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Is exercise prescription in cardiac rehabilitation influenced by physical capacity or cardiac intervention?

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Abstract

This study investigated the influence of cardiac intervention and physical capacity of individuals attending an Australian outpatient cardiac rehabilitation program on the initial exercise prescription. Eighty-five patients commencing outpatient cardiac rehabilitation at a major metropolitan hospital had their physical capacity assessed by an incremental shuttle walk test, and the initial aerobic exercise intensity and resistance training load prescribed were recorded. Physical capacity was lower in surgical patients than non-surgical patients. While physical capacity was higher in younger compared with older surgical patients, there was no difference between younger and older non-surgical patients. The initial exercise intensity did not differ between surgical and non-surgical patients. This study highlights the importance of pre-program exercise testing to enable exercise prescription to be individualised according to actual physical capacity, rather than symptoms, comorbidities and age, in order to maximise the benefit of cardiac rehabilitation.

Key words: Exercise capacity, coronary artery bypass surgery, cardiovascular disease, risk factors

Introduction

Physical deconditioning and consequent reduced exercise tolerance is commonly observed in individuals who have experienced a recent cardiac event or cardiac surgery (Hamm et al., 2013; Sumide et al., 2009), both as a direct result of the cardiac event and due to the effects of inactivity during recovery (Ades et al., 2006; Oldridge & Stump, 2004). Patients entering cardiac rehabilitation therefore have a considerably lower (by approximately 60% in males) exercise capacity than age-matched individuals free of coronary heart disease (Ades et al., 2006). This concurs with self-reported data on physical function from individuals recovering from an acute cardiac event (Jette & Downing, 1994; Pepin, Alexander, & Phillips, 2004). Additionally, physical capacity appears to be associated with the type of treatment, as patients receiving cardiac surgery typically have lower exercise capacity than those treated medically or with a percutaneous coronary intervention (Ades et al., 2006; Sumide et al., 2009).

Cardiac rehabilitation offers patients a supervised exercise training and education program designed to improve exercise capacity and physical function while decreasing the risk of future cardiac events (Piepoli et al., 2010a; Squires et al., 2018). Demographically, men experience a higher rate of acute coronary events and are more likely to receive cardiac rehabilitation than women (Suaya et al., 2007). Individuals attending cardiac rehabilitation vary in age, but it is not clear whether younger cardiac rehabilitation patients experience the same degree of physical impairment that occurs in older individuals (Fleg & Lakatta, 1988; Fleg et al., 2005; Fleg & Strait, 2012). However, given age-related declines in physical capacity of approximately 10% per decade (Kaminsky, Arena, & Myers, 2015), alongside inactivity-related declines in physical fitness, both muscular strength and physical capacity should be important focal points for cardiac rehabilitation (Ades, Maloney, Savage, & Carhart, 1999; Fleg & Strait, 2012). In Australia, the guidelines for exercise during cardiac rehabilitation are more conservative than those in other nations (Price et al., 2016), recommending low to moderate intensity aerobic exercise training with minimal focus on resistance training (National Heart Foundation of Australia & Australian Cardiac Rehabilitation

Association, 2004). Despite physical capacity being associated with cardiac treatment (Ades et al., 2006; Sumide et al., 2009), current Australian guidelines (National Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004) for exercise prescription in cardiac rehabilitation do not discriminate between the treatments received by individuals or their current exercise capacity. Failure to discriminate between these factors could result in a reduction in the beneficial influence of exercise training on individual outcomes, or at worst, fail to prevent a decline in health by providing insufficient stimulus to halt disease progression (Piepoli et al., 2010b; Squires et al., 2018).

This study aimed to investigate the measured and self-reported physical capacity of individuals commencing an outpatient cardiac rehabilitation program in Australia following surgical and non-surgical cardiac interventions, and determine whether these factors influenced initial exercise prescription. The effect of age was a secondary outcome within each cardiac intervention category. The study also investigated whether exercise intensity/load at the beginning of cardiac rehabilitation was prescribed according to national guidelines (National Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004).

