Article

Comparative Effects of High-Intensity Interval Training vs Moderate-Intensity Continuous Training in Phase III of a Tennis-Based Cardiac Rehabilitation Program: A Pilot Randomized Controlled Trial

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Abstract: The aim of the present study was to investigate the effects of two tennis-based cardiac rehabilitation programs using two protocols: high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) in the body composition, physical fitness, heart rate variability, and health-related quality of life. It was performed as a single-blinded randomized controlled trial of 21 people with acute coronary syndrome. The 12-week cardiac rehabilitation program consisted of three sessions per week of 60 min with the main part consisting of 10 sets of 15 s with 15 s of active recovery at 85%–90% of their maximum heart rate or 40 min at 70%–85% of their maximum heart rate in the HIIT and the MICT groups, respectively. Results show that both cardiac rehabilitation programs improved the agility and the mental components of the health-related quality of life (p -value < 0.05). The HIIT protocol also showed a significant improvement in the flexibility of upper and lower limbs (p -value < 0.05). Moreover, significant group $\times$ time interaction was found in the handgrip strength in favor of the HIIT group (p -value = 0.035). Nevertheless, no significant effects on cardiorespiratory fitness or heart rate variability were found. Importantly, no adverse event was detected, so HIIT appears to be a safe and effective alternative for the rehabilitation of patients with acute coronary syndrome.

Keywords: heart rate variability; health-related quality of life; tennis; HIIT; MICT; body composition; flexibility; strength; 6-MWT

1. Introduction

Cardiovascular disease (CVD) is one of the most important causes of disability and premature death worldwide [1,2]. It is predicted that in 2030 CVD will contribute to over 23 million deaths annually [3]. In this regard, the coronary artery diseases (CAD) is the leading cause of death and morbidity in Europe [4], with acute coronary syndrome (ACS) being the most common clinical manifestation of CAD [5,6].

Cardiac rehabilitation (CR) is an effective tool for the prevention and management of CVD [7] since the main aim is to improve the overall functional capacity and health-related quality of life (HRQoL) [8,9]. The CR programs have different phases that assist patients from hospitals (phase-I) with the transition to their daily activities through phases II, III, and IV. In this regard, previous studies have shown that CR improves HRQoL [10], body composition [11–13], physical fitness [14,15], or heart rate variability (HRV) [16,17]. HRV is a non-invasive index that evaluates autonomic nervous system

activity (the balance between sympathetic and parasympathetic nervous systems). It is based on successive heartbeat variation over an interval of time [18]. Interestingly, low HRV is associated with an increased risk of death from several causes [19,20].

Despite all these interesting health improvements, less than 3% of survivors of any CVD enroll in CR programs, and adherence is relatively poor among patients who do enroll in CR settings [21]. Thus, different innovations, combining patient safety, efficacy, and enjoyment have been introduced in CR programs, such as different sport modalities or intensities. Regarding physical exercise modalities, a previous study investigated the effects of tennis-based CR on physical function compared with a traditional cycle-ergometer CR program [22]. In this regard, tennis could be adapted to fulfill all the recommendations for this population [22,23]. In addition, different studies have investigated the introduction of high-intensity interval training (HIIT) in patients with CAD [24]. Results showed that it is a safe, effective, and enjoyable training for patients with CAD [25]. Moreover, when HIIT and moderate-intensity continuous training (MICT) have been compared, greater improvements in aerobic findings have been observed in HIIT protocols [26–28].

However, to the best of our knowledge, the effects of a HIIT tennis-based CR program in phase III have not been studied. Thus, this study aimed to investigate the effects of two tennis-based CR programs using two protocols, HIIT and MICT, on physical fitness, body composition, HRV, and HRQoL.

2. Materials and Methods

2.1. Trial Design

This study was conceived as a single-blinded, randomized controlled trial where participants were randomly allocated into two groups: a tennis-based high-intensity interval training (HIIT) and a tennis-based moderate-intensity continuous training (MICT). All procedures were approved by the University research ethics committee (approval number: 148/2015).

