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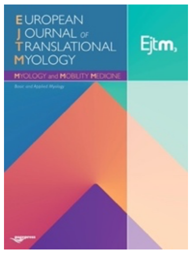

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Short-term blood pressure variability after continuous versus interval aerobic training combined with resistance exercise in ischemic heart disease: a pilot study

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Abstract

Arterial hypertension and increased Blood Pressure Variability (BPV) are major prognostic determinants in patients with Ischemic Heart Disease (IHD). This randomized pilot study compared the effects of Continuous Combined Training (CCT; moderate-intensity continuous aerobic exercise plus resistance training) and Interval Combined Training (ICT; high-intensity interval aerobic exercise plus resistance training) on BPV and Blood Pressure (BP) parameters. Thirty-six clinically stable patients with IHD and hypertension were randomized to CCT or ICT for 12 weeks. Between-group changes in the study outcome were analysed by ANCOVA. Short-term systolic BPV significantly decreased in the CCT group but remained unchanged in the ICT group: [adjusted between-group difference −2.1 mmHg (95% CI: −3.2 to −1.4; $p = 0.036$). Resting systolic BP decreased similarly in both groups, whereas no significant changes were observed in 24-hour BP values. Peak oxygen uptake improved in both groups with a greater increase in the ICT group [adjusted between-groups difference +1.7 $mL \cdot kg^{-1} \cdot min^{-1}$ (95% CI: 0.7 to 2.2; $p = 0.044$). These findings suggest that, in patients with IHD, continuous combined training may be more effective than interval combined training in reducing short-term BPV, whereas interval training may confer greater improvements in aerobic capacity. Further adequately powered studies are warranted to confirm these results.

Keywords: combined interval training, hypertension, blood pressure variability, ischemic heart disease.

Arterial hypertension remains one of the leading modifiable determinants of cardiovascular morbidity and mortality, affecting over 1.3 billion adults worldwide and accounting for a substantial burden of ischemic and heart failure events.[1,2] In individuals with Ischemic Heart Disease (IHD), hypertension is particularly frequent, representing both a precipitating factor and a prognostic amplifier of adverse outcomes.[3-5] Therefore, optimization of Blood Pressure (BP) levels represents a cornerstone of secondary prevention in patients with established IHD.[6] Beyond mean BP levels, Blood Pressure Variability (BPV), the oscillation of BP over time, has emerged as an independent predictor of cardiovascular events.[7,8] Oscillations in BP can be assessed using various methods: very short-term BPV refers to beat-to-beat fluctuations in BP; short-term BPV is typically evaluated using 24-hour Ambulatory BP Monitoring (ABPM); long-term BPV reflects BP fluctuations occurring over extended periods, including weeks, months, or years. In particular, an elevated short-term BPV, resulted as the most powerful predictor of cardiovascular events when compared to long-term BPV[9] and average 24/h BP.[10] However, despite the growing evidence supporting the prognostic role of BPV, there is currently limited evidence regarding effective interventions capable of reducing BPV.[11,12] Exercise training is a well-established nonpharmacological intervention for preventing and treating both hypertension and IHD.[13,16] Aerobic Moderate Intensity Continuous Training (MICT) is considered the gold standard for treating IHD patients in the context of cardiac rehabilitation programs since it has been associated with reduced cardiovascular mortality, cardiac events, and hospitalizations.[17] In recent years, combined training protocols, which integrate aerobic and dynamic resistance components, have been proposed to maximize cardiovascular and musculoskeletal adaptations.[18,19] Combined training has also demonstrated to reduce short-term BPV in patients with IHD more efficiently than other exercise modalities, including MICT alone.[20,21] High-Intensity Interval Training (HIIT), characterized by alternating bouts of high- and low-intensity exercise, may elicit physiological adaptations that are superior to those achieved with MICT in patients with IHD.[22,23] However, the available clinical evidence remains limited, largely due to the small sample sizes and short follow-up durations of the studies conducted to date. HIIT has demonstrated small reductions in systolic BP, with minimal impact on diastolic BP in comparison to MICT;[24] however, direct comparisons in patients with IHD are lacking. Moreover, to the best of the authors' knowledge, no studies have specifically investigated the effects of HIIT on BPV in these patients. Nevertheless, evidence directly comparing continuous combined training (MICT plus resistance) versus interval combined training (HIIT plus resistance) in hypertensive patients with IHD are also lacking. The present study investigated whether replacing the MICT component of the combined training sessions with HIIT would produce different effects on BPV, BP values, and peak oxygen uptake (VO_2 peak) in IHD patients. To this purpose, we conducted a prospective randomized pilot study whose primary objective was to estimate the effects of the two exercise interventions on systolic short-term BPV. Other outcome parameters were changes in diastolic short-term BPV, resting BP, 24/h mean BP, and VO_2 peak.

