be used in any reports on this study. You are most welcome to request a copy of the results of the project should you wish. Please note that there will be a delay between data collection and publication of results.

The data collected will be securely stored in such a way that only the lead researcher Dr Sandy Mandic and Master's student, Garrick Hately will have access to personal information. Data will be entered in a research database using a unique study identifier. As required by the University's research policy, raw but anonymous data related to the project will be kept in secure storage for five years, after which it will be destroyed.

Future Contact. We would like to contact you in future for follow-up assessments if such research studies are designed. There are no expectations of you to take part or feel obligated to take part in the follow-up assessments.

Changing Your Mind and Withdrawing from the Project. You may decide to not take part in this project without any disadvantage to yourself of any kind. You may also withdraw your data from inclusion in this project at any time and without any disadvantage.

Questions about the project. If you have any questions about our project, either now or in the future, please feel free to contact:

Mr Garrick Hately, Master’s student
School of Physical Education, Sport and Exercise Sciences
University Telephone Number: 03 479 9112

Dr Sandy Mandic
School of Physical Education, Sport and Exercise Sciences
University Telephone Number: 03 479 5415

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 6256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the project is entirely voluntary;
2. I am free to withdraw from the project at any time without any disadvantage;
3. Personal identifying information will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which they will be destroyed;
4. The exercise tests that I will perform are generally regarded as very safe. I may experience temporary muscle soreness for a few days after the exercise testing;
5. I understand the compensation provisions for this study;
6. If I belong to the Phoenix Club, The Larks or Taiari Fit and Fun Group, I consent to researchers accessing data from the club attendance records.
7. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity;
8. I understand that I may be contacted by the researchers for follow-up assessments in future. I am free to decide to not take part in the follow-up assessments without any disadvantage.

I agree to take part in this project.

Name of participant (Please print) Study ID (Researchers to complete)

(Signature of participant) (Date)

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix D Accelerometer Information Sheet and Consent Form

Information Leaflet for Participants
Physical Activity Assessment

What you will be asked to do

You will wear a small activity meter (the size is a little larger than an iPod shuffle) on a belt around your waist for 7 days (either underneath or on top of your clothing). This activity meter called accelerometer records general movement and allows us to get a better idea of your overall activity level. Nobody, not even you, will be able to see the data.

Attend a 20-Minute Appointment at the University of Otago

Research staff will measure your height, weight and waist circumference and set up an activity meter for you. These measures will be taken without shoes and while wearing light clothing in a private area. Research staff will also give you a log to write down the times when you wear the meter.

Wear Your Activity Meter for 7 Days

You will keep the activity meter on all day (unless sleeping, swimming or in the water).

You will be asked to wear a meter for 7 days, for at least 12 hours per day. If you wear the meter for less time, we may have to send it back for you to wear again.

The researchers will send you daily reminders by e-mail, text or phone during these 7 days.

The activity meters are very expensive (over $400) and sensitive. They do not show you any data, have a short battery life and can only be used by the researchers. Therefore, it will be important to wear an activity meter as instructed, take care of the device to prevent damage or loss and return it on time.

Return Your Activity Meter to Researchers

After 7 days, you will return your activity meter and a log to the University of Otago or mail it back using a pre-paid addressed envelope (provided by research staff).

If you forget to return the meter, the researchers will remind you by phone or e-mail.

Receive a Summary Showing Your Activity Levels

How to sign up

Mail or e-mail a complete enclosed consent form to researchers:

Garrick Hately | hatga356@student.otago.ac.nz
School of Physical Education, Sport and Exercise Sciences, PO Box 56, Dunedin, 9054

How to get more information

Active Living Laboratory website | www.otago.ac.nz/active-living/research
Garrick Hately, Master's student | Phone: 03 479 9112 | E-mail: hatga356@otago.student.ac.nz
Dr Sandy Mandic, Principal Investigator | Phone: 03 479 5415 | E-mail: sandra.mandic@otago.ac.nz
Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

Consent Form for Participants

I have read the Information Sheet for the Physical Activity Assessment and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the project is entirely voluntary.
2. I am free to withdraw from the project at any time without any disadvantage.
3. I understand that my participation in this study is confidential and that no material that could identify me will be used in any reports on this study.
4. I agree to wear an activity meter as instructed and take care of it to prevent damage or loss.
5. I understand that during these 7 days the researchers will remind me daily by e-mail, text or phone to wear the activity meter and to return it on a scheduled return date.
6. I agree to return the device after 7 days. If I forget to return the device, I agree that researchers can contact me by phone, e-mail or mail to remind me to return the device.
7. I understand that I may be asked to wear the meter again if I do not wear it for full 7 days initially.
8. I understand that if I wear the meter for 7 days, for at least 12 hours a day, and return the device and log to an agreed location on a scheduled date, I will receive a summary of my activity graphs.
9. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand). No personal information about individual participants will be reported.