2.2. Participants

The intervention was carried out in the Faculty of Sport Sciences (Cáceres, Spain) from February 2016 to April 2016. A total of 21 ACS patients, with a mean age of 55.85 (5.69) years old, were included in this pilot randomized controlled trial. All of them were recruited until 20 January, 2016. The participant inclusion criteria were as follows:

- a. Had previously completed phase II of the cardiac rehabilitation program.
- b. Men or women with ACS categorized as low risk by a cardiologist [29,30].
- c. Had read, accepted, and signed the written informed consent.

Moreover, participants were excluded if the following applied to them:

- a. Had a condition that would make the high-intensity exercises contraindicated, such as retinopathy, musculoskeletal injuries, or major balance problems.

A technician randomly allocated the participants into the two groups (HIIT or MICT) using random numbers. The researcher who allocated the participants in the groups did not take part in the evaluation or the data acquisition. Another researcher blinded to the grouping allocation developed the evaluation and data analyses. Participants were unable to be allocated since the two protocols were explained in the informed consent.

2.3. Intervention

The HIIT and the MICT training were based on tennis. In this regard, the interventions were performed in an indoor tennis court. The HIIT and MICT programs consisted lasted 12 weeks, with three days per week (32 sessions of 60 min) of tennis-based training. The characteristics of these programs were as follows:

- HIIT: The training started with 8 min of warm-up. For the first 5 min, participants perform joint mobility, walk, or run at 50%HRmax. Then, three sets of three repetitions (each repetition lasted 10 s at 80%HRmax) with one minute of active recovery at 50%HRmax. After 5 min of active recovery, 10 sets of 15 s with 15 s of active recovery at 85%–90%HRmax were performed. The calm-down consisted of 3 min of active (walking around the tennis court) and 7 min of passive recovery. All the exercises performed under the HIIT approach were based on tennis.
- MICT: The training started with 8 min of warm-up. For the first 5 min, participants have to perform joint mobility, walk, or run at 50%HRmax. Then, participants have to perform 40 min of tennis-based exercises. Since tennis is an intermittent sport, following the recommendation of Casasola [23] and García, Giraldo, Barrado, and Casasola [22], some adaptations were performed to maintain the intensity at 70%–85%HRmax during the session. For example, participants were allowed to let the ball bounce twice or using mainly doubles rather than singles games. Moreover, four different on-court movement intensities were introduced (i.e., walking slowly, walking fast, jogging, and running), to maintain the effort within the heart rate limits. Lastly, the calm-down consisted of 3 min of active (walking around the tennis court) and 7 min of passive recovery.

All the training sessions were conducted and supervised by a kinesiologist with six years of tennis training experience. The heart rate of participants during the sessions was monitored using a Polar RS800CX (Finland) heart rate monitor.

2.4. Outcomes

2.4.1. Physical Fitness and Body Composition

Bimanual Handgrip. Handgrip strength was measured using a hand dynamometer (Takei TKK 5401 Digital Handgrip Dynamometer, Tokyo Japan). Participants had to squeeze the dynamometer with an optimal grip-span. The sum of the better of two attempts for each hand was used in the analyses.

Broad Jump Test. Lower limb strength was assessed by the broad jump test. Participants were instructed to bend their knees (the depth of the flexion was self-selected) and bring their arms behind their bodies. Then, they have to extend their legs, move their arms forward, and jump as far as possible. The distance, in centimeters, of the best of two attempts were used to the statistical analyses [31].

T-test. Four cones were set up in a “T” shape. Cone A and B were placed 9.14 m apart from each other. Cone B and C, and B and D were placed 4.57 m apart from each other. The participant started at cone A, touched the base of cone B with their right hand, and then had to move left and shuffle sideways to cone C. Once they had touched its base (this time with their left hand), participants had to shuffle sideways to the right to cone D (touching its base with the right hand). Then, they shuffle back to cone B, touching it with the left hand, and run backwards to cone A. The time that participants employed in this agility test was used in the analyses [32].