Materials and Methods

Population

The study enrolled 36 patients, average age = 65 ± 7,55, males/females = 33/3. These subjects were evaluated at San Raffaele IRCCS of Rome before starting a cardiac rehabilitation program to which they were referred by their cardiologist or primary care physician. The recruitment period started in January 2024 and was concluded in March 2025. Inclusion criteria of the study were: age ≥ 45 years old; previous diagnosis of IHD; established diagnosis of hypertension; clinical stability (no cardiovascular events in the previous six months); Left Ventricular Ejection Fraction (LVEF) (assessed by echocardiography) above 40%; the ratio between E-wave velocity and the average of septal and lateral e'-wave velocities below 14 (also assessed by echocardiography). Diagnosis of IHD relied on the following information obtained from the clinical history: previous myocardial infarction; previous percutaneous coronary intervention or coronary artery bypass grafting. All patients had to be under optimal pharmacological therapy, with resting BP values under acceptable control (systolic BP < 150 mmHg; diastolic BP < 90mmHg) and no changes in medications in the previous three months. All classes of antihypertensive drugs were admitted, and there were no restrictions on the number of antihypertensive drugs taken by the patients. The following exclusion criteria were adopted: secondary hypertension; significant heart valve diseases; hypertrophic obstructive cardiomyopathy; signs and/or symptoms of myocardial ischemia at rest and/or during the ergometric test, uncontrolled arrhythmia, neurological and or orthopedic conditions contraindicating or limiting exercise training; diagnosis of chronic obstructive pulmonary disease with GOLD stage III–IV; chronic anemia with blood hemoglobin levels below 10.5 g/dL; previous diagnosis of chronic heart failure; presence of signs and/or symptoms of heart failure during the evaluation; symptomatic peripheral arterial disease. Patients who needed further and more sustained pharmacological interventions for lowering BP were excluded from the study.

Study design

The study design, which is summarized in Figure 1, complied with CONSORT guidelines.[25] The present research was conceived as a randomized pilot study that included two intervention arms: a Continuous Combined Training (CCT) and an Interval Combined Training (ICT). The protocol lasted 12 weeks for each group. Patients in both groups exercised three times a week, with each session lasting 80 minutes. Patient recruitment occurred after a screening visit during which eligibility was assessed according to the predefined inclusion and exclusion criteria. Eligible patients were then asked to participate in the study, and those who agreed signed an informed consent. The screening visit (V0) included medical and pharmacological history, collection of anthropometric measurements (weight and height), measurement of BP at rest, Electrocardiography (ECG), and Cardiopulmonary Exercise Testing (CPET). If the patient had not undergone a recent echocardiogram (within the previous 3 months), this examination was performed to assess LVEF. A second visit (V1) was scheduled within one week of screening. During V1, participants performed a six-minute walk test (6MWT); moreover, an in-person training session was conducted to ensure that participants had hands-on experience with the devices they would be using during the study. Patients performed a first 24-hour ABPM within two days of V1. Once the training programs were completed, patients repeated the 24-hour ABPM between two and five days after the last session. Then, patients were re-evaluated during a third visit (V2) that was organized within 10 days from the end of the training period and during which they performed a second 6MWT and CPET. This was an open-label trial. Patients were randomly assigned on a 1:1 basis to either the CCT or ICT group within a week from the screening visit. Randomization was performed using a computer-generated allocation sequence with allocation concealment ensured by sealed, opaque, sequentially numbered envelopes prepared by an investigator not involved in participant recruitment or assessment. All patients provided written informed consent to participate in the study, which was approved by the local Ethics Committee (N registration: SR 7/2024). The study has been registered on ClinicalTrials.gov (ID: NCT04763629, approval date: 20 January 2022).