I agree to take part in this study:

_________________________________   ___________________________   ___________
Name (please print)              Signature              Date

Contact details for researchers:

E-mail: ________________________________

Home phone: ___________________   Cell phone: __________

Preferred way of communication:   Home phone   Cell phone   E-mail   (Please circle one)

Preferred time for a 2-hour appointment: Morning   Mid-day   Afternoon   Other: __________

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph: 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix E Sociodemographic, Medical History and Medication Sheets

Study number:    Study site code:    Participant ID:    

Assessment code:    

Project Title:  
Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

Contact Information

1. Assessment date:    
2. First name:    
3. Middle name:    
4. Last name:    
5. Date of birth:    

Your contact information

6. Street address:    
7. City / Town / Village:    
8. Postal code    
9. Country    
10. Contact phone number:    
11. Alternative phone number (optional):    
12. E-mail (optional):    

Interest in Future Research

13. Are you interested to be contacted for future research studies?    
   Yes    No

Community Group Membership

14. Do you belong to physical activity related community group or club?    
   Yes    No
   a. If yes, which club(s) do you belong to?    
   b. In which year did you join this club for the first time?    

Your GP

15. Would you like your GP to be informed that you are a participant in this study?    
   Yes    No
   a. If yes, please write down name of your GP:    

Thank you for your time and effort. Your participation is much appreciated.
ABOUT YOU

These questions help us describe the groups of people who participated in this study. All this information remains confidential.

1. How old are you? ___________ years

2. Are you?  
   □ 1 Male  □ 2 Female

3. Which ethnic group do you belong to?  
   (Mark the box or boxes which apply to you.)
   □ 1 New Zealand European  □ 4 Cook Island Māori  □ 7 Chinese
   □ 2 Māori  □ 5 Tongan  □ 8 Indian
   □ 3 Samoan  □ 6 Niuean  □ 9 Other (such as Dutch, Japanese, Tokelauan.)
   Please state: __________________

4. How long have you lived in New Zealand?  
   □ 1 Always lived in New Zealand  □ 2 Less than 1 year  □ 3 2-3 years  □ 4 4 or more years  □ 5 Don't know

5. What is your marital status?  
   □ 1 Single  □ 2 Married / living with a partner  □ 3 Separated / divorced  □ 4 Widowed  □ 5 Other

6. What is your highest level of education?  
   □ 1 Primary school  □ 2 Secondary school to 5th form  □ 3 Secondary school to 6th form
   □ 4 Secondary school to 7th form  □ 5 Highest University degree: Please state: __________________
   □ 6 Other qualifications: Please state: __________________

7. Which one of the following best describes you?  
   (Tick one box only. If more than one category applies, mark the one you spend more time during over a week.)
   □ 1 Working full-time  □ 5 Retired
   □ 2 Working part-time  □ 6 Sick / Invalid
   □ 3 Unemployed / Actively seeking employment  □ 7 Student (full-time, including secondary school)
   □ 4 At home  □ 8 Other. Please specify: __________________

8. If working full-time or part time, what is your present occupation? __________________
6. In your medical history, have you had (or do you currently have) any of these health conditions?

(Tick one box only for each condition)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>If yes:</th>
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</thead>
<tbody>
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<td>a High blood pressure</td>
<td></td>
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<td>Type I diabetes</td>
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<td>b High cholesterol</td>
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<td>d Being overweight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e Smoking</td>
<td></td>
<td></td>
<td>Current smoker</td>
</tr>
<tr>
<td>f Alcohol abuse</td>
<td></td>
<td></td>
<td>Quit more than 6 months ago</td>
</tr>
<tr>
<td>g Heart attack / myocardial infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h Angina / Chest pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i Bypass surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j Valve surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k Angioplasty or stent inserted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l Pacemaker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m Peripheral vascular disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n Heart failure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Mini stroke or TIA*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Mini stroke is described as temporary weakness or difficulty with speech that lasted a short time and resolved completely. Mini stroke is also known as TIA (transient ischemic attack)

| p Stroke                                     |     |    |                              |
| q Other cardiovascular disease               |     |    |                              |

If yes, please specify:
7. In your **medical history**, have you had (or do you currently have) any of these health conditions? 

