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Comparative effects of high intensity interval training versus moderate intensity continuous training on quality of life in patients with heart failure: Study protocol for a randomized controlled trial☆

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ABSTRACT

Purpose: To compare the effect of high intensity interval training (*HIIT*) and moderate intensity continuous training (*MICT*) on physical fitness and quality of life (*QoL*) in patients with chronic heart failure (*CHF*).
Methods: Twenty-two male *CHF* patients (*LVEF* < 45%, mean age 53.8 ± 8 yr) were studied before and after 12 weeks of supervised aerobic training for 60 min, three times a week. Patients were randomly (1:1) to *MICT* (n = 10) and *HIIT* (n = 12). Both training programs involved treadmill exercise. The group *MICT* at 75% of peak heart rate (HR) and *HIIT* at ≈95% of peak HR. Outcome measurements included an assessment of *QoL* (Minnesota Living with Heart Failure Questionnaire (*MLHFQ*) and *SF-36*), measurements of 6-min walk test (*6MWT*) and peak oxygen consumption (*VO_2 peak*).
Results: Exercise was associated with a significant increased of *6MWT* in 19.4% and 23.1% from *MCIT* and *HIIT*, respectively ($p < 0.001$), but not between-group differences. It was observed an improvement in *VO_2 peak* by 11.2% in the *HIIT* group and 8.3% in the *MCIT* group, with between-group differences ($p < 0.01$). Quality of life improved significantly and in all domains in both groups (p-value time-effect). All patients showed significant improvements in all domains from baseline, it was observed in both groups ($p < 0.05$), with between-group differences for functional capacity (*SF-36*). No changes were observed in pain (*SF-36*) for both groups.
Conclusion: Both training programs were equally effective in improving *QoL* and functional capacity in *CHF* patients.
Trial registration: (http://www.ensaiosclinicos.gov.br/): RBR-6hk9p6; registered on 15 May 2013.

1. Introduction

Up to five million Americans over 20 years old have chronic heart failure (*CHF*). Projections show that by 2030, the prevalence of *CHF* will increase with 25% from 2013 [1]. *CHF* is a complex chronic condition that results from any structural or functional impairment of ventricular filling or ejection of blood [2]. One of the major central characteristics of this condition is an imbalance of the cardiovascular system caused by complex hemodynamic, anatomical, functional and biological progressively worsening, thus creating a vicious cycle [3,4].

As a result, most heart failure patients experience symptoms as shortness of breath and fatigue, which interfere with daily activities and often have a tremendous impact on the quality of life (*QoL*) [5,6]. The quality of life is much lower compared to healthy individuals and other diseases [7]. Current guidelines for the treatment and management of heart failure firmly recommend regular physical activity and structured exercise training [8]. The major benefits of this multidisciplinary approach include an enhancement in peripheral blood circulation [9], as well as in skeletal muscle and functional capacity [10–13], early return to routine, increased aerobic conditioning and significant benefits in social life [14,15]. Moreover, exercise training, as an important adjuvant part of this rehabilitation program, has been shown to improve endothelial function and oxidative capacity of the skeletal muscle [16,17], increase of peak oxygen consumption [16,18,19] and maximal aerobic power and reduce neurohumoral exacerbation [12,15].

However, despite its proven effectiveness, the search for better exercise modalities that fit patients' taste better and are more likely to improve adherence and hence clinical outcomes in heart failure patients is still ongoing. As such, recent data have already shown that high intensity interval training is superior to moderate continuous training for

☆ All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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eliciting improvements in peak VO_2 and systolic heart failure in *CHF* patients [20]. However, less is known about the effect of this emerging exercise intensity on the quality of life of these patients. The study presented three components of the definition of quality of life self reports by patients with heart failure, the being: performing physical and social activities; maintaining happiness, and; engaging in fulfilling relationships [21]. Based on these reports [21] and the effects of high-intensity exercise found in the meta-analysis [22], the hypothesis of our study is to show greater increases in scores for quality of life of patients with HF submitted to *HIIT* compared to *MCIT*, also already shown in a recent study [23]. Therefore, the aim of this pilot study was to assess the potentials of *HIIT* to improve quality of life and physical fitness in patients with chronic heart failure.

2. Methods

2.1. Study design and population

A randomized controlled double-blind trial was performed to evaluate the effect of *HIIT* vs *MICT* on quality of life and physical fitness in *CHF* patients. Patients were recruited at the Divisions of Cardiology of the public and private hospitals of Florianopolis, Santa Catarina State, Brazil. Eligibility criteria were that participants should be: 1) male; 2) aged 40 yr or older; 3) with a resting left ventricular ejection fraction under 40%; 4) peak oxygen uptake under 20 ml·kg·min; 5) classified as New York Heart Association class (*NYHA*) II–III who were clinically stable and on optimal medical therapy for at least 30 days. In addition, they should be free of physical or mental disabilities, which could limit physical training. Patients were excluded if they presented with unstable angina pectoris, uncompensated heart failure, primary pulmonary hypertension, pulmonary infections or active pulmonary thromboembolism, myocardial infarction in the past 4 weeks and complex ventricular arrhythmias.