Outcomes measure

Resting blood pressure

Resting systolic and diastolic BP were measured using an automated oscillometric device (Omron HEM-7130™; Omron Healthcare Inc., Lake Forest, IL, USA). Measurements were obtained after at least 5 minutes of seated rest, with participants instructed to abstain from caffeine, exercise, and smoking for ≥ 60 minutes beforehand. The cuff was placed on the upper arm at heart level, and measurements were performed in a quiet environment without conversation. All assessments were conducted between 9:00 and 10:30 a.m.

Exercise capacity

Maximal and submaximal exercise capacity were investigated through CPET and 6MWT. These two assessments were performed respectively at V0 and V1 prior to initiation of the training program and were subsequently repeated at V2 upon completion of the study protocol. During CPET, patients were positioned on an electrically braked bicycle ergometer with monitoring of gas exchange (Quark CPET, COSMED, Frascati, Italy). Exercise started with 2 minutes of unloading pedaling, then there was a progressive increase of the load, at a rate of 10 W every minute until exhaustion, which was defined as the inability to keep the pedaling rate steady at 60 rpm. Peak VO_2 was defined as the highest VO_2 observed during the exercise, averaged for a 30-s recording during the last minute of the effort. Respiratory exchange ratio was calculated at the same time-point. A value > 1.10 was considered representative of a maximal effort. The ventilation/carbon dioxide output (VE/VCO_2) slope, which relates the rate of increase in ventilation/unit increase in carbon dioxide, was calculated for the whole exercise period. A 12-lead electrocardiogram was recorded continuously during the test, and BP was measured every 2 minutes by a sphygmomanometer. The 6MWT was performed in a 100 m long corridor, according to standardized procedures [26] and was supervised by a physical therapist.

Twenty-four–hour ambulatory blood pressure monitoring

Twenty-four–hour Ambulatory Blood Pressure Monitoring (ABPM) was conducted using a validated oscillometric device (Cardioline Walk200B, Trento, Italy), with the cuff positioned on the non-dominant arm. BP was recorded every 15 minutes from 06:00 to 22:00 and every 20–30 minutes from 22:00 to 06:00. For analysis, only readings obtained between 08:00 and 20:00 (daytime) and between 00:00 and 06:00 (nighttime) were included to exclude transition periods. Participants were instructed to maintain usual daily activities and medication regimens during monitoring. All recordings were performed on working days and initiated between 09:00 and 10:30. ABPM data were considered valid if at least 75% of measurements were successfully obtained. The following parameters were analyzed: 24-hour, daytime, and nighttime systolic and diastolic BP. Methods used to assess BPV were: i) Average Real Variability (ARV), calculated as previously described by Mena *et al.*:[27] $ARV = 1/(N-1) \sum|BP_{k+1}-BP_k|$, where N represents the number of valid BP measurements; ii) Coefficient of variation (CV) that is calculated as standard deviation (SD)/mean BP x 100.[28]

Exercise sessions

Each exercise session lasted 80 minutes and consisted of an aerobic phase (45 minutes) followed by a resistance training phase (35 minutes). All sessions were conducted in the morning, between 8:30 a.m. and 12:00 p.m. Aerobic exercise was performed on a stationary cycle ergometer (Technogym Wellness System, Technogym, Cesena, Italy). Participants assigned to the CCT group cycled at a constant Heart Rate (HR) corresponding to 60–70% of VO_2 peak as determined during CPET. HR was continuously monitored via the cycle ergometer display, which provided real-time feedback, including average and maximal HR. Participants in the ICT group performed aerobic exercise on the stationary cycle ergometer using an interval protocol consisting of alternating bouts of 5 minutes at 80–90% of VO_2 peak and 10 minutes at 50–60% of VO_2 peak. This sequence was repeated three times, resulting in a total aerobic exercise duration of 45 minutes. At the end of the aerobic phase, patients were allowed a 10–20-minute rest period before initiating the resistance phase; this interval was not included in the calculation of total exercise session duration. The resistance training component included the following exercises: leg press, leg extension, shoulder press, chest press, low row, and vertical traction (Technogym Wellness System, Technogym, Cesena, Italy). For each muscle group, a preliminary one-repetition maximum (1-RM) assessment was performed. The 1-RM was defined as the highest force achieved during three prior 5-second maximal voluntary contraction trials. Attention was paid to ensure that contractions were limited to the target muscle groups, minimizing the recruitment of accessory muscles. For each exercise, patients performed three sets, with each set consisting of 10 repetitions. A two-minute rest period was allowed between sets. The intensity of every exercise was set at 60% of 1-RM.