*(Tick one box only)*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Asthma</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>Respiratory tract infection</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>Chronic obstructive pulmonary disease</td>
<td>0</td>
</tr>
<tr>
<td>d</td>
<td>Hay fever or other seasonal allergies</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>Arthritis</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>Osteoporosis</td>
<td>0</td>
</tr>
<tr>
<td>g</td>
<td>Back pain or back problems</td>
<td>0</td>
</tr>
<tr>
<td>h</td>
<td>Anxiety disorder</td>
<td>0</td>
</tr>
<tr>
<td>i</td>
<td>Depression or mood disorder</td>
<td>0</td>
</tr>
<tr>
<td>j</td>
<td>Breast cancer</td>
<td>0</td>
</tr>
<tr>
<td>k</td>
<td>Colon cancer</td>
<td>0</td>
</tr>
<tr>
<td>l</td>
<td>Prostate cancer</td>
<td>0</td>
</tr>
<tr>
<td>m</td>
<td>Other cancer</td>
<td>0</td>
</tr>
<tr>
<td>n</td>
<td>Other physical health condition</td>
<td>0</td>
</tr>
<tr>
<td>o</td>
<td>Other mental health condition</td>
<td>0</td>
</tr>
</tbody>
</table>

If yes, please specify: ____________________________

8. Do you have... *(Tick one box only)*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>A father or brother who had a heart attack or heart surgery before the age of 55</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>A mother or sister who had a heart attack or heart surgery before the age of 65</td>
<td>0</td>
</tr>
</tbody>
</table>

9. Have you experienced the following symptoms? *(Tick one box only)*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Discomfort in the chest with exercise and exertion</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>Shortness of breath with mild exertion</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>Dizziness, fainting, or blackouts</td>
<td>0</td>
</tr>
<tr>
<td>d</td>
<td>Burning or cramping sensation in your lower legs when walking short distances</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>Musculoskeletal problems that limit your physical activity</td>
<td>0</td>
</tr>
</tbody>
</table>
**MEDICATIONS**

Do you take... *(Tick one box only)*

<table>
<thead>
<tr>
<th></th>
<th>Heart medications</th>
<th>1 Yes</th>
<th>0 No</th>
<th>If yes, indicate reason:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Prescription medications</th>
<th>1 Yes</th>
<th>0 No</th>
<th>If yes, indicate reason:</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please list in this box all medications that you take:

1. __________________________________________
2. __________________________________________
3. __________________________________________
4. __________________________________________
5. __________________________________________
6. __________________________________________
7. __________________________________________
8. __________________________________________

Researchers to complete this section:

<table>
<thead>
<tr>
<th>Code</th>
<th>1) Beta blocker</th>
<th>2) ACE inhibitor</th>
<th>3) Ca²⁺ Channel blocker</th>
<th>4) Aspirin</th>
<th>5) Lipid lowering agents</th>
<th>6) Nitrates</th>
<th>7) GTN Spray</th>
<th>8) Diuretics</th>
<th>9) Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

If yes, list:

---

**HOSPITAL ADMISSIONS**

Have you been admitted to the hospital in the last 12 months?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

If yes, when: ______________________ (mm/yyyy)

Describe reason: __________________________________________________________

---

Data checked by: ________
Appendix F Physical Function Collection Sheets

Physical Activity, Quality of Life and Physical Function in Community-Based Cardiac Rehabilitation Participants

Physical Function Assessment

Participant Name: 

Assessment date: [dd/mm/yyyy]  
Start time: [hh:mm]

Stations

Tick box when completed  
Research assistant to initial when station is completed

- [ ] Station 1: Welcome and orientation
- [ ] Station 2: Resting heart rate and blood pressure
- [ ] Station 3: Anthropometry
- [ ] Station 4: 10-meter Shuttle Walk Test
- [ ] Station 5: Physical Function testing
- [ ] Station 6: Muscle strength
- [ ] Station 7: Medical history
- [ ] Station 8: Physical Activity questions
- [ ] Station 9: 6-Minute walk test

When participant completes the last station (6-minute walk test), please send participant to the front desk (Station 1) with their data collection forms.