After obtaining written informed consent patients were randomized to *HIIT* or *MICT*. The randomization code was generated by means of a simple allotment to select random permuted blocks (Fig. 1).

The study was accomplished according to the World Medical 1975 Declaration of Helsinki on ethics in medical research [24] and was approved by the local Research Ethics Committee of the University of the State of Santa Catarina. The design and results of the study are registered in Clinical trials: RBR-6hk9p6 (http://www.ensaiosclinicos.gov.br/).

2.2. Measurements

All measurements were performed at baseline and after the 12-week intervention period, i.e. two days after the last training session, by blinded investigators. Assessments were done at the same time of day for each individual patient.

2.2.1. 6-min walk test (6MWT)

The *6MWT* was used to assess functional capacity [25]. After informing the patients about the aim of the *6MWT*, all patients performed two *6MWT's* with a 30 min rest period in between. Each patient was instructed to cover the longest distance as possible in 6 min. They were told to walk continuously, however at their limits they could slow down or stop, if necessary. The test was performed by a blinded exercise physiologist who encouraged all patients in a standardized fashion [26,27]. Outcome measure was the total walking distance covered in 6 min. The Borg Score (0 to 10 scale) was assessed at the end of the *6MWT* [28].

2.2.2. Cardiopulmonary exercise test

Subsequently a maximal graded cardiopulmonary exercise test to evaluate their exercise capacity by measuring VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$), until evolutional exhaustion was performed according to *ESC* guidelines [29] on a treadmill (Centurion 200 — Micromed; Brasília, DF, Brazil) using a ramp protocol individually adjusted to last 8 to 12 min after warm-up [30]. During the test, heart rate, a five-lead electrocardiogram (Elite — Micromed; Brasília, DF — Brazil) and respiratory gas exchange measurements which was performed by using breath by breath analysis (Metalyser 3B — Cortex Biophysik; Leipzig, Germany) were recorded continuously. Blood pressure was measured by auscultatory method [31] every 2-min, at the peak exercise and recovery. A leveling off of oxygen uptake despite increased workload and a respiratory exchange ratio higher than 1.05 were used as criteria for maximal oxygen uptake [32]. *VO_2 peak* was define at the highest level of oxygen uptake achieved during the last 30 s. Maximal Heart Rate (HR) at the end of the test was set as the patients' maximum HR. Oxygen uptake in milliliters per kilogram per minute at a fixed submaximal work load defined

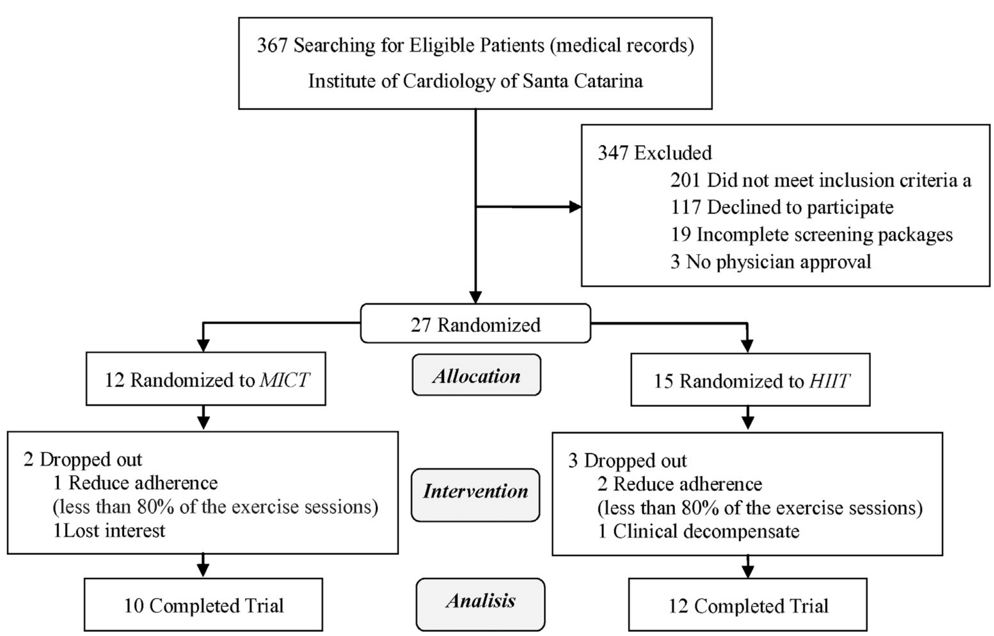

Fig. 1. Flow of study participants through the Trial.

work economy. Before each test, the equipment was calibrated according to the manufacturer's instructions.