Statistical analysis

This study was designed as a pilot investigation; therefore, no formal a priori sample size calculation was performed; the sample size was determined based on feasibility and participant availability.[29] Continuous variables are presented as mean ± Standard Deviation (SD). Data normality was assessed using the Shapiro–Wilk test. Each examined variable demonstrated a normal distribution. Comparison between baseline parameters were made by Student's t-test and chi-square test. Between-group differences in study outcomes at follow-up were assessed using Analysis Of Covariance (ANCOVA), with group as the fixed factor and the baseline value of the outcome included as a covariate. To account for potential confounding, the number of antihypertensive medications was additionally entered as a covariate in all models. All statistical analyses were conducted using IBM SPSS Statistics (version 29.0).

Results

From an initial number of 79 patients screened, fifteen did not accept the proposal to participate in the study; thirteen were excluded for having uncontrolled BP values at rest requiring changes in their anti-hypertensive therapy; nine patients had a history of heart failure, and six were excluded for presenting signs of ischemia during the exercise test. All enrolled participants completed the exercise protocol, and their data were included in the analysis. Baseline characteristics are reported in Table 1. All patients had a BMI over 25, and seventeen out of 36 (47%) were obese. All patients were taking more than one medication to lower their BP, with an average number of 2.8 ± 1.4. The percentage of participants who took two, three, or four medications with anti-hypertensive effect was 47.2%, 30.5%, and 22.2%, respectively. All patients randomized completed the study, and their data were analysed. Both exercise protocols were well tolerated, and no clinical events occurred during the entire study. Patients in the CCT group attended 30 out of 36 planned exercise sessions (83.3%) while those in the ICT group attended 31 out of 36 (86.1%).
After adjustment for baseline values, VO_2 peak at follow-up was significantly higher in the ICT group compared with the CCT group, indicating a greater improvement in aerobic capacity with ICT [adjusted between-group difference: +1.7 mL/kg//min (95% CI: 0.7 to 2.2)] (Figure 2). In contrast, no significant between-group differences were observed for the VE/VCO_2 slope or for 6MWT distance at follow-up, suggesting comparable training-related adaptations between the two exercise protocols for these outcomes. Concerning BPV, short-term systolic BPV assessed by ARV

was significantly lower at follow-up in the CCT group compared with the ICT group, after adjustment for baseline values [adjusted between-group difference: −2.1 mmHg; (95% CI: −3.2 to −1.4)]. Conversely, no significant between-group differences were observed for diastolic BPV assessed by ARV or for both systolic and diastolic BP variability assessed by CV. Similarly, no significant between-group differences were detected for 24-hour, daytime, or nighttime systolic or diastolic BP values following the 12-week intervention. Although resting systolic BP decreased from baseline in both groups, the magnitude of reduction did not differ significantly between groups after baseline adjustment (Table 2).