- [ ] Station 10: Results report given to the participant

Finish time: [hh:mm]

Please make sure that the participant has completed all stations and was given a report with the results and study certificate.

Final data check completed by: 

**Anthropometry**

*Before performing measurements:*
- Ask participant to remove their shoes.
- Ask participants to remove their jacket and sweaters and empty their pockets.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (without shoes):</td>
<td>cm</td>
</tr>
<tr>
<td>Weight (without shoes and jackets):</td>
<td>kg</td>
</tr>
<tr>
<td>Body mass index (calculate)</td>
<td>kg/m²</td>
</tr>
<tr>
<td>Waist circumference:</td>
<td>cm</td>
</tr>
<tr>
<td>Hip circumference:</td>
<td>cm</td>
</tr>
<tr>
<td>Waist to hip ratio:</td>
<td></td>
</tr>
</tbody>
</table>

**Body composition:**

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td>Body fat (kg)</td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td>Percentage body fat (%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Fat-free mass (kg)</td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td>Percentage fat-free mass (%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

*Completed by:*

**Comments:**
Resting Hemodynamics

Put heart rate monitor on a participant. Make sure that participant is sitting quietly for at least 5 minutes before measuring heart rate and blood pressure. Place blood pressure cuff on the right arm.

Assessment time: [hh:mm]

Please answer the following questions:

Did you drink coffee today? [Yes/No] If yes, when? [Hours]

Did you drink tea that has caffeine today? [Yes/No] If yes, when? [Hours]

Did you drink alcohol today? [Yes/No] If yes, when? [Hours]

Did you have food today? [Yes/No] If yes, when? [Hours]

Heart rate at rest: [Beats per minute]

Blood pressure at rest: [Left arm]

Measure 1: [Systolic]/[Diastolic] mm Hg

Measure 2: [Systolic]/[Diastolic] mm Hg

Average: [Systolic]/[Diastolic] mm Hg

Completed by: [Signature]

Comments:
### Muscle Strength

#### A. Upper Body Strength – Handgrip Dynamometer

*Instructions:* Hand the dynamometer to the subject and assist them in assuming the proper position. Instruct the subject to keep the upper part of the arm being tested adducted fully against his or her body while flexing the elbow to 90 degrees. The subject must hold the dynamometer with his/her own strength. Dynamometer should be held perpendicular to the floor during testing. Instruct the subject to squeeze as hard as he or she can (be enthusiastic!). Give the subject at least 30 seconds of rest before repeating test 2 more times.

<table>
<thead>
<tr>
<th>Dominant hand</th>
<th>Right</th>
<th>Left</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Highest score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-dominant hand</td>
<td>Right</td>
<td>Left</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### B. Lower Body Strength – 30 sec Chair Stand Test

Explain participants that this test is different from the other chair stand test. This test is measuring how many times they can get up and sit down from a chair in 30 seconds. The other test is timing how fast they can get up and sit down from a chair for 5 times.

**Pre-Test: Single chair stand test**

Participants fold their arms across their chest and try to stand up once from a chair.

- Safe to stand without help test  □ Yes □ No

**30-Second Chair Stand Test**

- Safe to perform 30 second chair stand test  □ Yes □ No

- If 30-second chair stand test was completed successfully, record number of complete stand-up and sit down cycles. Give participant 3 minute rest between the trials, or more if needed.

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Best score</th>
</tr>
</thead>
</table>

C. If participant did not attempt test or failed, circle why:
- Tried but unable  1
- Participant could not stand unassisted  2
- Not attempted, you felt unsafe  3
- Not attempted, participant felt unsafe  4
- Participant unable to understand instructions  5
- Other (Specify)  6
- Participant refused  7

Completed by: □

Comments:
Physical Function Testing

Follow the instructions provided.

Test 1: Balance Tests

A. Side-by-side-stand (Feet together side by side)
   - Held for 10 sec: 1 point
   - Not held for 10 sec: 0 points
   - Not attempted: 0 points
   If 0 points, end Balance Tests
   Number of seconds held if less than 10 sec: ___ ___ sec

B. Semi-Tandem Stand (Heel of one foot against side of big toe of the other foot)
   - Held for 10 sec: 1 point
   - Not held for 10 sec: 0 points
   - Not attempted: 0 points (circle reason above)
   If 0 points, end Balance Tests
   Number of seconds held if less than 10 sec: ___ ___ sec

C. Tandem Stand
   - Held for 10 sec: 2 points
   - Held for 3 to 9.99 sec: 1 point
   - Held for < than 3 sec: 0 points
   - Not attempted: 0 points (circle reason above)
   Number of seconds held if less than 10 sec: ___ ___ sec

D. Total Balance Tests score: (Sum points A to C)

E. One-Foot Balance Test (Up to 30 seconds)
   - ___ ___ sec
   Completed by: 

Comments:
Physical Function Testing

Follow the instructions provided.