It used the procedures of the Statement on Cardiopulmonary Exercise testing ATS/ACCP [33] for evaluation of the changes in VE/Vo_2, VE/VCO_2, respiratory exchange ratio (*RER*) and expired PCO_2 with changes in VO_2 associated with the work rate, ventilatory threshold (*VT*) was identified as the VO_2 point the transition of VE/VO_2 from falling to rising phases occurred before the transition of VE/VCO_2 from falling to rising phases, and that of expired PCO_2 from increasing and the leveling off to decreasing occurred. The VO_2 point at which the latter two transitions occurred was defined as the respiratory compensation point (*RCP*). First and second ventilatory thresholds were recorded as an indication of aerobic and anaerobic thresholds, respectively. Anaerobic threshold was defined as 1) the point where the ventilatory equivalent for O_2 (VE/VO_2) was minimally followed by a progressive increase; 2) the point after which the respiratory gas exchange ratio consistently exceeded the resting respiratory gas exchange ratio; and 3) the VO_2 after which a nonlinear increase in minute ventilation occurred relative to VO_2.

Finally, subjective feelings of exhaustion were assessed at the end of the test by means of the 10-point Borg scale rating [34].

2.2.3. Echocardiography

All patients were examined at rest in the left lateral supine position with a Vivid E portable (GE Vingmed Ultrasound, Horten, Norway) scanner with B-mode ultrasound at a frame rate of 50 Hz. Left ventricle chamber dimensions were evaluated using standard procedures according to the recommendations of the American Society of Echocardiography [35]. Left ventricle ejection fraction (*LVEF*) was calculated from 2-dimensional apical images according to Simpson's method [36].

2.2.4. Quality of Life (QoL)

Self-reported data on perceived *QoL* were collected by means of two questionnaires: the Minnesota Living with Heart Failure Questionnaire (*MLHFQ*) [37] and the generic *SF-36* health status survey (*SF-36*) [38]. *MLHFQ* is a disease-specific measure of quality of life in *CHF* patients, which assesses patient perception of the degree to which *CHF* and its treatment influences physical symptoms, physical and social functions and psychological components of living. The total score is the sum of the all items and the possible total score ranges from zero to 105. Higher scores reflect worse quality of life. This questionnaire has been shown to be valid. [39]. In addition, we used the Brazilian version of the 36-item Short-Form Health Survey (*SF-36*) [38]. This generic instrument consists of 36 questions divided into the following domains: physical functioning, role-physical, pain, general health perception (five items), vitality (four items), social functioning (two items), role-emotional (three items), and mental health (five items). Each dimension is individually analyzed and the scores of the eight components may range from 0 to 100 to a final score. Low scores indicate poor *QoL*. The range of 0–20 represents a very bad *QoL*, 20–40 represents a bad *QoL*, 40–60 moderate, 60–80 good and optimal 80–100 [40].

2.2.5. Exercise training

All patients were exercising in the morning, three times a week for 12 weeks under individual supervision of an exercise physiologist. The exercise protocol training was adapted of Wisloff et al. [41]. Exercise training involved uphill treadmill walking or running (Embrex, Brusque, Santa Catarina — Brazil; model: 570-Pro). Both *MICT* and *HIIT* started with a 7–10-min warm-up period at an intensity corresponding to 70% of peak heart rate (HR). Subsequently, patients randomized to the *MICT* group continued to walk continuously for an additional 30 min at an intensity of 75% of peak HR (corresponding to this first ventilatory threshold), without breathing heavily; the adapted perceptual scale of physical effort was set to be equivalent from moderate to somewhat hard [28]. Patients randomized to the *HIIT* group walked with intervals of 3-min at intensity equivalent to ~95% of peak heart rate (at least 10% above of respiratory compensation point). Each interval was interspersed by active recovery of 3-min, walking at 70% of peak HR. The adapted perceptual scale of physical effort was set to be equivalent to hard and very hard [28]. On average, patients randomized to *HIIT* would perform 4–6 intervals. All training sessions for both *MCT* and *HIIT* ended with a 5-min cool-down period at 50% of VO_2 *peak*. This represented a total exercise time for both groups of 60-min (10 min of warm-up; 40 min of *MICT* or *HIIT* and 10 min of cool down). All patients exercised using a heart rate monitoring device (Polar Electro, Kempele, Finland; model: RS800CX) and the velocity and inclination of the treadmill were adjusted constantly to ensure that each training session was carried out at the assigned intensity throughout the study period. In addition, the adapted Borg 0-to-10 scale was used to assess the subjective feelings of perceived exertion during and after each training session [28].

Patients were instructed to immediately stop physical training if they experienced chest pain or any other symptoms and were asked to refrain from any extra exercise beyond the study period. No symptoms were reported before, during or after training sessions.

2.2.6. Statistical analysis

Baseline characteristics of the study population are presented as number (percentages) for categorical variables and as means ± standard deviation (SD) for continuous variables. Normality of the data was checked by means of the Kolmogorov–Smirnov test. Both intragroup and intergroup comparisons were performed using two-way repeated-measures analysis of variance followed by the Tukey's post hoc test, with report time, group and interaction effect. The differences in categorical data were assessed by the Chi-squared test (χ^2). To verify the percentage differences between the beginning and the end of 12 weeks of intervention, the Delta variation (Δ%) was used. All analyses were performed using SPSS for Windows (version 18.0; SPSS, Chicago, IL). All p values were 2-sided. A p-value (two-sided) ≤0.05 was considered statistically significant.

