AGE

Effects of non-pharmacological interventions on cardiovascular risk factors in hypertensive elderly patients

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Abstract:

Recommendations for prevention of cardiovascular diseases (CVDs) risk factors among older adults highlighted the importance of non-pharmacological interventions, including endurance training (ET). However, the evidence of efficacy of other interventions based on short-bouts of exercise (circuit training, CT), and the practice of breath-control and meditation (relaxing training, RT) is growing. The aim of this study was to elucidate if CT or RT are equally effective in CVD risk factors reduction compared to ET. To this purpose, in forty elderly participants, with clinically diagnosed grade 1 hypertension, resting blood pressure, blood glucose and cholesterol levels, maximum oxygen uptake ( ), mechanical efficiency, quality of life were evaluated before and after 12 weeks of ET, CT, and RT treatments. Resting blood pressure reduced significantly in all groups by ~11%. In ET, blood cholesterol levels (-18%), (+8%), mechanical efficiency (+9%), and quality of life scores (+36%) ameliorated. In CT blood glucose levels (-11%), (+7%), and quality of life scores (+35%) were bettered. Conversely, in RT the lower blood pressure went along only with an improvement in the mental component of quality of life (+42%). ET and CT were both appropriate interventions to reduce CVDs risk factors, because blood pressure reduction was accompanied by decreases in blood glucose and cholesterol levels, increases in , mechanical efficiency, and quality of life. Although RT is not an appropriate stimulus to reduce some CVD risk factors, the reduction in blood pressure

	suggests the utilization of this approach in patients with mobility limitation.

ABSTRACT

Recommendations for prevention of cardiovascular diseases (CVDs) risk factors among older adults highlighted the importance of non-pharmacological interventions, including endurance training (ET). However, the evidence of efficacy of other interventions based on short-bouts of exercise (circuit training, CT), and the practice of breath-control and meditation (relaxing training, RT) is growing. The aim of this study was to elucidate if CT or RT are equally effective in CVD risk factors reduction compared to ET. To this purpose, in forty elderly participants, with clinically diagnosed grade 1 hypertension, resting blood pressure, blood glucose and cholesterol levels, maximum oxygen uptake ($\dot{V}o_2 max$), mechanical efficiency, quality of life were evaluated before and after 12 weeks of ET, CT, and RT treatments. Resting blood pressure reduced significantly in all groups by ~11%. In ET, blood cholesterol levels (-18%), $\dot{V}o_2 max$ (+8%), mechanical efficiency (+9%), and quality of life scores (+36%) ameliorated. In CT blood glucose levels (-11%), $\dot{V}o_2 max$ (+7%), and quality of life scores (+35%) were bettered. Conversely, in RT the lower blood pressure went along only with an improvement in the mental component of quality of life (+42%). ET and CT were both appropriate interventions to reduce CVDs risk factors, because blood pressure reduction was accompanied by decreases in blood glucose and cholesterol levels, increases in $\dot{V}o_2 max$, mechanical efficiency, and quality of life. Although RT is not an appropriate stimulus to reduce some CVD risk factors, the reduction in blood pressure suggests the utilization of this approach in patients with mobility limitation.

Effects of non-pharmacological interventions on cardiovascular risk factors in hypertensive elderly patients.

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ABSTRACT

Recommendations for prevention of cardiovascular diseases (CVDs) risk factors among older adults highlighted the importance of non-pharmacological interventions, including endurance training (ET). However, the evidence of efficacy of other interventions based on short-bouts of exercise (circuit training, CT), and the practice of breath-control and meditation (relaxing training, RT) is growing. The aim of this study was to elucidate if CT or RT are equally effective in CVD risk factors reduction compared to ET. To this purpose, in forty elderly participants, with clinically diagnosed grade 1 hypertension, resting blood pressure, blood glucose and cholesterol levels, maximum oxygen uptake ($\dot{V}o_2\,max$), mechanical efficiency, quality of life were evaluated before and after 12 weeks of ET, CT, and RT treatments. Resting blood pressure reduced significantly in all groups by ~11%. In ET, blood cholesterol levels (-18%), $\dot{V}o_2\,max$ (+8%), mechanical efficiency (+9%), and quality of life scores (+36%) ameliorated. In CT blood glucose levels (-11%), $\dot{V}o_2\,max$ (+7%), and quality of life scores (+35%) were bettered. Conversely, in RT the lower blood pressure went along only with an improvement in the mental component of quality of life (+42%). ET and CT were both appropriate interventions to reduce CVDs risk factors, because blood pressure reduction was accompanied by decreases in blood glucose and cholesterol levels, increases in $\dot{V}o_2\,max$, mechanical efficiency, and quality of life. Although RT is not an appropriate stimulus to reduce some CVD risk factors, the reduction in blood pressure suggests the utilization of this approach in patients with mobility limitation.