Test 2: Walking Speed Test

This test measures the time required to walk 4 meters at a normal pace.

A. First Walking Test
1. Time for walking 4 meters: __________ sec
2. If participant did not attempt test or failed, circle why:
   - Tried but unable
   - Participant could not walk unassisted
   - Not attempted, you felt unsafe
   - Not attempted, participant felt unsafe
   - Participant unable to understand instructions
   - Other (Specify)
   - Participant refused
   - Complete score sheet and go to chair stand test
3. Aids for first walk: None □ Cane □ Other □

B. Second Walking Test
1. Time for walking 4 meters: __________ sec
2. If participant did not attempt test or failed, circle why:
   - Tried but unable
   - Participant could not walk unassisted
   - Not attempted, you felt unsafe
   - Not attempted, participant felt unsafe
   - Participant unable to understand instructions
   - Other (Specify)
   - Participant refused
   - Complete score sheet and go to chair stand test
3. Aids for first walk: None □ Cane □ Other □

Comments:

What is the time for the faster of the two walks?

Record the shorter of the two times

[If only 1 walk done, record that time]

If the participant was unable to do the walk: □ 0 points
If time is more than 8.70 sec: □ 1 point
If time is 6.21 to 8.70 sec: □ 2 points
If time is 4.82 to 6.20 sec: □ 3 points
If time is less than 4.82 sec: □ 4 points

Completed by: □
Physical Function Testing

Follow the instructions provided.

Test 3: Chair Stand Test

This test measures the time required to perform FIVE rises from a chair to an upright position as fast as possible.

Pre-Test

Participants fold their arms across their chest and try to stand up once from a chair

A. Safe to stand without help ☐ Yes ☐ No
B. Results

☐ Participant stood without using arms → Go to Repeated Chair Stand Test

☐ Participant used arms to stand → End test; score as 0 points

☐ Test not completed → End test; score as 0 points

C. If participant did not attempt test or failed, circle why:
   Tried but unable 1
   Participant could not stand unassisted 2
   Not attempted, you felt unsafe 3
   Not attempted, participant felt unsafe 4
   Participant unable to understand instructions 5
   Other (Specify) 6
   Participant refused 7

Repeated Chair Stand Test

Participants fold their arms across their chest and perform FIVE rises from a chair to an upright position as fast as possible

A. Safe to stand five times ☐ Yes ☐ No
B. If five stands done successfully, record time in seconds

Time to complete 5 stands: __________ sec

C. If participant did not attempt test or failed, circle why:
   Tried but unable 1
   Participant could not stand unassisted 2
   Not attempted, you felt unsafe 3
   Not attempted, participant felt unsafe 4
   Participant unable to understand instructions 5
   Other (Specify) 6
   Participant refused 7

Scoring the Repeated Chair Test

Participant unable to complete 5 chair stands or completes stands in >60 sec: ☐ 0 points
If chair stand time is 16.70 sec or more: ☐ 1 points
If chair stand time is 13.70 to 16.69 sec: ☐ 2 points
If chair stand time is 11.20 to 13.69 sec: ☐ 3 points
If chair stand time is 11.19 sec or less: ☐ 4 points

Scoring for Physical Function Testing

<table>
<thead>
<tr>
<th>Test Score</th>
<th>Points (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Balance Test Score</td>
<td>☐</td>
</tr>
<tr>
<td>Gait Speed Test Score</td>
<td>☐</td>
</tr>
<tr>
<td>Chair Stand Test Score</td>
<td>☐</td>
</tr>
<tr>
<td>TOTAL Score</td>
<td>☐</td>
</tr>
</tbody>
</table>
### 10-Meter Shuttle Walk Test

**Instructions**: Instruct participants to **walk in a loop** around the markers (not a figure of 8). Participants must try to reach the marker before the beep sounds. If they are within one pace of the cone, they get a tick. If not, they continue to the next length and have an opportunity to catch up. If not, the test is finished.