Discussion

Exercise training is widely adopted as a non-pharmacological intervention for inducing BP reductions in individuals with hypertension. In recent years, a growing, but still limited, body of evidence has also demonstrated that exercise training can effectively reduce BPV, particularly short-term systolic BPV.[30,32] However, uncertainty remains regarding the most effective exercise modality and training protocol for optimizing BPV reduction. In the present pilot study, a combined exercise training program including MICT plus dynamic resistance exercise was more effective than HIIT combined with dynamic resistance exercise in reducing short-term BPV in hypertensive patients with underlying IHD. This finding, though very preliminary, is novel; to the best of our knowledge, no previous studies have directly compared these exercise modalities with respect to their effects on short-term BPV. In addition, a further element of novelty lies in the study's focus on a population of patients with IHD. Most studies that have evaluated the effects of exercise training on BPV have been performed in healthy individuals and in patients with hypertension. The largest meta-analysis to date, including 15 studies, reported a 10–20% exercise-mediated reduction in both systolic and diastolic short-term BPV compared with control conditions, with stronger evidence in favour of continuous aerobic training interventions.[33] Conversely, data on IHD, particularly within structured cardiac rehabilitation programs, remain very limited. In this context, a previous research demonstrated that a combined training protocol, including MICT and resistance exercise, was more effective than aerobic training alone in reducing systolic short-term BP variability.[21] Although the result of the present research should be considered with caution, given its small sample size, it supports the implementation of a well-powered randomized controlled trial. Expanding the data from this pilot study may further refine the understanding of the effects of exercise training on BPV in a population at very high cardiovascular risk, in whom improvements in BP control may yield meaningful prognostic benefits.[6] The absence of significant effects on BPV observed in the ICT group in the present study appears to be consistent with previous findings. Specifically, 24-hour systolic and diastolic short-term BPV have been shown to increase following a single session of HIIT, while decreasing after a combined exercise session consisting of MICT plus dynamic resistance exercise.[20] Moreover, Zercher *et al.*[34] reported an increase in BP reactivity, assessed using beat-to-beat measurements, following eight weeks of HIIT. In contrast to the findings for BPV, the present study did not demonstrate significant reductions in 24-hour systolic or diastolic BP values. These results differ from those reported by Martínez-Aguirre-Betolaza *et al.*,[35] who compared moderate-intensity continuous training with HIIT in obese hypertensive individuals and observed significant reductions in 24-hour systolic and diastolic BP in both groups, without changes in BPV indices. Several factors may account for these discrepancies. Differences in the BPV indices used (coefficient of variation versus average real variability), sample characteristics (including sex distribution, age, and body mass index), training duration (12 versus 16 weeks), and pharmacological treatment may all have contributed to the divergent results. In addition, patients enrolled in the present study were receiving multiple antihypertensive medications, which may have limited the magnitude of BP changes detectable in a relatively small sample. Regarding exercise capacity, the present study documented a greater increase in VO_2 peak in the ICT group compared with the CCT group. This finding is consistent with previous research in both healthy individuals and patients with IHD, with most studies reporting superior improvements in VO_2 peak following HIIT.[36] We can speculate that the greater impact of HIIT may be partly attributable to its higher caloric expenditure. Although the present study did not specifically investigate this aspect, this interpretation is supported by studies showing that when isocaloric exercise protocols are compared, HIIT and MICT produce similar improvements in VO_2 peak.[37] Further studies with larger sample sizes and longer follow-up periods are warranted to confirm and extend the findings of the present investigation.

Limitations

The main limitation of this study is the relatively small sample size; therefore, the findings should be confirmed in larger, adequately powered trials. Additionally, the results cannot be generalized to women, as the study population consisted predominantly of male participants. Since the entire study population was composed of overweight and obese patients, our results cannot be extended to those with a normal weight. Another limitation is the absence of a non-exercising control group. However, within the context of this, the lack of a non-exercise control group was unavoidable, as all participants were formally referred to an exercise-based cardiac rehabilitation program by their cardiologist or primary care physician under the Italian National Health Service reimbursement system; allocating patients to a non-exercise arm was therefore considered unethical. Nevertheless, since both study arms involved structured exercise training and no non-exercise control group was included, findings reflect comparative effects between exercise modalities rather than absolute effects of exercise on systolic short-term BP variability. The present study was restricted to patients with IHD exhibiting mild-to-moderate LV dysfunction but without a clinical diagnosis of chronic heart failure. By excluding individuals with LVEF <40% and/or elevated filling pressures (E/e′ >14), we intentionally avoided enrolling patients with more advanced LV dysfunction and greater hemodynamic compromise, who are at higher risk of overt heart failure and adverse clinical outcomes. While this approach ensured a more homogeneous and clinically stable study population, it may limit the generalizability of our findings to patients with more severe LV impairment or established heart failure. Finally, caloric expenditure was not quantified, and comparing equal durations of interval and continuous aerobic exercise may represent a methodological limitation.

Conclusions

In this study, continuous combined training was more effective than interval combined training in reducing short-term systolic BPV, whereas patients in the interval training group achieved greater improvements in aerobic capacity. These results, though very preliminary, underscore the importance of individualized exercise prescription in patients with IHD, tailoring training modalities to specific clinical and physiological objectives. These findings need to be verified, and they support the implementation of a definitive randomized controlled trial to quantify the effects of different exercise programs on BPV.