Keywords: aging; blood pressure; cardiovascular disease; circuit training; endurance training; relaxing training**.**

INTRODUCTION

Cardiovascular diseases (CVDs) are the main cause of mortality and the most common reason of permanent disability in the western countries (Go et al., 2013). Several risk factors contribute to the development of CVDs, such as age, elevated levels of blood cholesterol, diabetes, obesity, tobacco use, and hypertension (HYP) (Najjar et al., 2005). In the view of this close correlation between CVDs risk factors and lifestyle, the updated recommendations for prevention of CVDs highlight the importance of physical activity among treatments of HYP (Aronow et al., 2011; Mancia et al., 2013). Specifically, hypertensives are encouraged to participate in endurance training (ET) programs to reduce both systolic and diastolic arterial blood pressure. This ET-induced reduction in arterial pressure is generally accompanied by improvements in central and peripheral hemodynamic factors (Gibala et al., 2012; Hood et al., 2011) Additional benefits of ET are the improvement of maximal aerobic capacity ($\dot{V}o_2\,max$), that is highly correlated with longevity and independence of aged population (Venturelli et al., 2012; Venturelli et al., 2013), and the reduction of other CVDs risk factors, such as glucose and cholesterol levels, and obesity (Pescatello et al., 2004).

Also other emerging non-pharmacological treatments for HYP may reduce resting arterial blood pressure (Pal et al., 2013; Sousa et al., 2013). Interestingly, circuit-training (CT) physical exercise is becoming one of the most popular fitness programs in healthy old individuals because of its greater enjoyment with respect to standard ET (Bartlett et al., 2011). However, limited data are available on the effectiveness of this exercise approach on the reduction of CVDs risk factors in old hypertensives (Guimaraes et al., 2010; Lamina, 2010). Besides the potential appeal of CT for the old population, it is important to note that the physiological mechanisms activated by CT are different to those involved in ET in terms of central hemodynamics stimulation (Zhang et al., 2014). The limited heart rate (HR) and cardiac output responses are indeed counterbalanced by high stimulation of the peripheral circulation as during small muscle mass exercise (Esposito et al., 2010; Esposito et al., 2011).

Remarkably, a reduction in arterial blood pressure has been observed also after an alternative healthcare practice, based on breath control and meditation (relaxing training, RT) (Patel, 1975; Santaella et al., 2006). RT is a simple method to improve autonomic balance, respiratory control, and, consequently, to reduce blood pressure in hypertensive individuals. However, whether this alternative treatment can also ameliorate other CVDs risk factors is still a matter of investigation.

Given the clear evidence of ET effectiveness on the amelioration of several CVDs risk factors, exercise capacity, and quality of life in elderly patients with HYP, the aim of this study was to elucidate if other emerging non-pharmacological interventions, based upon CT (mainly peripheral stimulation) or RT (no central or peripheral hemodynamic involvement), are equally successful with respect to ET (both central and peripheral stimulation). To this purpose, resting blood pressure, blood glucose and cholesterol levels, maximal exercise capacity, mechanical efficiency, and quality of life were evaluated before and after 12 weeks of ET, CT, and RT treatments. We hypothesized that a similar positive effect on blood pressure will be retrieved in all conditions. However, this expected outcome will be complemented with positive effects on blood glucose and cholesterol levels, maximal exercise capacity, mechanical efficiency, and quality of life only in ET and CT, but not in RT.

METHODS

Participants: Forty elderly participants (20 males and 20 females), with clinically diagnosed grade 1 hypertension, corresponding to a mean systolic and diastolic blood pressure of 140-159 mmHg, and/or 90-99 mmHg, respectively, volunteered in the study and signed a written informed consent form. All procedures conformed with the standards set by the 1974 Declaration of Helsinki, and the Institutional Review Boards of the local University approved the study. Patients with beta-blockers were excluded from the study. Participants medications were not altered throughout the investigation. A complete list of medications, participants characteristics, and comorbidity is displayed in Table 1.