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>Level</th>
<th>Number of shuttles</th>
<th>Heart rate before test:</th>
<th>Start time: (hh:mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.80</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.41</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.03</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.63</td>
<td>4</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.25</td>
<td>5</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.86</td>
<td>6</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.47</td>
<td>7</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.09</td>
<td>8</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.69</td>
<td>9</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.31</td>
<td>10</td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.92</td>
<td>11</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.53</td>
<td>12</td>
<td>89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Max:** Number of shuttles: **12**  
**VO_{2peak}:** **ml/kg/min**

#### Reason(s) to END TEST:
- Normal endpoint reached fatigue
- Leg fatigue
- Shortness of breath
- Reached max age-predicted HR
- Chest pain (angina)
- Claudication
- Technical difficulties
- Could not keep up with pace/beep
- Other: Describe:

#### Symptoms on exercise:
- None
- Chest pain
- Shortness of breath
- Knee pain
- Hip pain
- Back pain
- Other: Describe:

#### Age:
Age-predicted max HR (220-age): **bpm**

#### Test duration:
Recovery heart rate (sitting) 1 minute after test: **bpm**  
2 minutes after test: **bpm**

#### Completed by:

- Tick completed shuttles during the test
- Record heart rate and Borg’s scale rating at the end of each stage (see highlighted shuttles) and at the end of the test.
6-Minute Walk Test

**Instructions**: Instruct a participant to cover as much distance as they can in 6 minutes. Time is not stopped if a participant takes a rest. Inform participants when 2, 4 and 6 minutes have passed. You may say "well done" and "keep going" once during the test.

### Test 1

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Distance (laps)</th>
<th>Heart rate</th>
<th>Borg's scale</th>
<th>Rests (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 (End)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Start time**: [ ] [ ] (hh:mm)

**End time**: [ ] [ ] (hh:mm)

**Total distance**: [ ] meters (number of laps multiplied by 60)

**Recovery heart rate (sitting)**

- 1 minute after test: [ ] bpm
- 2 minutes after test: [ ] bpm

**Comments:**

- Cross off completed laps during the test
- Record heart rate and Borg's scale rating at the end of each minute and at the end of the test

### Test 2

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Distance (laps)</th>
<th>Heart rate</th>
<th>Borg's scale</th>
<th>Rests (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 (End)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Start time**: [ ] [ ] (hh:mm)

**End time**: [ ] [ ] (hh:mm)

**Total distance**: [ ] meters (number of laps multiplied by 60)

**Recovery heart rate (sitting)**

- 1 minute after test: [ ] bpm
- 2 minutes after test: [ ] bpm

**Completed laps (cross off during the test):**

- 1 2 3 4 5 6 7 8 9 10
- 11 12 13 14 15 16 17 18 19 20

(1 lap = 60 meters)

**Symptoms on exercise:**

- None
- Shortness of breath
- Hip pain
- Other. Describe: [ ]
- Chest pain
- Knee pain
- Back pain

**Comments:**
Appendix G SF-36 Quality of Life Questionnaire

Your Health and Well-Being

This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this questionnaire!

For each of the following questions, please mark an □ in the one box that best describes your answer.

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

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 4</td>
<td>□ 5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Much better now than one year ago</th>
<th>Somewhat better now than one year ago</th>
<th>About the same as one year ago</th>
<th>Somewhat worse now than one year ago</th>
<th>Much worse now than one year ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 3</td>
<td>□ 4</td>
<td>□ 5</td>
</tr>
</tbody>
</table>
3. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Lifting or carrying groceries</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Climbing several flights of stairs</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Climbing one flight of stairs</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Bending, kneeling, or stooping</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Walking more than a kilometre</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Walking several hundred metres</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Walking one hundred metres</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Bathing or dressing yourself</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
4. **During the past 4 weeks**, how much of the time have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>1. Cut down on the amount of time you spent on work or other activities</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
<tr>
<td>2. Accomplished less than you would like</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
<tr>
<td>3. Were limited in the kind of work or other activities</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
<tr>
<td>4. Had difficulty performing the work or other activities (for example, it took extra effort)</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>1. Cut down on the amount of time you spent on work or other activities</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
<tr>
<td>2. Accomplished less than you would like</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
<tr>
<td>3. Did work or other activities less carefully than usual</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
<td>□ □ □ □ □</td>
</tr>
</tbody>
</table>
6. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>None</th>
<th>Very mild</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Very severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
</tbody>
</table>