Methods

Participants

Male and female patients who had experienced an acute myocardial infarction, coronary artery bypass graft surgery, percutaneous coronary intervention, cardiac valve repair/replacement or other cardiac surgery, and attended outpatient cardiac rehabilitation at a major metropolitan hospital in Australia, were eligible for inclusion in this cross-sectional study. Exclusion criteria included the presence of unstable cardiac disease, co-morbidities that increase the risk of complications with exercise, an inability to understand written and/or spoken English, or significant cognitive impairments that limited patient understanding or ability to follow instructions. Patients were

1 recruited consecutively following assessment against exclusion criteria by the program's cardiac
2 nurse. All patients were living independently within the community.

3 Demographic data including sex, age, and cardiac intervention were collected. Cardiac
4 intervention was categorised into surgical (coronary artery bypass graft (CABG) or valve surgery)
5 and non-surgical (percutaneous coronary intervention or medical management), as a difference in
6 physical capacity has been identified between these intervention categories previously (Ades et al.,
7 2006; Sumide et al., 2009). Participants were categorised as younger (<65 years) and older (≥65
8 years) within each category of cardiac intervention, as there is a known decline in physical capacity
9 with increasing age (Fleg & Lakatta, 1988; Fleg et al., 2005; Fleg & Strait, 2012). These age
10 categories were selected as they align with those specified in the Australian framework for cardiac
11 rehabilitation for the classification of exercise intensity (National Heart Foundation of Australia &
12 Australian Cardiac Rehabilitation Association, 2004).

13 Written informed consent was obtained from all participants after a detailed description of
14 the study was provided. The study conformed to the Declaration of Helsinki and was approved by
15 the hospital's Human Research Ethics Committee (reference number: XXXXX).

16

17 **Anthropometric measurements**

18 Using standardised procedures, height and body mass were measured using a wall-mounted
19 stadiometer (Surgical and Medical Supplies Pty. Ltd., Adelaide, Australia) and digital scales (Tanita
20 HD-316, Arlington Heights, IL, USA) respectively (Gore, 2000). Body mass index (BMI) was
21 calculated from the measured height and body mass (Riebe, Ehrman, Liguori, & Magal, 2018).
22 Waist circumference was used as an indicator of central adiposity and measured using a metal tape
23 measure (Gore, 2000). Both BMI and waist circumference represent obesity-related risk factors for
24 cardiovascular disease (Riebe et al., 2018).

25

26 **Physical capacity testing**

The physical capacity of patients was assessed prior to commencement of the cardiac rehabilitation program. The incremental shuttle walk test (ISWT) (Singh, Morgan, Scott, Walters, & Hardman, 1992), a standardised symptom-limited test frequently used in cardiac rehabilitation programs (Fowler, Singh, & Revill, 2005; Sandercock, Cardoso, Almodhy, & Pepera, 2013), was completed to determine physical capacity. The test was conducted according to the protocol described by Singh et al. (1992) by a single assessor, and was terminated when patients were unable to maintain the required walking speed, or by patient choice. A published regression equation was used to estimate peak oxygen uptake from the total distance walked (VO_{2peak} (ml/kg/min) = $7.81 + [0.03 \times \text{ISWT distance (m)}]$) (Fowler et al., 2005), and this was converted to metabolic equivalents (METs) for comparison with exercise intensity recommendations in the Australian guidelines for cardiac rehabilitation (National Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004). Previous research has demonstrated good test/retest reliability for the ISWT in cardiac rehabilitation patients, reporting ICC values of .80 to .99 between a first and second test (Fowler et al., 2005; Hanson, Taylor, & McBurney, 2016; Jolly, Taylor, Lip, Singh, & Committee, 2008; Pepera, McAllister, & Sandercock, 2010), and .99 between a second and third test (Fowler et al., 2005). Strong correlations ($r \geq .70$) between ISWT distance and VO_{2peak} measured using gas analysis have been identified in a variety of clinical populations (Parriera et al., 2014).