3. Results

A flow chart of the trial is shown in Fig. 1. After checking the medical records of the 367 cardiac patients at our department, 201 were excluded for not meeting the eligibility criteria. Of the remaining; 117 refused to participate, 19 incomplete screening packages and three no physician approval by doctor. In the end, 27 *CHF* patients could be randomized to *MCIT* ($n = 12$; mean age 54.0 ± 9.9) or *HIIT* ($n = 15$; mean age 53.2 ± 7.0). Five patients dropped out during the study due to: not completing a minimum of 80% of the exercise sessions (one *HIIT* and two *MCIT*), lost interest (one *HIIT*) and clinical decompensation unrelated to the exercise training (one *MCIT*). Therefore, our analyses are based on data from the remaining 22 *CHF* patients. There were no adverse events related to exercise training reported during the study.

Table 1 shows the baseline and demographic characteristics of the included patients. At baseline, there were no significant differences between both intervention groups. *CHF* patients ranged in age from 41 to 71 years (mean age 54.08 ± 7.5 years). Most patients were public hospital, classified in the lower and middle class, and were functioning in *NYHA* II. The mean left *LVEF* was $33.99 \pm 7.7\%$, average VO_2 *peak* averaged 20.46 ± 4.2 $ml \cdot kg^{-1} \cdot min^{-1.}$ Medication remained unchanged during the study.

As can be seen in Table 2, both groups showed a significant improvement on hemodynamics, in functional capacity and two score questionnaires' of *QoL*.

Patients reported that a diversity of factors affected their QOL. Further significant favorable effects were seen on all dimensions of *QoL* assessed by the specific (*MLHFQ*; Fig. 2) and general (*SF-36*; Fig. 3) questionnaires following *MICT* and *HIIT*. Patients reported in

Table 1
Baseline descriptive characteristics of *CHF* patients.

	MCIT (n = 10)	*HIIT* (n = 12)	*t*	p-Value
Age (years)	54.02 ± 9.9	53.15 ± 7.0	0.231	0.820
Weight (kg)	81.03 ± 19.9	85.4 ± 17.1	−0.543	0.593
Height (cm)	170.73 ± 17.1	169.3 ± 8.8	0.415	0.683
BMI (kg/m^2)	27.47 ± 4.6	29.73 ± 5.4	−1.047	0.307
Hemodynamics				
Resting SBP (mm Hg)	113.63 ± 14.3	130.00 ± 25.5	−1.834	0.082*
Resting DBP (mm Hg)	73.9 ± 9.3	79.3 ± 12.8	−1.104	0.284
Resting HR (beats/min)	88.25 ± 24.9	84.80 ± 24.19	0.327	0.747
Functional class (NYHA) n(%)[a]				
II	11 (50%)	10 (45.5%)	0.873	0.350
III	1 (4.5%)	-		
CHF etiology n(%)[a]				
Ischaemic	8 (36.4%)	7 (31.8%)	0.028	0.867
Non-ischaemic	4 (18.2%)	3 (13.6%)		
Socioeconomic status n(%)[a]				
High/highest	1 (4.5%)	0 (0%)	0.917	0.632
Middle	6 (27.6%)	5 (22.7%)		
Low/lowest	5 (22.7%)	5 (22.7%)		
SUS patients n(%)[a]	11 (50%)	7 (31.8%)	1.721	0.190
Ethnic characteristics n(%)[a]				
Caucasian	9 (40.9%)	8 (36.4%)	0.078	0.781
Concomitant diseases n(%)[a]				
CAD	7 (31.8%)	5 (22.7%)	0.153	0.696
Hypertension	6 (27.3%)	8 (36.4%)	2.121	0.145
Diabetes	–	2 (9.1%)	2.640	0.104
Dyslipidemia	1 (4.5%)	2 (9.1%)	0.630	0.427
Current smoking?	4 (18.2%)	7 (31.8%)	2.933	0.087
Overweight	5 (22.7%)	3 (13.6%)	1.497	0.473
Obesity	3 (13.6%)	5 (22.7%)	1.744	0.4367
Medication drugs during follow-up n(%)[a]				
ACE inhibitors	11 (50%)	8 (36.4%)	0.630	0.427
β-blockers	10 (45.5%)	10 (45.5%)	1.833	0.176
Digitalis	7 (38.8%)	5 (22.7%)	0.153	0.696
Diuretics	11 (50%)	9 (40.9%)	0.018	0.892
Nitrates	3 (13.6%)	3 (13.6%)	0.069	0.793
Anticoagulants	9 (40.9%)	5 (22.7%)	1.473	0.225
Antiarrhythmic	2 (9.1%)	1 (4.5%)	0.206	0.650
Statins	4 (18.2%)	7 (31.8%)	2.933	0.087
LVEF (%)	32.8 ± 7.7	35.40 ± 6.7	−0.793	0.439
VO_2 *peak* (ml·kg^{-1}·min^{-1})	18.39 ± 4.3	21.41 ± 4.1	−0.908	0.375
6MWT (m)	447.4 ± 60.3	456.6 ± 36.3	0.343	0.735