Back Scratch Test. This test was used to assess upper limb flexibility [33]. Participants had to try to touch with the middle finger of both hands behind the back. Thus, they had to pass one hand behind their head, flexing their elbow and directing the middle finger down while they make the opposite movement with the other hand. After that, they performed the movements changing the right and left arm actions. A staff member assessed the distance between the fingers with a measuring tape [31].

Sit and Reach Test. Participants had to sit on the floor and place their legs fully extended and directing the tip of the foot towards the ceiling. At the evaluator’s signal, the subjects had to flex their hips trying to touch the tip of their big toe with the middle finger of their hand. The result was negative if the hands did not reach the foot, and positive if it was passed [34]. The best result of two attempts was used in the analyses [31].

6-Minute Walking Test (6-MWT). This test was used to measure cardiorespiratory fitness, determining the maximum distance (in meters) the patients can walk in 6 min following a rectangular

path of 45.7 m [35]. The following well-established equation has been used to estimate the maximum oxygen uptake ($\text{VO}_{2\text{max}}$) [36]:

$$\text{Mean Peak } \text{VO}_2 = 4.948 + 0.023 \times \text{mean 6MWD (meters)}. \quad (1)$$

Both the 6MWD and the $\text{VO}_{2\text{max}}$ (mL/kg/min) estimation were included in the analyses.

2.4.2. Heart Rate Variability

A Polar RS800CX (Finland) heart rate monitor was used to record HRV, following the recommendations of the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [37]. Therefore, a short-term record (5 min) was employed for each HRV acquisition. HRV data was extracted using the Kubios HRV software (v. 3.3) [38,39]. A middle filter was applied to correct possible artifacts, identifying those RR intervals, which are shorter/longer than 0.25 s, compared to the previous beats average. Correction replaces the identified artifacts by cubic spline interpolation.

Time-domain, frequency-domain, and non-linear variables were analyzed in the present study. Regarding time domain, mean heart rate (mean HR), the standard deviation of the successive NN intervals (SDNN); RR50 count divided by the total number of all RR ranges (Pnn50), and the square root of differences between adjacent RR intervals (RMSSD). In the frequency domain, the low frequency (LF, 0.04–0.15 Hz) and high frequency (HF, 0.15–0.4 Hz) ratio (LF/HF) were studied. Lastly, in the non-linear measures, the RR variability from heartbeat to short term Poincaré graph (width) (SD1), the RR variability from heartbeat to long-term Poincaré graph (length) (SD2) and the Sample Entropy (SampEn) were included.

2.4.3. Quality of Life

SF-12v2. The SF-12 is a multipurpose short-form to assess the health-related quality of life (HRQoL) with only 12 questions, all selected from the SF-36 Health Survey [40]. This questionnaire evaluates eight dimensions: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH). Moreover, two summary scores are estimated: physical summary score (PCS) and mental summary score (MCS). The scores represent the person's health status (100 = full HRQoL, 0 = death) [41].

2.5. Statistical Analysis

The SPSS statistical package (version 20.0; SPSS, Inc., Chicago, Ill.) was used to analyze the data. According to the results of the Shapiro–Wilk and Kolmogorov–Smirnov tests, non-parametric analyses were conducted.

Data from all 21 initial participants were used to conduct the intention-to-treat analysis by multiple imputations (MI) of missing values following the Sterne, et al. [42] guidelines. Our missing data were classified as missing at random. The SPSS software was used to perform MI of data.

Mann–Whitney U test was employed to study the differences at baseline in the age, weight, body mass index (BMI), 6MWT, SDNN, MCS, and PCS.

The difference between post and pre was calculated for each variable. These differences were used to study the effects of the intervention between groups by the Mann–Whitney U test in the different variables. Within-group effects were explored using the Wilcoxon signed-rank test (HIIT and MICT separately).

Additionally, effect sizes were calculated for the non-parametric tests through r , which is classified as follows: 0.5 is a large effect, 0.3 is a medium effect, and 0.1 is a small effect [43,44]. The alpha level of significance (0.05) was adjusted according to the Benjamini–Hochberg procedure to avoid type I error derived from multiple comparisons [45].