Experimental design and training protocols: The experimental design, with the proposed interventions, is represented in Figure 1. All volunteers participated to a series of sessions to familiarize with the exercise protocols and interventions. During the last familiarization session, blood pressure was measured and fasting blood samples were taken. On a different day, participants performed a graded maximal cycle exercise test to assess $\dot{V}o_2$peak with indirect calorimetry. After the baseline evaluations (PRE), participants were randomly allocated with stratification for gender to four different groups (n=10, 5 males + 5 females each group): ET, CT, RT, and hypertensive controls (CTRL).

Training sessions for ET, CT and RT lasted 60 min each, for 3 times a week. ET group performed endurance exercise training on treadmill, elliptical, and stepper ergometers. Duration of twenty minutes at 70% of maximal exercise capacity, was set for each ergometer and maintained for the entire duration of ET program. CT group executed short bouts of dynamic exercises on knee extension, knee flexion, calf rise, and leg press ergometers. CT exercises were performed at 1 Hz at 70% of the maximal mechanical power. The duration of a single bout of CT exercise was 60 s, with 60 s of recovery in between. RT group participated to a relaxing training program characterized by breathing at 5-6 cycles/min and meditation (Hering et al., 2013). CTRL did not undergo a specific intervention, therefore their data were utilized as control group. Exercise training compliance was evaluated as a percentage of training sessions attended. All the baseline evaluations were then repeated after 12 weeks of intervention (POST).

Exercise modalities: Cycle exercise was performed on an electromagnetically braked cycle ergometer (Bike-Race Technogym SpA, Gambettola, Italy). Treadmill walking exercise was performed on a motorized inclinable treadmill (Run-Race Technogym SpA, Gambettola, Italy). Elliptical exercise was performed on an elliptical ergometer (Sinchro Technogym SpA, Gambettola, Italy). Step exercise was performed on a stepper ergometer (Step-Race Technogym SpA, Gambettola, Italy). KE, KF, CR, and LP exercises were performed on commercially ergometers (Excite line, Technogym SpA, Gambettola, Italy). RT was performed in a soundproof room. This group of participants, remained supine for the entire duration of the relaxation session, and an expert trainer supervised the training session with verbal feedbacks on the breathing frequency.

Measurements and calculations: Breath-by-breath O_2 and CO_2 expiratory airflow and HR were continuously recorded and digitized (Quark *b*[2], Cosmed, Rome Italy) during PRE and POST graded maximal cycle exercise tests. During maximum test pedal rate was maintained at 60 revolutions per minute (±3%) and work rate was progressively increased (15 W per min) until voluntary exhaustion. Pulmonary ventilation ($\dot{V}E$) and gas exchange parameters were calculated as the average of the last 30 s of any given workload. Energy expenditure and power output were expressed in watts. Delta efficiency was calculated as the reciprocal of the slope of the linear relationship between power output and energy expenditure (3 data points corresponded to 80, 95, and 110 W) (Poole et al., 1992). Maximal exercise capacity was determined for ET and CT ergometers with standard graded maximal tests as follows: on the treadmill both speed and slope were progressively increased until voluntary exhaustion (Bruce et al., 1973); on both elliptical and stepper ergometers, work rate was progressively increased (15 W per min), with a cadence at 60 per minute, until voluntary exhaustion. KE, KF, CR, and LP ergometers were instrumented with a commercially available electronic system (TGS-power control, Technogym SpA, Gambettola, Italy). Range of motion, velocity, and power output were continuously monitored and utilized as feedback for participants. Maximal exercise capacity for KE, KF, CR, and LP was assessed with a graded increased workloads protocol, with 1-min steps at a frequency of 60 contractions per min, until voluntary exhaustion. The 70% of the maximal workload achieved during these evaluations was utilized for ET and CT interventions. HR monitors (Polar RS400) were utilized to measure HR response during the interventions. HR response was assessed also in CTRL while sitting on a chair for a period of time similar to the duration of the intervention. HR reserve (HRR) was calculated as the difference between exercise and resting HR, divided by the difference of age-predicted maximal and resting HRs.