Values are reported as mean ± SD.
Abbreviations: *HIIT*: high-interval intensity training; *MICT*: moderate-intensity continuous training; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; *NYHA*: New York Heart Association; *CHF*: chronic heart failure; SUS: Brazil's Unified Health System; *LVEF*: left ventricular ejection fraction; VO_2 *peak*: peak of oxygen consumption; *6MWT*: six minute walk test; CAD: coronary artery disease; *ACE* inhibitors: angiotensin-converting enzyme inhibitors.
[a] Chi-square test.
* $p < 0.05$.

start intervention that a variety of factors affected their *QoL*. Some of these factors improved in both groups, such as physical symptoms (increased ~80%), general health (increased ~55%) and other changes, with exception to the field of pain (*SF-36*) that has not changed. No significant differences between both groups could be observed for any of the domains (p-value for all >0.05).

4. Discussion

The results of this randomized trial demonstrate that 12 weeks of high exercise training three times per week was as effective as moderate intensity continuous training for improving *QoL* in stable *CHF* patients. This research confirms the beneficial effects of exercise training in the management of heart failure [2,5,14,42,43], and shows that both programs can be used to improve *QoL* in this patients' population. However, a recent position statement of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation recommends regular physical activity and structured exercise training in the cardiac rehabilitation programmers'. However, this recommendation is still poorly implemented in daily clinical practice outside specialized centers for *CHF* [8].

A recent review demonstrated that there is strong epidemiological evidence on the beneficial effects of regular exercise and can overcome those of common drugs when one considers that the exercise is the real polypill that combines preventive, multi-systemic effects with a little adverse consequences and at lower cost [44], such evidences can be observed in the present study. The authors add that the identification of exercise adaptations is helping to improve our understanding of the pathophysiology of chronic diseases, especially the *CHF*, which could help to investigate new approaches and therapeutic targets [44]. It should be emphasized that *CHF* is a chronic and progressive syndrome, in which lower *QoL* is associated to high rates of hospital readmission and mortality [45,46], and in this study there were no complications. Fletcher et al. [47] described that aerobic exercise is clearly beneficial in lowering mortality compared to a sedentary lifestyle. In current statements of *CHF* there is a suggestion of three different training modalities (continuous endurance, interval endurance, resistance/strength, and respiratory) in stable *CHF* patients. These training modalities have been proposed with different combinations (different intensities), according to exercise capacity and clinical characteristics [8]. In this case, we proposed to test a hypothesis in this study, which high intensity exercise has higher impact at higher increases in *QoL* when compared with moderate intensity. Unfortunately it was not confirmed for all domains, except for the physical domain of the *SF-36* that relationship to VO_2 *peak*.

The distance in *6MWT* and VO_2 *peak* increased in both groups after 12 weeks of training, the improvement was significantly superior in the *HIIT* ($p = 0.025$). In our study we found a significant increase intragroup, *HIIT* and *MCIT*, respectively of 11.2% and 8.3% of VO_2 *peak*, 23.1% and 19.4% in the *6MWT*, and improvement in classes of functional capacity, according to Weber [48]. However the two groups were not associated with regard to the total amount of work performed, this study points out high aerobic intensity as a key factor for increasing functional capacity in this group. We highlight the Bittner et al. [26] study, which had already demonstrated that the *6MWT* distance traveled is inversely related to mortality in patients with *CHF* who walked less than 300 m had high risk of death. Nevertheless, in this same study, the distances on the *6MWT* were assigned superiors' both groups after intervention. In a meta-analysis, Piepoli et al. [49] also described that exercise training significantly reduced mortality in 35% in interventions, mainly above 28 weeks. However, in our study we found significant differences in a shorter protocol, but with higher intensity than the reported from Piepoli et al. [49]. The effects of higher versus others (moderate and low) exercise intensity with regard to increase capacity functional have been demonstrated in earlier studies of systematic reviews [50–54].

Haykowsky et al. [53] complement that high intensity leads to significantly larger increases in VO_2 *peak* compared with moderate intensity (mean difference 2.14 ml·kg^{-1}·min^{-1}). The increase in VO_2 *peak* observed in this study can be explained according to systematic review that report the improvements in oxygen uptake resulting from high-intensity exercise were achieved through increases in maximal cardiac output [55]. The study Wisløff et al. [41] was the first study to demonstrate the superior effects of high-intensity exercise. The major finding was that high-intensity was superior to moderate-intensity in patients with post-infarction heart failure with regard to reversal of left ventricular remodeling, aerobic capacity, endothelial function, and *QoL* [41].

Preliminary studies [56,57] have shown that aerobic exercise improves scores *MLWHFQ* in *CHF* patients, but higher than changes have been reported due to the exercise of high intensity interval [41,58],

Table 2
Baseline and changes in hemodynamics, functional capacity, and quality of life (*MLHFQ* and *SF-36*) after 12 weeks of training.