a. Did you feel full of life?........... □ 1........... □ 2........... □ 3........... □ 4........... □ 5

b. Have you been very nervous?....... □ 1........... □ 2........... □ 3........... □ 4........... □ 5

c. Have you felt so down in the dumps that nothing could cheer you up?......................... □ 1........... □ 2........... □ 3........... □ 4........... □ 5

d. Have you felt calm and peaceful?................................................... □ 1........... □ 2........... □ 3........... □ 4........... □ 5

e. Did you have a lot of energy?...... □ 1........... □ 2........... □ 3........... □ 4........... □ 5

f. Have you felt downhearted and depressed?............................................ □ 1........... □ 2........... □ 3........... □ 4........... □ 5

g. Did you feel worn out?.............. □ 1........... □ 2........... □ 3........... □ 4........... □ 5

h. Have you been happy? ................ □ 1........... □ 2........... □ 3........... □ 4........... □ 5

i. Did you feel tired? .................. □ 1........... □ 2........... □ 3........... □ 4........... □ 5

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

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
<tr>
<td>□ 1</td>
<td>□ 2</td>
<td>□ 3</td>
<td>□ 4</td>
<td>□ 5</td>
</tr>
</tbody>
</table>
11. How TRUE or FALSE is each of the following statements for you?

<table>
<thead>
<tr>
<th>Definitely true</th>
<th>Mostly true</th>
<th>Don’t know</th>
<th>Mostly false</th>
<th>Definitely false</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
<td>▼</td>
</tr>
</tbody>
</table>

1. I seem to get sick a little easier than other people...........[ ] [ ] [ ] [ ] [ ]
2. I am as healthy as anybody I know ................................[ ] [ ] [ ] [ ] [ ]
3. I expect my health to get worse .....................................[ ] [ ] [ ] [ ] [ ]
4. My health is excellent .................................................[ ] [ ] [ ] [ ] [ ]

Thank you for completing these questions!
Appendix H International Physical Activity Questionnaire – Short Form

Physical Activity Questionnaire
Version 4  (10 November 2015)

One of the things we are looking at in this study is person's exercise habits. We are interested in what physical activities people are involved in and why.

These questionnaires are subjective. We want to find out about your thoughts and perceptions, not thoughts and perceptions of others. We are not judging what activities people are doing.

When we talk about exercise, we usually consider those things we normally think about – walking, running, swimming, biking and gym exercise. In addition to those, we will also look at more team sports or sport related activities, such as golf, tennis, and bowls. We also want to consider gardening, hunting and fishing. If you are still working, we will ask you a few questions about your job. We spend many years at our jobs – whether they are very active or very sedentary.

**YOUR RECENT PHYSICAL ACTIVITY (PAST 7 DAYS AND 12 MONTHS)**

**YOUR LIFETIME PHYSICAL ACTIVITY**

**ESTIMATE OF FITNESS**

How to answer

Use a blue or black pen or a dark pencil. Put a tick inside the box provided. (Do not mark any areas outside the box.).

If you change your mind or make a mistake:
Fill in the whole box and mark the correct one as shown.
YOUR PHYSICAL ACTIVITY IN THE PAST 7 DAYS

The following questions will ask about the time you spent being **physically active in the last 7 days**. Do not include activity undertaken today.

Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your housework and gardening, to get from place to place, and in your spare time for recreation, exercise or sport. The questions ask you separately about brisk walking, moderate activity and vigorous activity.

**Do not count the same time more than once:**

**Example 1.** You run for 20 minutes. Count this time as vigorous activity only, not also as moderate.

**Example 2.** A 45 minute ball game with 30 minutes at moderate intensity then 15 minutes at vigorous intensity. Count this activity as 30 minutes moderate and 15 minutes vigorous.

1. **Walking**

   During the last 7 days, on how many days did you **walk at a brisk pace**? (A pace at which you are breathing harder than normal.) This includes walking at work, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

   Think only about walking done **for at least 10 minutes at a time**. (Tick one box only)

   - [ ] 0 days
   - [ ] 1 days
   - [ ] 2 days
   - [ ] 3 days
   - [ ] 4 days
   - [ ] 5 days
   - [ ] 6 days
   - [ ] 7 days

   How much time did you **usually** spend doing such brisk walking on each of those days? (Write in number)

   [ ] Minutes per day OR [ ] Hours per day

2. **Moderate physical activity**

   During the last 7 days, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. (Moderate physical activity will cause a slight, but noticeable, increase in breathing and heart-rate.)