3. Results

Figure 1 shows the flow diagram of the participants. A total of 27 people with ACS were assessed for eligibility. However, six declined to participate in the study. Therefore, 21 adults with ACS were randomized into two groups: HIIT ($n = 11$) and MICT ($n = 10$). One participant of the MICT group did not complete the intervention. In this regard, intent-to-treat analyses were applied to this participant's data. No cardiovascular-related adverse events were reported in relation to HIIT or MICT sessions.

Figure 1. Flow chart of participants.

Table 1 shows the characteristics of the participants included in the study. A total of 21 people with ACS, with a mean age of 55.85 (5.69) years old, participated in the study. Significant differences were not observed (p -value > 0.05) between HIIT and MICT groups in weight, BMI, 6-MWT, SDNN, MCS, or PCS.

Table 1. Baseline characteristics of the participants.

	All (n = 21)	HIIT Group (n = 11)	MICT Group (n = 10)	<i>p</i> -value *
Age (years)	55.85 (5.69)	55.27 (7.13)	56.55 (3.50)	0.148
Weight (kg)	86.67 (13.68)	87.87 (16.64)	85.34 (10.23)	0.751
BMI (kg/m ²)	30.54 (4.22)	31.04 (5.14)	29.98 (3.11)	0.438
6-MWT (m)	583.26 (72.40)	584.09 (82.71)	603.54 (83.62)	0.218
SDNN	40.88 (19.19)	50.89 (22.71)	40.18 (21.66)	0.425
MCS	35.24 (5.64)	35.91 (6.56)	35.01 (4.73)	0.573
PCS	35.48 (5.64)	35.99 (7.53)	34.41 (2.42)	0.888

BMI: Body Mass Index; MICT: Moderate-intensity continuous training; HIIT: High-Intensity interval training; PCS: Physical components summary; MCS: Mental components summary; kg: kilograms; m: meters; cm: centimeters; s: seconds; * The p -values were calculated with U Mann-Whitney test.

Table 2 shows the effect of HIIT and MICT in the body composition and physical fitness of people with ACS. Within-group analyses show that the performance in the T-test (agility) improved in both HIIT (p -value = 0.03) and MICT (p -value = 0.047) groups with an effect size that can be classified as large. Moreover, the HIIT group had significantly improved performance in the back scratch (p -value = 0.011) and sit and reach (p -value = 0.008) flexibility tests, with an effect size that can be classified as large. In addition, between-group analyses showed a significant group*time interaction in the bimanual handgrip (p -value = 0.035) with greater benefits observed in the HIIT group.

Table 2. Intent-to-treat of 16-weeks of HIIT and MICT in the body composition and physical fitness of people with acute coronary syndrome (ACS).

Variables		Within Group Comparison					Between Group Comparison		
		Pre	Post	Z	p-value *	Effect Size	Z	p-value *	Effect Size
Body composition									
BMI (kg/m²)	HIIT	31.04 (5.14)	31.34 (5.33)	−1.736	0.083	−0.523	−1.096	0.273	−0.239
	MICT	29.98 (3.11)	29.92 (3.16)	−0.256	0.798	−0.080			
Fat Mass (%)	HIIT	26.52 (6.54)	27.69 (6.07)	−1.511	0.131	−0.455	−1.797	0.144	−0.392
	MICT	27.04 (4.56)	26.23 (5.51)	−0.051	0.959	−0.016			
Physical Fitness									
Bimanual Handgrip (kg)	HIIT	85.91 (13.40)	86.82 (13.04)	−0.934	0.350	−0.281	−2.113	0.035*	−0.461
	MICT	81.32 (9.71)	78.77 (9.26)	−1.478	0.139	−0.467			
Horizontal Jump (m)	HIIT	1.79 (0.45)	1.82 (0.39)	−0.204	0.838	−0.061	−0.681	0.496	−0.149
	MICT	1.67 (0.38)	1.73 (0.25)	−0.700	0.484	−0.221			
T-test (s)	HIIT	14.90 (1.98)	11.89 (1.56)	−2.934	0.003*	−0.884	−1.620	0.157	−0.353
	MICT	14.94 (1.92)	13.27 (1.17)	−1.988	0.047*	−0.629			
Back scratch (cm)	HIIT	−14.09 (14.00)	−10.09 (12.09)	−2.548	0.011*	−0.768	−1.420	0.155	−0.310
	MICT	−8.00 (12.89)	−5.65 (8.17)	−1.785	0.074	−0.564			
Sit and reach (cm)	HIIT	−7.64 (15.49)	2.27 (11.38)	−2.934	0.008*	−0.884	−0.247	0.805	−0.054
	MICT	−7.60 (18.07)	−5.65 (8.17)	−0.667	0.505	−0.211			
6-MWT (m)	HIIT	584.09 (82.71)	603.54 (83.62)	−1.156	0.248	−0.348	−1.479	0.139	−0.322
	MICT	569.22 (41.53)	560.94 (53.13)	−0.866	0.386	−0.273			
VO2max estimation (mL/kg/min)	HIIT	18.38 (1.90)	18.83 (1.92)	−1.156	0.248	−0.348	−0.991	0.322	−0.216
	MICT	18.01 (1.01)	17.95 (1.25)	−0.420	0.674	−0.133			