	MCIT (n = 10)				*HIIT* (n = 12)				
	Baseline	12 weeks follow-up	Δ%	p-Value	Baseline	12 weeks follow-up	Δ%	p-Value	p-Value**
Hemodynamics									
Resting SBP (mm Hg)	113.1 ± 13.7	105.0 ± 12.5	−8.2	0.065	130.0 ± 25.5	111.4 ± 15.5*	−16.3	0.004	0.305
Resting DBP (mm Hg)	73.7 ± 8.9	68.7 ± 8.5	−8.1	0.108	79.3 ± 12.8	71.9 ± 8.0*	−10.3	0.049	0.386
Resting HR (beats/min)	84.7 ± 12.8	71.8 ± 11.6*	−19.6	0.007	83.1 ± 19.1	75.4 ± 10.4	−12.0	0.295	0.463
LVEF (%)	32.8 ± 7.7	35.7 ± 11.3	8.12	0.369	35.4 ± 6.4	39.9 ± 8.8*	9.7	0.013	0.315
Functional capacity									
VO_2 *peak* (ml·kg^{-1}·min^{-1})	18.39 ± 4.3	20.23 ± 3.0*	8.3%	0.041	21.41 ± 4.1	24.2 ± 4.6*,**	11.2%	<0.001	0.003
6MWT (m)	464.0 ± 60.3	557.9 ± 56.9*	19.4%	<0.001	456.6 ± 36.3	596.3 ± 48.5*	23.1%	<0.001	0.954
MLHFQ									
Physical dimension	13.9 ± 6.9	8.4 ± 5.9*	−110%	0.012	12.3 ± 9.9	7.8 ± 6.7*	−120%	0.027	0.967
Emotional dimension	9.4 ± 4.6	4.7 ± 3.6*	−320%	0.034	8.5 ± 7.1	5.1 ± 4.4*	−207%	0.017	0.767
Reminiscent questions	15.7 ± 3.9	8.1 ± 5.0*	−246%	0.008	12.8 ± 6.2	6.8 ± 5.0*	−266%	0.010	0.590
Total scale score	39.1 ± 12.1	20.8 ± 11.6*	−156%	<0.001	33.5 ± 17.4	18.9 ± 14.7*	−289%	0.005	0.826
SF-36									
Physical functioning	54.5 ± 18.6	74.1 ± 16.8*	29.2%	0.020	69.0 ± 18.2	89.5 ± 7.6*,**	23.2%	0.009	0.025
Role-physical	16.6 ± 22.1	78.1 ± 23.9*	80.1%	<0.001	20.0 ± 28.3	75.0 ± 23.5*	77.5%	<0.001	0.543
Bodily pain	62.1 ± 18.2	65.5 ± 15.6	1.7%	0.557	53.9 ± 19.9	57.7 ± 15.6	2.9%	0.613	0.220
General Health	5.0 ± 4.7	13.2 ± 5.7*	53.8%	0.010	8.5 ± 6.8	14.9 ± 3.0*	47.1%	0.007	0.642
Vitality	50.8 ± 20.5	70.4 ± 14.5*	26.5%	0.015	57.5 ± 22.6	78.5 ± 14.7*	26.5%	0.008	0.668
Social functioning	56.2 ± 18.1	94.7 ± 9.9*	40.8%	0.001	67.5 ± 25.1	90.0 ± 14.9*	26.7%	0.002	0.500
Role-emotional	61.1 ± 23.0	90.6 ± 20.5*	23.5%	0.012	79.4 ± 18.1	96.6 ± 10.5*	18.1%	0.005	0.114
Mental health	66.0 ± 25.3	81.3 ± 19.1*	18.6%	0.033	69.8 ± 239	81.2 ± 17.3*	16.6%	0.002	0.787

SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; *LVEF*: left ventricular ejection fraction; VO_2 *peak*: peak of oxygen uptake; *6MWT*: six minutes walk test; *MLHFQ*: Minnesota Living with Heart Failure Questionnaire; *SF-36*: Long Form 36 Health Survey; *WRpeak*: limit of tolerance. Footnotes indicate significant changes. Values in mean ± SD.
* From baseline to 12 weeks ($p < 0.05$) within groups.
** From 12 weeks to 12 weeks ($p < 0.05$) between groups.

which might explain the major findings in our study. Morgan et al. [5] also in a systematic review emphasized the innovation of *CHF* treatment by means of primary and secondary interventions, in order to maintain and improve the clinical conditions associated with *QoL* of these patients, decreasing dyspnea, fatigue, and palpitations that these patients feel to perform daily activities. So, the exercise is also recognized in full cardiac