List of abbreviations

BPV Blood pressure variability
IHD Ischemic heart disease
BP Blood pressure
CCT Continuous combined training
ICT Interval combined training
MICT Moderate intensity continuous training
HIIT High-intensity interval training
LVEF Left ventricular ejection fraction
ECG Electrocardiography

CPET Cardiopulmonary exercise testing
6MWT Six-minute walk test
ABPM Ambulatory blood pressure monitoring
ARV Average real variability
HR Heart rate
1-RM One-repetition maximum
BMI Body mass index
CV Coefficient of variation

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Contributions

Matteo Vitarelli, Marco Alfonso Perrone, Ferdinando Iellamo, and Giuseppe Caminiti contributed to the conceptualization of the paper; Camilla Calandri, Antonella Antelmi, Domenico Mario Giamundo, and Valentina Morsella prepared the initial draft after acquisition, analysis, and interpretation of the results; Giuseppe Marazzi, Bruno Ruscello, Elvira Padua, and Maurizio Volterrani substantively revised the paper. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Ethics approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Ethics Committee of San Raffaele IRCCS of Rome (protocol code SR 7/2024, approval date 21 September 2023).

Informed consent

Informed consent was obtained from all subjects involved in the study. Written informed consent has also been obtained from the patients to publish this paper.

Data availability

The data presented in this study are available upon request from the corresponding authors.

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Table 1. Baseline features of participants according to their allocation group.

	ICT (n = 18)	CTT (n = 18)	*p*
Age, y	66.1 ± 11.2	65.4 ± 12.7	0.682
BMI, kg/m^2	29.3 ± 6.8	29.1 ± 8.0	0.473
Males, n (%)	17 (94.4)	16 (88.8)	0.457
Previous STEMI/NSTEMI-UA, n (%)	13 (72.2) / 5 (27.7)	14 (77.7) / 4 (22.2)	0.542
Previous CABG/PCI, n (%)	10 (55.5) / 14 (77.7)	11 (61.1) / 14 (77.7)	0.846
Multivessel disease, n (%)	13 (72.2)	15 (83.3)	0.439
Carotid artery disease, n (%)	9 (50.0)	10 (55.5)	0.598
Diabetes, n (%)	4 (22.2)	5 (27.7)	0.362
Hypercholesterolemia, n (%)	16 (88.8)	17 (94.4)	0.248
Previous/active smoker, n (%)	13 (72.2) / 3 (16.6)	11 (61.1) / 2 (11.1)	0.623
eGFR, mL/min/1.73 m^2	74.8 ± 10.3	72.5 ± 13.6	0.528
LVEF, %	54.2 ± 7.2	53.8 ± 8.2	0.344
E/e’ ratio	7.2 ± 2.2	7.8 ± 1.6	0.597
Treatment			
ACE-i/ARBs, n (%)	18 (100.0)	18 (100.0)	0.784
Betablockers, n (%)	18 (100.0)	18 (100.0)	0.572
MRAs, n (%)	5 (27.7)	4 (22.2)	0.211
Thiazide diuretic, n (%)	9 (50.0)	11 (61.1)	0.668

Ivabradine, n (%)	2 (11.1)	3 (16.6)	0.395
Statins, n (%)	18 (100.0)	18 (100.0)	0.714
CCAs, n (%)	10 (55.5)	11 (61.1)	0.848
Acetylsalicylic acid	16 (88.8)	16 (88.8)	0.652
Clopidogrel, GLT-2	3 (16.6)	2 (11.1)	0.283

Table 2. Between-group differences ~~in~~ changes of study outcomes.

	ICT		**CCT**		**Adjusted between-group *p***
	Baseline	12-weeks	Baseline	12-weeks	
CPET					
VO2, ml/ kg/min	25.5 ± 3.9	29.4 ± 3,6*	24.9 ± 4.3	27.1 ± 38	0.044
VE/VCO2	31.3 ± 6.9	29.2 ± 7.8	32.4 ± 8.1	29.5 ± 6.4	0.155
Exercise time, sec	498 ± 66.2	567.3 ± 73.1	512.6 ± 78.8	581.2 ± 84.1	0.348
6MWT distance, m	351.7 ± 88.4	426.3 ± 92.1	349.4 ± 84.8	413.3 ± 98.2	0.189
SBP at rest, mmHg	116.5 ± 1 2.7	112.1 ± 7.9	117.2 ± 10.3	114.6 ± 8.4	0.224
DBP at rest, mmHg	78.1 ± 6.8	75.7 ± 7.6	77.7 ± 6.8	77.3 ± 5.4	0.563
24/h BP monitoring, mmHg					
BP averages					
24/h SBP	117.6 ± 6.6	117.4 ± 8.1	119.1 ± 10.8	118.2 ± 9.6	0.463
Daytime SBP	119 ± 17.4	121.1 ± 16.9	121.9 ± 22.3	120.4 ± 18.4	0.159
Nighttime SBP	111.5 ± 13.2	112.1 ± 16.8	112.7 ± 13.5	112.1 ± 15.0	0.063