* p -value < 0.05; 6-MWT: Six-minutes walking test; BMI: Body mass index; HIIT: High-Intensity interval training; MICT: Moderate-intensity continuous training; VO₂max: maximum oxygen uptake.

Table 3 shows the effects of HIIT and MICT on HRV. Neither within- nor between-group differences were observed for time-domain, frequency-domain, or non-linear measures after 12 weeks of intervention.

Table 3. Intent-to-treat of 16-weeks of HIIT and MICT in the heart rate variability of people with ACS.

HRV Measures		Within Group Comparison					Between Group Comparison		
		Pre	Post	Z	p -value *	Effect Size	Z	p -value *	Effect Size
Heart Rate (bpm)	HIIT	64.16 (7.10)	62.93 (10.31)	−0.711	0.477	−0.214	−0.563	0.573	−0.123
	MICT	67.55 (13.60)	67.84 (11.18)	−0.255	0.799	−0.081			
SDNN	HIIT	50.89 (22.71)	43.87 (19.75)	−0.978	0.328	−0.295	−0.423	0.673	−0.092
	MICT	40.18 (21.66)	39.60 (19.39)	−0.968	0.330	−0.306			
RMSSD	HIIT	34.14 (23.54)	34.40 (21.59)	−0.178	0.859	−0.054	−0.810	0.418	−0.177
	MICT	25.74 (18.38)	25.30 (25.90)	−1.478	0.139	−0.467			
Pnn50	HIIT	12.34 (16.01)	13.40 (19.50)	−0.178	0.859	−0.054	−0.493	0.622	−0.108
	MICT	6.93 (13.22)	7.63 (15.31)	−1.423	0.155	−0.450			
HF	HIIT	28.00 (15.11)	36.06 (20.19)	−1.334	0.182	−0.402	−1.972	0.100	−0.430
	MICT	28.60 (18.22)	22.78 (11.03)	−1.326	0.185	−0.419			
LF	HIIT	71.89 (15.07)	63.77 (20.23)	−1.334	0.182	−0.402	−1.831	0.100	−0.400
	MICT	71.32 (18.27)	74.90 (12.94)	−0.764	0.445	−0.242			

Table 3. Cont.

HRV Measures		Within Group Comparison					Between Group Comparison		
		Pre	Post	Z	p-value *	Effect Size	Z	p-value *	Effect Size
LF/HF	HIIT	3.58 (2.32)	3.32 (3.97)	−0.800	0.424	−0.241	−1.408	0.159	−0.307
	MICT	4.24 (4.13)	6.51 (9.66)	−0.968	0.333	−0.306			
SD1	HIIT	24.19 (16.69)	24.37 (15.30)	−0.178	0.859	−0.054	−0.986	0.324	−0.215
	MICT	18.22 (13.00)	17.48 (17.75)	−1.478	0.139	−0.467			
SD2	HIIT	67.25 (28.82)	56.27 (25.18)	−1.245	0.213	−0.375	−0.352	0.725	−0.077
	MICT	52.97 (29.06)	52.86 (23.77)	−0.764	0.445	−0.242			
SampEn	HIIT	1.46 (0.19)	1.45 (0.34)	−0.178	0.859	−0.054	−0.986	0.324	−0.215
	MICT	1.32 (0.22)	1.18 (0.27)	−1.784	0.074	−0.564			

* p-value < 0.05; HIIT: High-Intensity interval training; MICT: Moderate-intensity continuous training.