Muscle strength was assessed in each hand with a digital hand-grip dynamometer (Jamar Plus+, Patterson Medical, Warrenville, IL, USA) with the mean of three attempts recorded (Mathiowetz, Weber, Volland, & Kashman, 1984).

Self-report questionnaires for physical function and mental health

The physical function section from the validated Medical Outcomes Study 36-item Short Form Questionnaire (SF-36) (Brown, 2003; Stewart, Hays, & Ware, 1988) was used to establish self-reported physical function. The Ewart self-efficacy scale, developed in cardiac patients (Ewart, Stewart, Gillilan, & Keleman, 1986; Ewart & Taylor, 1985), was used to enable patients to rate

their confidence to undertake walking and lifting activities. The National Health and Nutrition Examination Survey (NHANES) Functional Status Survey (Hubert, Bloch, & Fries, 1993) assessed the level of difficulty experienced with activities of daily living to determine an overall disability score. The SF-36 questionnaire was also utilised to assess general mental health (Brown, 2003; Ware & Sherbourne, 1992).

Exercise training

The initial exercise sessions (four sessions, typically two weeks) of the 12-session comprehensive multidisciplinary cardiac rehabilitation program were examined to provide an understanding of the initial exercise intensity/load prescribed to patients, and how this was influenced by physical capacity measured prior to commencement. The cardiac rehabilitation program was typically completed twice a week over six weeks and included one hour of both supervised exercise and group education in each session. The first week (sessions one and two) provided patients with the opportunity for familiarisation with the program and exercise equipment, leading into a more typical initial exercise prescription in the subsequent two sessions.

Walking, stationary cycling and light intensity resistance training were prescribed at low to moderate intensity in accordance with the national guidelines for cardiac rehabilitation (National Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004). Clinical judgement of participant wellbeing and function was used to prescribe initial exercise workloads, as is common practice within the program. Borg's rating of perceived exertion CR10 scale (Borg, 1982) was used to monitor exercise training intensity, with a target rating of two to three. Heart rate was also monitored following aerobic training but was not utilised in exercise prescription due to the prevalence of beta-blocker medication use in this population (Australian Institute of Health and Welfare, 2017). Exercise intensity was progressed from the first to second week using clinical judgement based on the observations made during the exercise sessions.

The intensity of aerobic training was calculated using the American College of Sports Medicine metabolic equations for walking and leg cycling (Riebe et al., 2018). The aerobic training intensity, incorporating both walking and cycling components, was calculated as the mean of the first and second exercise sessions, and the mean of the third and fourth sessions. Mean resistance training load was determined by multiplying the mass lifted by the number of sets and repetitions for the same sessions as aerobic training intensity.

Data were excluded when there were greater than 14 days between the first and second ($n = 1$), or third and fourth ($n = 4$), training sessions. In instances where recorded training information was incomplete, data were carried over from the alternate week. This conservatively estimated no progression to the training prescription (week 1: $n = 4$ for aerobic training and $n = 2$ for resistance training; week 2: $n = 3$ for resistance training). Sensitivity analyses (paired t-tests) confirmed that statistical differences between weeks existed whether training data were carried over ($p < .001$) or excluded ($p < .001$).

Statistical analysis

Statistical analysis was undertaken using IBM SPSS Statistics 24 (IBM Corp., Armonk, NY, USA). Data are presented as mean and 95% CI. Normality was confirmed using the Shapiro-Wilk test and visual examination of histograms. Differences between and within (for age) cardiac intervention categories were assessed using two-sample t-tests. A value of $p < .05$ was considered statistically significant.

Results

Participant demographics

Eighty-five patients (76 males and nine females) with a mean $\pm$ SD age of 62.1 ± 10.5 years (range 29 to 83 years) were assessed. Approximately 60% of patients had received non-surgical treatment. The majority of non-surgical intervention patients (34 of 50 patients, 68%) had received

1 percutaneous coronary intervention following an acute myocardial infarction; remaining patients
 2 within the non-surgical intervention category received percutaneous coronary interventions
 3 electively or after presenting with unstable angina, or medical management following an acute
 4 myocardial infarction. Approximately two-thirds (22 of 35 patients, 63%) of surgical intervention
 5 patients had undergone CABG surgery; four of these patients had experienced an acute myocardial
 6 infarction prior to surgery, while four also underwent aortic valve replacement. Remaining surgical
 7 intervention patients had received valvular surgery. All female patients received non-surgical
 8 interventions. Patients who received surgical or non-surgical interventions were similar in height,
 9 body mass, BMI, waist circumference and age, with approximately one-third of each treatment
 10 group being older (Table 1).