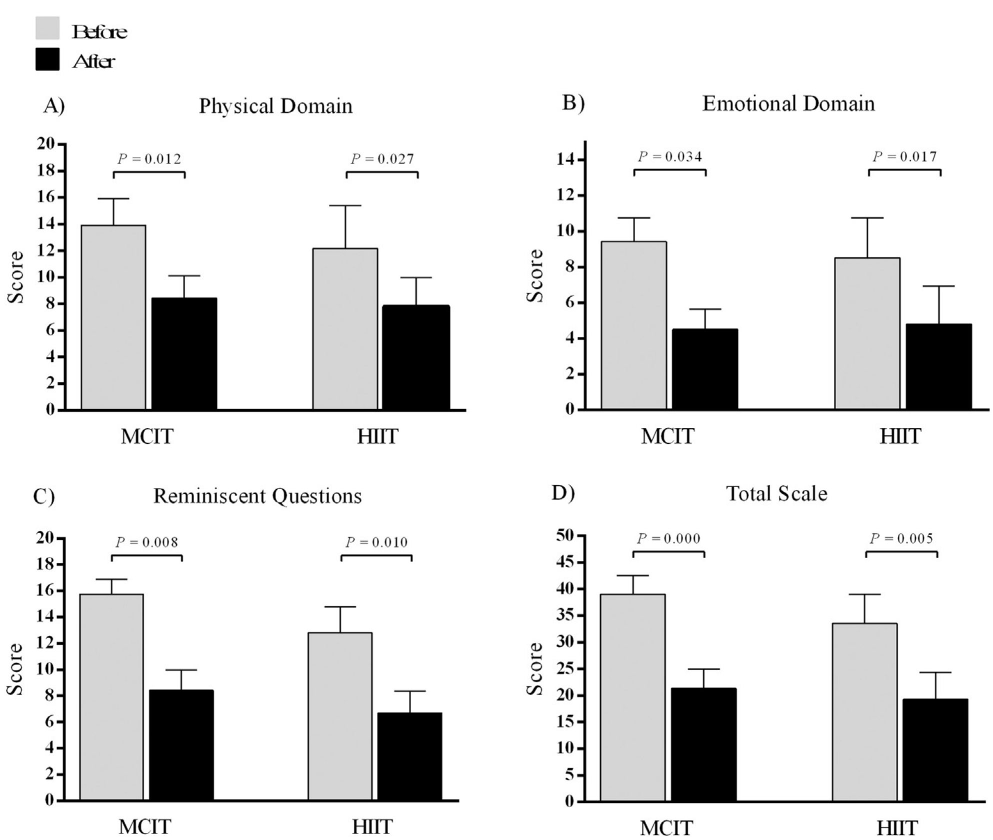

Fig. 2. Quality of life (*MLHFQ*) evaluated by the multiple domain questionnaires both before and after 12 weeks of exercise training. Significant differences between the moments (before vs after) ($p < 0.05$). ($p < 0.05$) Abbreviations: *MICT*: moderate-intensity continuous training; *HIIT*: high-interval intensity training.