Table 4 shows the effects of HIIT and MICT in HRQoL of people with ACS. Significant within-group improvements (p -value < 0.05) in both HIIT and MICT groups were observed in PCS and MH. Moreover, both groups significantly reduced PCS (p -value < 0.05). A significant reduction in BP was also observed in the HIIT group. However, a significant improvement in VT was observed in the HIIT group. Significant group $\times$ time interactions were not found in HRQoL between HIIT and MICT.

Table 4. Intent-to-treat of 16-weeks of HIIT and MICT in HRQoL of people with ACS.

Quality of Life		Within Group Comparison					Between Group Comparison		
		Pre	Post	Z	<i>p</i> -value *	Effect Size	Z	<i>p</i> -value *	Effect Size
Summary Scores									
MCS	HIIT	35.99 (7.53)	54.47 (3.38)	−2.934	0.003 *	−0.884	−0.070	0.944	−0.015
	MICT	34.41 (2.42)	53.44 (4.78)	−2.803	0.005 *	−0.886			
PCS	HIIT	35.91 (6.56)	28.47 (3.90)	−2.934	0.003 *	−0.884	−0.282	0.778	−0.061
	MICT	35.01 (4.73)	27.77 (3.70)	−2.599	0.009 *	−0.822			
SF-12v2 domains									
PF	HIIT	22.73 (28.40)	13.64 (17.19)	−1.081	0.279	−0.326	−1.120	0.263	−0.244
	MICT	20.00 (32.91)	16.67 (25.00)	−0.447	0.655	−0.141			
RP	HIIT	70.45 (14.00)	81.82 (23.29)	−1.172	0.241	−0.353	0.349	0.727	0.076
	MICT	65.00 (19.36)	73.61 (19.21)	−1.421	0.155	−0.449			
BP	HIIT	18.18 (25.23)	2.27 (7.54)	−2.121	0.034 *	−0.639	−0.676	0.499	−0.147
	MICT	15.00 (26.87)	5.56 (11.02)	−1.633	0.102	−0.516			
GH	HIIT	52.73 (19.28)	64.09 (20.59)	−1.769	0.077	−0.533	−0.301	0.763	−0.006
	MICT	50.50 (20.88)	58.89 (24.59)	−1.852	0.064	−0.585			
VF	HIIT	31.82 (29.77)	75.00 (15.81)	−2.595	0.009 *	−0.782	−1.184	0.237	−0.258
	MICT	37.50 (21.24)	63.89 (18.16)	−1.852	0.064	−0.585			
SF	HIIT	29.55 (33.20)	6.82 (16.17)	−1.638	0.101	−0.494	−0.845	0.398	−0.184
	MICT	20.00 (22.97)	11.11 (22.05)	−1.300	0.194	−0.411			
RE	HIIT	78.41 (19.44)	79.54 (20.37)	−0.322	0.748	−0.010	−1.011	0.312	−0.220
	MICT	75.00 (22.82)	86.11 (17.05)	−1.469	0.142	−0.464			
MH	HIIT	19.32 (15.17)	86.36 (11.80)	−2.952	0.003 *	−0.890	−0.231	0.817	−0.050
	MICT	15.00 (19.36)	79.17 (21.65)	−2.533	0.011 *	−0.801			

* p-value < 0.05; BP: Bodily Pain; GH: General Health; HIIT: High-Intensity interval training; MCS: Mental components summary; MH: Mental Health; MICT: Moderate-intensity continuous training; PCS: Physical components summary; PF: Physical functioning; RE: Role emotional; RP: Role Physical; SF: Social Functioning; VT: Vitality.