11 The mean (95% CI) duration between hospital admission and commencement of cardiac
 12 rehabilitation was 50 (43 to 58) days and did not differ between surgical and non-surgical patients
 13 ($p = .780$) or between younger and older patients ($p = .680$). Patients took 2.7 (2.4 to 2.9) weeks to
 14 complete the first four sessions of the cardiac rehabilitation program, and there was no difference
 15 between surgical and non-surgical patients in the time taken ($p = .195$).

16

17 **Physical capacity and mental health outcomes**

18 Mean physical capacity data are presented in Table 2. Patients who received surgical
 19 interventions had a significantly lower physical capacity than those who received non-surgical
 20 interventions ($p = .009$). Approximately 20% of all patients had a physical capacity of less than five
 21 METs; two-thirds of these patients received surgical interventions. There was no difference in hand-
 22 grip strength between surgical and non-surgical interventions ($p = .167$). However, younger surgical
 23 patients had a significantly higher physical capacity compared to older surgical patients, although
 24 differences in grip strength did not reach statistical significance (Table 2).

25 Patients who had received non-surgical interventions self-reported significantly higher
 26 physical function ($p = .019$), and self-efficacy for lifting ($p < .001$) and walking ($p = .005$) than

those who received surgical interventions. There was no difference in self-reported disability score ($p = .084$) between the two intervention categories. Self-reported physical function was not different between younger and older patients in either intervention category ($p < .05$). Responses to the SF-36 demonstrated that general mental health was similar between the two intervention groups (mean (95% CI) scores of 73 (66 to 81) and 74 (68 to 80) respectively on a 0-100 scale, with higher scores indicating better mental health), and that mental health comorbidities were not highly prevalent in the patients in this study.

Training intensity/load

The initial aerobic training intensity (sessions one and two: $p = .670$; sessions three and four: $p = .053$) and resistance training load (sessions one and two: $p = .379$; sessions three and four: $p = .987$) did not differ between surgical and non-surgical cardiac interventions (Table 3). Aerobic training intensity ($p < .001$) and resistance training load ($p < .001$) significantly increased from the first two sessions to the third and fourth sessions. Aerobic training intensity and resistance training load were similar for younger and older surgical patients (sessions one and two: $p = .638$; sessions three and four: $p = .994$), but were higher for younger non-surgical patients than older non-surgical patients (sessions one and two: $p = .011$; sessions three and four: $p = .020$) (Table 3). The initial aerobic training intensity was in accordance with the Australian guidelines for cardiac rehabilitation (National Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004) and when expressed as an absolute value was low intensity for younger patients (Figure 1) and low-moderate intensity for older patients (Figure 2). When aerobic exercise intensity was expressed relative to their physical capacity, the intensity of training was moderate to vigorous (Figure 3) and therefore aligned more closely with international cardiac rehabilitation guidelines (American Association of Cardiovascular and Pulmonary Rehabilitation, 2013; Piepoli et al., 2010a).

Discussion

1 The type of cardiac intervention received by patients was associated with both measured
2 physical capacity, as has previously been demonstrated (Ades et al., 2006; Sumide et al., 2009), and
3 self-reported physical functioning outcomes, but age-related differences in physical capacity of
4 surgical patients were not reflected in self-report measures. Despite differences in physical capacity
5 and self-reported physical function between surgical and non-surgical cardiac patients, the initial
6 intensity/load of exercise was not different. However, initial exercise intensity was greater in
7 younger non-surgical patients than older non-surgical patients, despite there being no statistical
8 difference in either physical capacity measured by ISWT or self-reported physical function. Exercise
9 intensity therefore appears to be determined by evaluation of symptoms, comorbidities and age
10 rather than physical capacity.