Blood analyses: A fasted venous blood sample was analyzed for glucose, high- and low-density lipoprotein blood levels by standard techniques.

Blood pressure: Two different physicians measured blood pressure with standard auscultatory and mercury sphygmomanometer technique at about the same time of the day to minimize the effect of circadian rhythm on the measurement. Both operators repeated the blood pressure evaluations 2 times in blind before and after intervention. Data reported in the text are the average of the four evaluations.

Health-related quality of life: The Italian version of the SF-36 health survey (Apolone et al., 1998) was administrated before and after the interventions. Briefly, the first 4 items of the SF-36: physical functioning, role-physical, bodily pain, general health were assessed and categorized in the physical component of the SF-36. Similarly, the remnants 4 items: vitality, social functioning, role-emotional, and mental health were recorded and summarized in the mental component of the SF-36. The items scores were than calculated with the computer-based tool (http://www.sf-36.org; SF-36® Health Survey Health Assessment Lab, Medical Outcomes Trust, and QualityMetric Incorporated).

Statistical analysis: Raw data were analyzed using a statistical software package (IBM SPSS Statistics v. 19, Armonk, NY, USA). To check the normal distribution of the sampling, a Shapiro-Wilk test was applied. A two-way (time and group) ANOVA for repeated measures was applied on each variable before and after the interventions to assess the effects of training, and the interaction between the two factors. The location of possible differences was assessed by a Holm-Sidak post-hoc test. The level of significance was set at $\alpha<0.05$. Unless otherwise stated, the results are expressed as mean ± standard error (SE).

RESULTS

The participants' characteristics are summarized in Table 1. No difference was observed between ET, CT, RT and CTRL concerning anthropometrics, comorbidity, and pharmacological treatments ($p = 0.8$).

Intervention compliance: The small-group approach to the interventions with the supervision of expert operators resulted in 92±3% compliance for ET, 97±2% for CT, and 95±4% for RT, without statistical difference between groups ($p = 0.8$).

HR response during ET, CT, RT interventions: HR response, recorded during a single session in the 1st week of the ET exercises, was 21% higher respect to CT. Similarly, the difference between CT and RT was 22% (Figure 2; Panel A). Despite the exercise-intensity adopted for both ET and CT was 70% of maximal capacity, the lowest HR attained during CT was determined by the short intermittent exercise modality (1 min of exercise followed by 1 min of recovery) (Figure 2; Panel B) essential to the premise of the current experimental design. Interestingly, HR recorded during a session of the 12th week of intervention was significantly reduced only during the ET exercise, while was not changed during CT, and RT (Figure 2; Panel A). Data from CTRL are also provided.

Resting HR and blood pressure: Prior to training, no significant difference in HR, SBP, and DBP were found among ET, CT, RT, and CTRL groups (Figure 3; Panels A, B, and C). As a consequence of ET, CT, and RT training, the hypertensive subjects exhibited a significant and similar decrease in SBP and DBP. However resting HR was not changed after the interventions (Figure 3; Panel C).

Blood analyses and health-related quality of life: At baseline, glucose and cholesterol were not different in ET, CT, RT, and CTRL groups, (Table 2). The effect of CT was more pronounced in the reduction of glucose (-26 mg/dl), while ET training, ameliorated both HDL (+9 mg/dl) and LDL (-14 mg/dl). Mental component of the SF-36 survey for health-related quality of life was equally increased for ET, CT, and RT. However, only ET and CT demonstrated a significant increase in the physical component of SF-36 (Table 2).

Maximal cycle exercise pre- and post- ET, CT, RT and CTRL: Maximum work rate during cycle exercise increased significantly after the 12 weeks of intervention by ~30 W for both ET and CT, and by ~15 W for RT. No change was observed for the CTRL group. Pre-training, cycle $\dot{V}o_2peak$ was 1260±104, 1199±105, 1214±111, and 1189±131 ml/min for ET, CT, RT, and CTRL respectively. Post-training cycle $\dot{V}o_2peak$ was significantly increased in both ET (+8%) and CT (+7%), while in RT and CTRL was similar to pre-training values (Figure 4; Panel D). Pre-training $\dot{V}co_2$ attained during maximal cycling exercise was similar for all the 4 groups ~1390 ml/min, however after the intervention peak of $\dot{V}co_2$ was increased by ~9% in RT, ~11% in CT, ~2% in RT, and

~1% in CTRL (Figure 4; Panel C). Pre-training, peak in $\dot{V}_E$ was not different between groups ~47 l/min, but similar to the $\dot{V}co_2$ results, was significantly increased in RT and CT after the interventions (Figure 4; Panel B). Pre-training HR peak reached during cycle exercise was similar ~150 BPM in the four groups. However, post-training maximum HR was significantly augmented only in ET ~7%, while CT ~3%, RT ~2%, and CTRL ~2% did not changed (Figure 4; Panel A).