4. Discussion

The present study investigated the effects of two tennis-based CR programs focused on HIIT and MICT protocols. Results showed that both CR programs improved the agility and the mental components of HRQoL. The HIIT protocol also showed an improvement in flexibility. Moreover, significant group $\times$ time interaction was found in the handgrip strength in favor of the HIIT group.

Previous studies have shown improvements in physical fitness after CR programs [14,15]. Our results are consistent with these results, showing agility enhancements in both HIIT and MICT groups. Moreover, participants of the HIIT group also improved their flexibility in both upper and lower limbs. These results are relevant since a decline in flexibility or agility causes difficulties in performing daily activities [46]. Moreover, flexibility has a great impact on HRQoL, but it is usually under-evaluated in randomized controlled trials [47]. In addition, our results showed a significant group*time interaction in the handgrip strength in favor of the HIIT group. This is quite relevant since grip strength is correlated with mortality [48] and could predict cardiac adverse events in patients with cardiac disorders [49]. Despite this interesting finding, HIIT appears to provide similar benefits to MICT for improving body composition or cardiorespiratory fitness, which is also in line with previous research [50].

HRV is a non-invasive index that evaluates the balance between sympathetic and parasympathetic nervous systems. Moreover, HRV is associated with increased risk of death from several causes [19], and is an interesting tool in the management of chronic diseases, such as diabetes [51] or CAD [52]. In this regard, our results did not show any significant effect of HIIT or MICT protocols, or any significant group interaction between these programs. Nevertheless, previous studies have shown controversial results in this topic. Whereas some studies reported positive effects of HIIT or MICT protocols on the HRV of people with CAD [16], others did not find significant effects in this outcome [53–55]. In this regard, considering both our results and the previous research, it can be hypothesized that interventions should be longer than 4 months to improve HRV. This hypothesis is also supported by previous studies in other populations [51,56,57].

Our results showed an increase in the mental component of HRQoL in both HIIT and MICT protocols. This is consistent with previous studies where CR programs have been useful tools to improve HRQoL of people with CAD [10,58,59]. Moreover, within-group differences indicated that vitality significantly increased in the HIIT group. This is relevant since previous studies have shown that HIIT protocols could have a greater impact on HRQoL than MICT protocols in people with CAD [60,61]. However, a significant decline in the physical component of HRQoL was detected in both HIIT and MICT. This could be influenced by the results of the pain dimension, where the within-group analyses indicated that pain was increased in the HIIT group (also a tendency can be found in the MICT). Although hypothetically, these results might be influenced by delayed onset muscle soreness, which participants had not experienced before the intervention.

Adherence is one of the greater challenges of CR programs. In this regard, previous studies have pointed out that the lack of motivation could be the reason why CAD patients dropped out of CR programs [62,63]. However, HIIT protocols have shown to be a safe, effective, and enjoyable tool for patients with CAD within CR [25]. This is quite relevant since adherence is maintained only when participation is perceived as enjoyable [64]. Moreover, our CR program is based on tennis, which addresses elements of the self-determination theory [65]. These could be the reasons why only one participant interrupted the intervention, achieving 100% and 90% adherence in HIIT and MICT protocols, respectively.

This study has some limitations that should be acknowledged. Firstly, the small sample size could mean that only greater differences would reach the significance level. Secondly, only men participated in this study, so results cannot be extrapolated to women with ACS.

5. Conclusions

Results showed that both MICT and HIIT protocols improved the agility and mental components of HRQoL. Moreover, the HIIT group showed an improvement in flexibility and vitality dimensions of HRQoL. This is relevant since a decline in flexibility or agility causes difficulties in performing daily activities. In addition, the main finding of the study was the significant group $\times$ time interaction found in the handgrip strength in favor of the HIIT group. This is quite important due to the relationship

between handgrip strength and mortality. Importantly, any adverse event was detected, so HIIT appears to be a safe and effective alternative for the rehabilitation of patients with ACS.

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