11 Patients who had received surgical cardiac interventions had a lower physical capacity than
12 those who had undergone non-surgical cardiac interventions. This is unsurprising as post-surgical
13 musculoskeletal problems, including sternal and harvest site wound pain or discomfort, may limit
14 patient mobility, and these have been demonstrated to persist for as long as 12 months following
15 CABG surgery (Hunt, Hendrata, & Myles, 2000). Surgical intervention patients are also more likely
16 to experience longer hospitalisation and require longer recovery (Ades et al., 2006; Sumide et al.,
17 2009). Age had a significant effect on physical capacity only in surgical patients, and physical
18 capacity in younger surgical patients was similar to that in older non-surgical patients. Therefore,
19 the severity of the cardiac condition necessitating the requirement for surgical intervention is likely
20 to be additive to the age-related decline in physical capacity (Fleg & Lakatta, 1988; Fleg et al.,
21 2005; Fleg & Strait, 2012). This reduction is probably due to structural and/or functional changes to
22 the heart rather than muscle strength (Fleg & Lakatta, 1988; Frontera, Meredith, O'Reilly, Knuttgen,
23 & Evans, 1990), which was not different between cardiac intervention categories and showed
24 equivalent age-related declines in patients receiving both categories of intervention.

25 A substantial proportion of older patients who had undergone surgical intervention had a
26 physical capacity of less than five METs. An exercise capacity of less than five METs has been

1 established as a strong predictor of all-cause mortality risk (Kokkinos et al., 2010; Myers et al.,
2 2002), repeat cardiac events (Arena et al., 2007), and adverse events during exercise participation
3 (American Association of Cardiovascular and Pulmonary Rehabilitation, 2013). Patients at higher
4 risk require close monitoring for signs and symptoms of exercise intolerance during exercise-based
5 cardiac rehabilitation, but identifying those patients who are at higher risk of exercise-related events
6 is difficult without routine exercise testing prior to commencing cardiac rehabilitation.

7 Self-reported measures of physical function were sensitive enough to discern differences in
8 physical capacity between those who received surgical cardiac interventions and those who did not.
9 However, they could not discriminate differences in physical capacity between younger and older
10 individuals receiving surgical cardiac interventions as identified by objective measures. It is
11 possible, but unable to be confirmed through this study, that self-reporting reduced physical function
12 or increased disability is related to personal, family or physician concerns for patient safety (Ades et
13 al., 1999; Ades et al., 2002; Neill et al., 1985), with a recent history of myocardial infarction also
14 likely influencing perceived disability (Ades et al., 2002). Subjective measures of physical capacity
15 may be useful as an adjunct to direct assessment of physical capacity to identify patients who
16 perceive their capacity to be different than it actually is, to enable the provision of counselling about
17 safety of exercise and resuming usual activities (Ades et al., 1999). However, due to the lack of
18 sensitivity and the limited information that can be obtained regarding the type of impairment that an
19 individual may experience (Pepin et al., 2004), self-reported physical function should not be used as
20 an exclusive basis for exercise prescription in cardiac rehabilitation.

21 The absolute aerobic training intensity (METs) within this study complied with the light to
22 moderate intensity classifications in the Australian guidelines for cardiac rehabilitation (National
23 Heart Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004).
24 Interestingly, the upper limit of moderate intensity exercise recommended using absolute values,
25 which are adapted from American College of Sports Medicine recommendations (Pollock et al.,
26 1998) and therefore are based on healthy adults rather than those with heart disease, is not