   Think only about those physical activities done **for at least 10 minutes at a time**. (Tick one box only)

   - [ ] 0 days
   - [ ] 1 days
   - [ ] 2 days
   - [ ] 3 days
   - [ ] 4 days
   - [ ] 5 days
   - [ ] 6 days
   - [ ] 7 days

   How much time did you **usually** spend doing moderate physical activities on each of those days? (Write in number)

   [ ] Minutes per day OR [ ] Hours per day

3. **Vigorous physical activity**

   During the last 7 days, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, running, rugby, netball, or fast bicycling? (Vigorous activity is activity that makes you “huff and puff”, and where talking in full sentences between a breath is difficult.)

   Think only about those physical activities done **for at least 10 minutes at a time**. (Tick one box only)

   - [ ] 0 days
   - [ ] 1 days
   - [ ] 2 days
   - [ ] 3 days
   - [ ] 4 days
   - [ ] 5 days
   - [ ] 6 days
   - [ ] 7 days

   How much time did you **usually** spend doing vigorous physical activities on each of those days? (Write in number)

   [ ] Minutes per day OR [ ] Hours per day

**Please check that you have not counted the same activity more than once.**
4. **Crucial Question!** Please answer carefully. Thinking about all your activities (brisk walking, moderate, or vigorous), on how many of the last 7 days were you active? *(Tick one box only)*

   "Active" means doing 15 minutes or more of vigorous activity, or a total of 30 minutes or more of moderate activity or brisk walking.

   - [ ] 0 days
   - [ ] 1 day
   - [ ] 2 days
   - [ ] 3 days
   - [ ] 4 days
   - [ ] 5 days
   - [ ] 6 days
   - [ ] 7 days

5. Were your answers to the last two questions (Q3-Q4) clearly affected because of illness, injury, or disability? *(Tick one box only)*

   - [ ] No
   - [ ] Yes, because of a temporary illness
   - [ ] Yes, because of a long-term illness
   - [ ] Yes, because of a temporary injury
   - [ ] Yes, because of a permanent injury or disability
   - [ ] Other. Please specify: ___________________________

6. Overall, how physically active do you consider yourself to be? *(Tick one box only)*

   Not at all physically active: [ ] [ ] [ ] [ ]
   Very physically active: [ ] [ ] [ ]

7. How long have you been active at this level?

   - [ ] Less than 1 month
   - [ ] 1-3 months
   - [ ] 4-6 months
   - [ ] 7-9 months
   - [ ] 9-12 months
   - [ ] More than 12 months

8. Over the next 6 months, do you think you will be…

   Less physically active: [ ] [ ] [ ] [ ]
   About the same: [ ] [ ] [ ] [ ]
   More physically active: [ ] [ ] [ ] [ ]

9. Consider your regular physical activity over the past six months, according to the definition below.

   "Regular physical activity" means at least 15 minutes of vigorous activity (makes you ‘huff and puff’) or a total of 30 minutes or more of moderate activity (causes a slight but noticeable increase in breathing and heart rate) each day for 5 or more days each week. Include brisk walking.

   *(Tick one box only)*

   - [ ] I am not regularly physically active and do not intend to be so in the next 6 months
   - [ ] I am not regularly physically active but am thinking about starting in the next 6 months
   - [ ] I do some physical activity but not enough to meet the description of regular physical activity
   - [ ] I am regularly physically active but only began in the last 6 months
   - [ ] I am regularly physically active and have been so for longer than 6 months
1. On average over the last 7 days, how much time did you spend on the activities listed below. Do NOT count the time spent at work.

<table>
<thead>
<tr>
<th>Over the last 7 days, how much time did you spend...</th>
<th>Hours per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  Watching TV or movie</td>
<td></td>
</tr>
<tr>
<td>b  Working on a computer</td>
<td></td>
</tr>
<tr>
<td>c  Driving or being a vehicle passenger</td>
<td></td>
</tr>
<tr>
<td>d  Reading newspaper or a book</td>
<td></td>
</tr>
<tr>
<td>e  Sitting (other than watching TV, working on computer, driving or reading)</td>
<td></td>
</tr>
<tr>
<td>f  Sleeping</td>
<td></td>
</tr>
</tbody>
</table>