Mechanical efficiency: Twelve weeks of ET resulted in an attenuated oxygen uptake recorded at given submaximal work rates (80-95-110 W) of the maximal cycle exercise. This outcome indicates a significant increase in mechanical efficiency that was obtained only by the ET group (Figure 4; Panel D; Figure 5). Interestingly, patients in ET group exhibited a similar trend in the reduction of HR at submaximal work rates (Figure 4; Panel A), indicating an increased cardiac reserve induced by the ET intervention.

DISCUSSION

With the intent to evaluate the effectiveness of different non-pharmacological treatments on the modification of CVDs risk factors, exercise capacity, and quality of life of old hypertensive individuals, we investigated the effects of three different interventional strategies (ET, both central and peripheral stimulation; CT, only peripheral stimulation; and RT, no central or peripheral hemodynamic involvement) in elderly patients with grade 1 of HYP. In agreement with our hypothesis, resting systolic and diastolic blood pressures were significantly reduced in all groups. This expected positive outcome was accompanied by different achievements in blood glucose and cholesterol levels, maximum aerobic power, mechanical efficiency and health-related quality of life scores. The reduction in blood pressure in ET was accompanied by a concurrent decrease in blood cholesterol levels and an increase in $\dot{V}o_2peak$, mechanical efficiency and quality of life scores. Similarly, in CT, blood pressure amelioration was accompanied by a decrease in blood glucose levels and an increase in $\dot{V}o_2peak$ and quality of life scores. On the contrary, in RT the lower systolic and diastolic blood pressure went along only with an improvement in the mental component of quality of life.

Non-pharmacological treatments and CVDs risk factors: Despite the three different approaches were similarly effective in the reduction of HYP, other CVDs risk factors were affected differently by ET, CT, and RT. Specifically, HDL and LDL, two important CVDs risk factors, were significantly ameliorated after the ET treatment, while the effect on cholesterol was not significant for CT, and RT. This result is in agreement with the majority of the literature, and it is likely caused by the predominant utilization of the free-fat acids derived from cholesterol during the ET (Braz et al., 2012).

Interestingly, while ET and RT exhibited a positive, but not significant, trend in the reduction of glucose, the effect of CT was more pronounced. These positive results on glucose reduction are in the range of outcomes usually retrieved in aerobic and resistance training (Short et al., 2003). Noticeably, this additional positive outcome reinforces the relationship between the positive effects of physical exercise and cardiovascular health (Guimaraes et al., 2010; Sousa et al., 2013). Collectively, it appears that non-pharmacological interventions based upon active exercise training, ET and CT, were both successful in the amelioration of several CVDs risk factors, while RT was less effective.

Non-pharmacological treatments and quality of life: Quality of life is a relevant aspect of health in old patients with HYP. It is well established that physical exercise can positively change these psychological and health-condition factors in this population (Tolonen et al., 2013). Our data on the mental component of the SF-36 confirm and advance these results, underlining that also a RT approach can improve the psychological component of quality of life. However, the results of physical component of the SF-36 survey indicate that the patients' perception of his/her health status increased only after a period of active exercise training (ET or CT). This contrast can be explained by the additional, and assessed in the current study, positive health-related improvements (blood pressure, glucose and cholesterol levels, and exercise capacity) obtained by ET and CT interventions. Therefore, it appears that these additional health-related gains obtained by the employment of active exercise, may predispose old individuals with HYP to a better perception of their quality of life. Again, the overall better responses on the CVDs risk factors together with the improved quality of life observed in our study, indicate that the best choices in terms of non-pharmacological treatment for HYP reduction are ET and CT.