1 substantially less than patients estimated peak exercise capacity. Cardiac rehabilitation guidelines
2 which have been published internationally do not typically include recommendations for exercise
3 prescription based on absolute intensity (Price et al., 2016). However, as formal exercise testing is
4 not routinely recommended for Australian cardiac rehabilitation programs (National Heart
5 Foundation of Australia & Australian Cardiac Rehabilitation Association, 2004), accurate
6 prescription of exercise intensity relative to physical capacity is difficult, and prescription based on
7 heart rate should be utilised with caution in this population due to frequent use of beta-blocker
8 medication (Hansen, Stevens, Eijnde, & Dendale, 2012). Relative measures of classifying exercise
9 intensity are more appropriate in the older, deconditioned populations attending cardiac
10 rehabilitation (Riebe et al., 2018), highlighting the need for the inclusion of recommendations for
11 formal exercise testing prior to commencement of cardiac rehabilitation to allow appropriate
12 determination of individual physical capacity and greater individualisation of exercise prescription
13 (Squires et al., 2018).

14 The small number of participants, along with the high percentage of males in this sample
15 population (89% males compared to 70-80% in other studies conducted in Australian cardiac
16 rehabilitation populations (Briffa et al., 2005; Higgins, Murphy, Goble, Le Grande, & Worcester,
17 2008)) means the findings may not be relevant to females attending cardiac rehabilitation; however,
18 there is no reason to believe the exercise prescription practices would differ between males and
19 females. The physical characteristics of patients will affect maximal walking speed, which has the
20 potential to limit the performance of patients during the ISWT (Arena et al., 2007). In particular,
21 height, leg length and body mass index have been found to be associated with ISWT performance
22 (Harrison et al., 2013; Probst et al., 2012). The ISWT also relies on the use of a regression equation
23 to convert either final walking speed or total distance walked to peak oxygen uptake or METs. To
24 date, validity studies for these equations have occurred in small groups of patients, which are not
25 representative of typical cardiac rehabilitation populations, and therefore the validity of these
26 equations is yet to be appropriately established. However, the equation employed in this study was

1 developed in a cardiac rehabilitation population similar in age (61.2 ± 8.5 years) and elapsed time
2 since hospital admission (6-8 weeks) (Fowler et al., 2005), and has been utilised in previous
3 research (Robinson, Samani, & Singh, 2011; Sandercock et al., 2013). Further, the physical capacity
4 data is comparable to values reported from other studies in patients commencing cardiac
5 rehabilitation who completed a symptom limited exercise test with expired gas analysis (Ades et al.,
6 2006; Grace, Parsons, Heise, & Bacon, 2015; Izawa et al., 2004). This suggests the equation used
7 was appropriate, if not adequately validated, for use in this population. Assessment of muscular
8 strength was limited to hand grip strength, which, despite being a commonly used measure of
9 muscular function (Roberts et al., 2011), does not provide information about lower extremity
10 strength. However, hand grip strength has previously been clinically validated as a marker of overall
11 health and risk of mortality, and demonstrated to closely correlate with measures of muscle strength
12 for other muscle groups (Vancampfort, Stubbs, Firth, & Koyanagi, 2018). Finally, these are
13 observations from a single cardiac rehabilitation program; however, as this program complies with
14 Australian guidelines for cardiac rehabilitation, it is likely to be representative of all cardiac
15 rehabilitation programs administered within Australia.

16 In conclusion, cardiac surgery is reflected by lower levels of physical capacity in individuals
17 commencing a cardiac rehabilitation program. Age appears to have an accumulative negative effect
18 in addition to surgery on physical capacity in individuals attending cardiac rehabilitation, but self-
19 reported measures are not sensitive enough to make this determination. The results from this study
20 suggest that formal testing of physical capacity is essential to differentiate between individuals and
21 guide the exercise prescription. A greater focus in cardiac rehabilitation guidelines on exercise
22 prescription based on physical capacity test results, with modifications to allow for musculoskeletal
23 problems and/or protect surgical sites as required, would ensure that all patients receive optimal
24 exercise prescription to maximise health benefits.