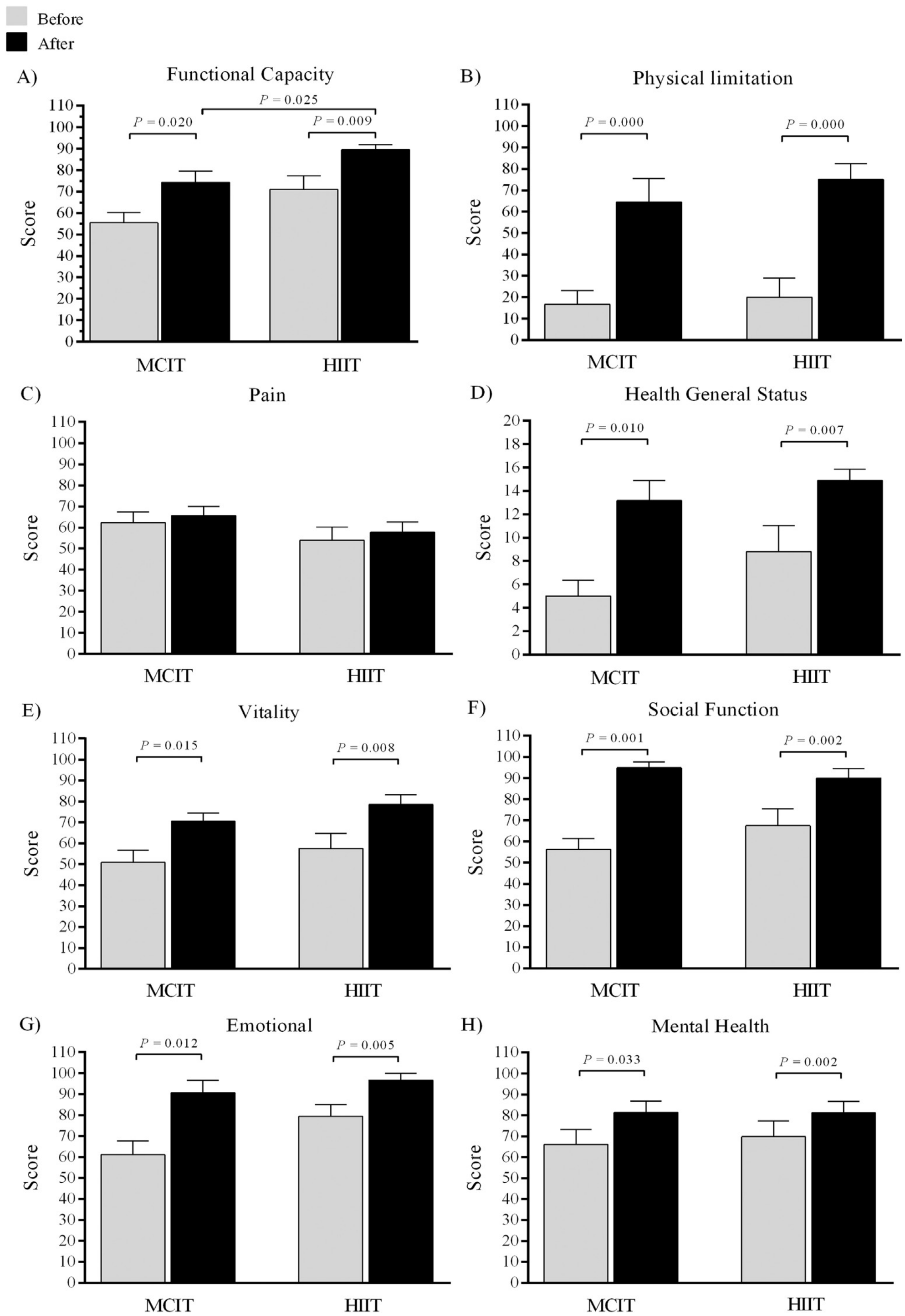

Fig. 3. Quality of life (*SF-36*) evaluated by the multiple domain questionnaires both before and after 12 weeks of exercise training. Significant differences between the moments (before vs after) ($p < 0.05$). ($p < 0.05$) Abbreviations: *MICT*: moderate-intensity continuous training; *HIIT*: high-interval intensity training.

rehabilitation in heart failure [8]. Carvalho et al. [59] ensure that the best physical, psychological and social conditions, as seen in this study with increasing *CF* and *QoL* and after intervention. Corroborating, Belardinelli et al. [60] using the *MLWHFQ* and Gianuzzi et al. [61], the modified Likert instrument, show an improvement in *QoL* in *CHF* patients associated with exercise capacity and clinical improvement [62]. On the other hand, studies were able to demonstrate improvement in *QoL* without necessarily having an increase in exercise tolerance [63,64], or even a weak association between these two variables [43,65]. With reduced physical symptoms through exercise seen in the present study, no such effect affects the aggravation of this syndrome, which in turn improves the emotional state which is evidently insecurity, independence, fear, and sadness [5,64,66,67]. Recent findings [68] in patients with *CHF* already belonging to the rehabilitation program situation, demonstrate having greater functional capacity, and lower *QoL* scores (good *QoL*) in all areas when compared to beginners in rehabilitation programs. Which may indicate involvement of these questions for the subjects who didn't participate rehabilitation program.

On the other hand, understanding *QoL* often reflects the discrepancy between the state of health perception of the patient's at the moment. It was evident in our results the perception of improvement in both groups, independent of exercise intensity. This in turn confirms the objective of rehabilitation, full improvement of these patients and the real benefits of the program [69]. We recognize the limitations in our study. Our study should be interpreted in few or many limitations. The research was accomplished at only one local, only with men, and was limited to a relatively mean age of 53 years with *CHF* patients. The exercise intensity was based on heart rate acquired by the ergometric test. The rationale for using heart rate for guiding exercise intensity in *CHF* is based on the relatively linear relationship between heart rate and VO_2 *peak* in exercise training programs [47]. However, an exercise training prescription based only on heart rate peak has been shown to overestimate exercise intensity [8,47]. The exercise sessions between the groups in terms of intensity, time and workload they could be also considered limiting factors. The results may be generalizable to patients with *CHF*. Aging is associated with increasing comorbidities and worsening heart failure. Another concern could be that the differing distribution of the etiologies among the groups could influence the results.

5. Conclusion

Summarizing, our results demonstrate that independently of exercise intensity in patients with *CHF* results in a significant improvement in *QoL*. It also shows that the high intensity of exercise may be an important factor for improving aerobic capacity, in patients with *CHF*. Meanwhile, our data also support the concept that exercise training must be part of a heart failure treatment plan. However, loopholes regarding optimal training protocol remain unanswered. These findings represent a vital implication for rehabilitation programs designated to *CHF* patients. Although exercise intervention is an attractive strategy for enhances of *CHF*, strategies for maintaining patient compliance to the training program would be necessary. In view of the prognostic importance of increasing functional capacity and *QoL* for this patient group, high intensity exercise may be considered in future rehabilitation programs. We assume that the differential of the rehabilitation program be extra-hospital might have substantially contributed to the improvement of social and psychological life, however, more research must be conducted in order to confirm our findings.

Conflict of interest

All authors meet the criteria for authorship, read and approved the manuscript, and none of them has any potential conflict of interest.

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