24/h DBP	76.6 ± 4.4	75.1 ± 5.7	72.9 ± 6.9	72.8 ± 8.0	0.722
Daytime DBP	78.2 ± 8.4	77.8 ± 9.1	75.3 ± 6.6	75.4 ± 9-4	0.372
Nighttime DBP	69.0 ± 5.7	68.3 ± 8.8	66.7 ± 7.3	67.0 ± 8.7	0.239
BP variability					
PAS – AVR	9.4 ± 2.1	9.5 ± 2.7	10.7 ± 2.6	8.3 ± 1.8*	0.036
PAD- AVR	7.6 ± 1.4	7.2 ± 1.0	8.1 ± 2.6	7.9 ± 2.8	0.245
PAS – CV	10.3 ± 1.8	10.5 ± 2.1	11.2 ± 2.6	11.4 ± 3.1	0.180
PAD- CV	13.3 ± 2.7	13.1 ± 1.9	13.0 ± 1.6	13.7 ± 2.0	0.248

Figure 1: Study flow-chart

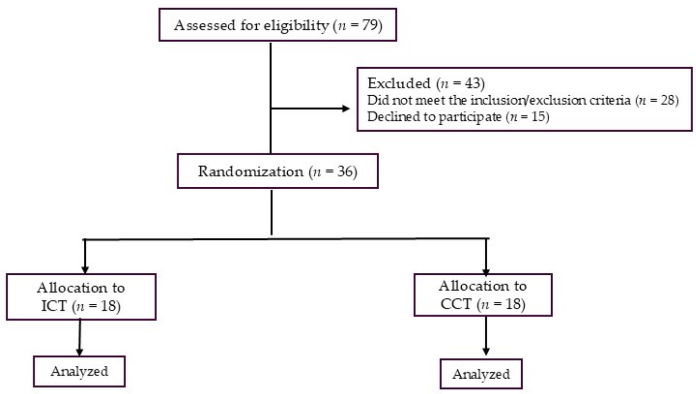

Figure 2. Changes in cardiopulmonary parameters (12 weeks versus baseline) in the ICT (grey bars) and CCT (orange bars) groups.

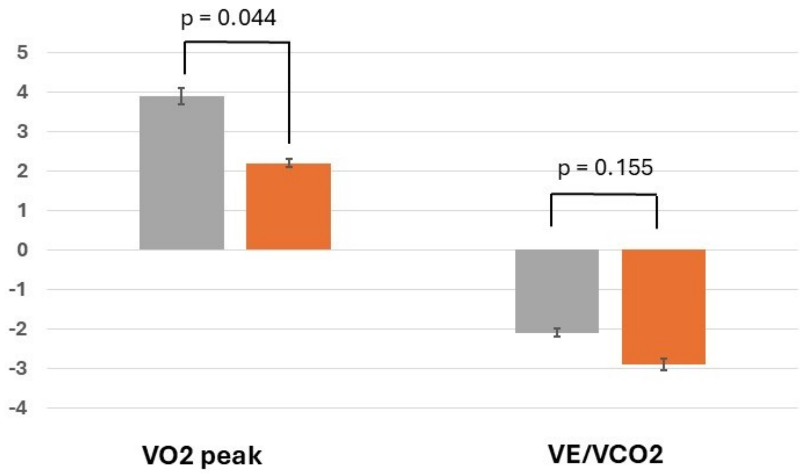

Figure 3. Changes in short-term systolic and diastolic blood pressure variability (12 weeks versus baseline) in the ICT (grey bars) and CCT (orange bars) groups.