25

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Table 1: Demographic and anthropometric characteristics of patients at intake assessment for cardiac rehabilitation

	All patients		Surgical intervention ^a			Non-surgical intervention ^a			
	(n = 85)	Total group	< 65 years	≥ 65 years	<i>p</i> value ^b	Total	< 65 years	≥ 65 years	<i>p</i> value ^b
		(n = 35)	(n = 21)	(n = 14)		(n = 50)	(n = 32)	(n = 18)	
Age (years)	62.1	63.8	55.6	73.7	< .001	61.7	56.0	71.8	< .001
	(60.2 – 64.8)	(59.9 - 67.7)	(51.7 – 59.4)	(70.4 – 77.0)		(58.8 – 64.5)	(53.6 – 58.3)	(69.2 – 74.3)	
Height (cm)	171.5	171.1	172.7	168.1	.036	171.9	172.4	171.1	.636
	(169.7 – 173.5)	(168.7 - 173.5)	(170.3 – 175.1)	(163.8 – 172.4)		(169.1 – 174.7)	(168.9 – 176.0)	(166.8 – 175.4)	
Body Mass (kg)	85.3	83.1	85.9	75.8	.041	88.2	88.0	87.7	.760
	(82.9 – 89.6)	(77.4 - 89.0)	(78.0 – 93.7)	(69.7 – 82.0)		(84.2 – 92.3)	(83.0 – 93.0)	(79.3 – 94.1)	
BMI (kg.m ⁻²)	29.0	28.3	28.7	26.8	.183	30.0	29.7	29.8	.922
	(28.2 – 30.4)	(26.7 - 30.0)	(26.4 – 31.0)	(25.0 – 28.6)		(28.5 – 31.5)	(28.0 – 31.3)	(26.6 – 33.1)	
Waist girth (cm)	100.5	99.5	100.9	94.6	.102	102.5	101.3	102.9	.640
	(98.7 – 104.0)	(95.0 - 104.1)	(94.4 – 107.4)	(89.9 – 99.2)		(99.2 – 105.8)	(97.2 – 105.3)	(96.7 – 109.1)	

BMI = body mass index.

Values expressed as mean (95% confidence interval).

There was no difference in age, height, body mass, BMI or waist girth between surgical and non-surgical cardiac intervention groups ($p > .05$).

^a Surgical intervention includes coronary artery bypass graft surgery and valve surgery. Non-surgical intervention includes percutaneous coronary intervention and medical management.

^b p value from independent t-test between age groups for each cardiac intervention.

Table 2: Physical capacity and self-reported physical function and mental health outcomes

	All patients		Surgical intervention ^a			Non-surgical intervention ^a			
	(n = 85)	Total group (n = 35)	< 65 years (n = 21)	≥ 65 years (n = 14)	<i>p</i> value ^b	Total group (n = 50)	< 65 years (n = 32)	≥ 65 years (n = 18)	<i>p</i> value ^b
ISWT functional capacity (METs)	6.2 (5.9 – 6.5)	5.7 ^c (5.3 – 6.1)	6.3 (5.8 – 6.7)	4.8 (4.2 – 5.5)	< .001	6.4 (6.0 – 6.8)	6.6 (6.2 – 7.0)	6.0 (5.3 – 6.8)	.144
Mean grip strength (kg)	36.9 (34.7 – 39.1)	35.7 (32.1 – 39.2)	37.3 (32.4 – 42.1)	32.9 (27.5 – 38.4)	.050	37.7 (34.7 – 40.6)	39.6 (35.6 – 43.3)	34.4 (29.4 – 39.4)	.233
SF-36 physical functioning (score out of 100) ^d	68.0 (63.0 – 72.9)	61.3 ^c (53.4 – 69.2)	63.8 (53.0 – 74.7)	57.7 (46.2 – 69.3)	.431	72.5 (66.3 – 78.7)	71.0 (62.3 – 79.7)	75.9 (66.9 – 85.0)	.435
Ewart <u>lifting</u> self-efficacy (%)	52.4 (46.6 – 58.2)	37.1 ^c (30.1 – 44.1)	39.9 (29.9 – 49.9)	32.3 (22.3 – 42.4)	.292	62.7 (55.8 – 69.7)	59.4 (50.2 – 68.7)	68.0 (57.6 – 78.4)	.216
Ewart <u>walking</u> self-efficacy (%)	56.2 (49.7 – 62.8)	45.3 ^c (36.1 – 54.6)	47.8 (37.0 – 58.7)	41.1 (21.4 – 60.8)	.478	63.6 (55.1 – 72.1)	67.8 (56.7 – 78.9)	56.3 (43.3 – 69.4)	.175
NHANES disability score (score out of 3.00) ^e	0.36 (0.25 – 0.47)	0.44 (0.28 – 0.59)	0.46 (0.23 – 0.7)	0.53 (0.27 – 0.80)	.682	0.31 (0.14 – 0.47)	0.31 (0.08 – 0.53)	0.27 (0.04 – 0.51)	.835
SF-36 general mental health (score out of 100) ^f	73.8 (69.2 – 78.4)	73.3 (65.8 – 80.8)	73.6 (63.2 – 84.1)	72.7 (60.2 – 85.3)	.905	74.2 (68.1 – 80.2)	71.5 (63.2 – 79.9)	78.3 (69.2 – 87.4)	.272

ISWT = incremental shuttle walking test, MET = metabolic equivalent, NHANES = National Health and Nutrition Examination Survey, SF-36 = Medical Outcomes Study 36-item short form questionnaire.

Values expressed as mean (95% confidence interval).

^a Surgical intervention includes coronary artery bypass graft surgery and valve surgery. Non-surgical intervention includes percutaneous coronary intervention and medical management.

^b *p* value from independent t-test between age groups for each cardiac intervention.

^c Patients undergoing surgical intervention had significantly lower values than non-surgical intervention patients ($p < .05$).

^d A score of 100 indicates that the individual is able to perform all types of physical activities including the most vigorous without limitations due to health.

^e A score of 3.00 indicates that the individual is unable to independently perform activities of daily living.

^f A score of 100 indicates that the individual felt peaceful, calm and happy all of the time in the four weeks prior to completing the questionnaire

Table 3: Prescribed exercise training intensity for the first four sessions of the cardiac rehabilitation program

	All patients		Surgical intervention ^a			Non-surgical intervention ^a			
	(n = 85)	Total group (n = 35)	< 65 years (n = 21)	≥ 65 years (n = 14)	<i>p</i> value ^b	Total group (n = 50)	< 65 years (n = 32)	≥ 65 years (n = 18)	<i>p</i> value ^b
<i>Training sessions 1 and 2</i>									
Absolute aerobic intensity (METs)	3.3 (3.2 – 3.4)	3.2 (3.1 – 3.4)	3.2 (3.0 – 3.4)	3.2 (2.9 – 3.4)	.638	3.4 (3.3 – 3.5)	3.4 (3.3 – 3.6)	3.0 (2.6 – 3.4)	.011
Resistance training load (kg)	269 (246 – 293)	280 (233 – 327)	300 (250 – 351)	223 (113 – 334)	.125	263 (237 – 289)	283 (251 – 315)	196 (149 – 244)	.002
<i>Training sessions 3 and 4</i>									
Absolute aerobic intensity (METs)	3.6 ^c (3.5 – 3.7)	3.5 ^c (3.3 – 3.7)	3.5 ^c (3.3 – 3.7)	3.5 ^c (3.1 – 3.9)	.994	3.7 ^c (3.6 – 3.8)	3.8 ^c (3.6 – 4.0)	3.5 ^c (3.3 – 3.7)	.020
Resistance training load (kg)	357 ^c (325 – 389)	353 ^c (294 – 412)	367 ^c (309 – 425)	312 ^c (169 – 455)	.360	359 ^c (320 – 399)	381 ^c (331 – 431)	294 ^c (232 – 355)	.029

MET = metabolic equivalent.

Values expressed as mean (95% confidence interval).

^a Surgical intervention includes coronary artery bypass graft surgery and valve surgery. Non-surgical intervention includes percutaneous coronary intervention and medical management.

^b *p* value from independent t-test between age groups within each cardiac intervention.

^c Significant increase compared to week 1 (*p* < .05).