Non-pharmacological treatments and maximal exercise capacity: Maximal exercise capacity, defined by $\dot{V}o_2\,max$, is a strong predictor of cardiovascular health and independence in older adults (Paterson et al., 2004) and hypertensives (Totsikas et al., 2011). Thus, the investigation of the effectiveness of non-pharmacological treatment has clear practical significance in terms of identifying the means by which the capacity for an independent lifestyle can be maintained (Mancia et al., 2013). Our data indicate that both ET and CT enhanced significantly the maximal exercise capacity assessed during cycle maximal test. According to the maximal work rate, $\dot{V}o_2peak$ increased significantly in both ET (+8%) and CT (+7%). Moreover, the lack of difference in maximal exercise capacity exhibited by the participants assigned to RT intervention suggests that this non-pharmacological approach for HYP reduction is not effective on the enhancement of $\dot{V}o_2peak$. Therefore, this additional result in favor of the ET and CT treatments suggests that the adoption of an active lifestyle characterized by the practicing of dynamic exercise has a remarkable effect not only on blood pressure, but also in maximal exercise capacity, and possibly in the independence of old hypertensives.

Another important outcome exhibited by the ET group, was the significant increase in the HR recorded at maximum exercise. It is important to note that this positive gain of ~7% was not obtained by the other groups, implying that only after an ET intervention a positive effect on the heart hemodynamics could be retrieved. Several studies emphasized the importance of cardiovascular stimuli, such as ET, that increase maximal cardiac output and HR, by which maximal exercise capacity can be enhanced (Carrick-Ranson et al., 2014). However, our data suggest that even with CT, characterized by a very limited cardiovascular stimulus, the $\dot{V}o_2peak$ was positively increased. This equal response in the maximal aerobic capacity obtained by the employment of these different approaches suggests that different factors affected this result. Indeed, the positive effect of ET on $\dot{V}o_2peak$ was likely caused by both central and peripheral adaptation, such as a better heart hemodynamics (Rodrigues et al., 2012), an increased skeletal muscle capillarization (Hansen et al., 2010), a higher nitric oxide bioavailability (Blanco-Rivero et al., 2013), and an increased mitochondrial density (Pesta et al., 2011). On the contrary, the increased maximal exercise capacity demonstrated after CT was primarily induced by peripheral adaptations (Gibala et al., 2012; Hood et al., 2011), predominantly related to a preserved response of mitochondrial function to this short-intermittent training.

Non-pharmacological treatments and mechanical efficiency: The $\dot{V}o_2 max$ is certainly one of the best predictors of independence. However, the metabolic demands obtained during the everyday tasks, such as walking, stairs climbing, and housekeeping, are only a fragment of the maximal aerobic capacity measured during a maximal test (Astrand, 2003). On the contrary, mechanical efficiency at submaximal intensity is more representative of the work economy by which the activities of daily life can be executed, and, in turn, has a clear consequence on the independence and quality of life of this old population (Venturelli et al., 2012; Venturelli et al., 2012; Venturelli et al., 2013). In this scenario, it has been demonstrated that mechanical efficiency is significantly reduced in sedentary patients with pulmonary and heart dysfunctions (Perrault, 2006; Richardson et al., 2004; Riescher et al., 2004). Moreover, the recent literature reports that non-pharmacological interventions, based upon high intensity exercise, are effective for the enhancement of mechanical efficiency (Hoff et al., 2007; Karlsen et al., 2009). Interestingly, our data revealed that mechanical efficiency was significantly ameliorated only after ET (Figure 5). Conversely, mechanical efficiency after CT and RT treatments was unchanged, suggesting that in old hypertensive individuals the stimulation of both central and peripheral factors is required to obtained a significant gain in mechanical efficiency. This positive finding was likely the consequence of: (i) an increased heart economy, exhibited by a reduction in cardiac output and HR, with a concomitant increase in stroke volume during exercise at given submaximal work-rates; and (ii) a peripheral adaptation to a slower skeletal muscle fiber phenotype (Gibbs et al., 1972; Hunter et al., 2001).

CONCLUSION

The choice of non-pharmacological treatments for the reduction of CVDs risk factors has to take into account not only the direct effects on cardiovascular health, but also other accessory outcomes that can affect the independence and quality of life of old hypertensive individuals. Moreover, personal psychological and economical barriers need to be accounted for the efficacy of the treatment. Therefore, it appears that the employment of an active lifestyle characterized by the execution of ET is the best choice to reduce CVDs risk factors, because the amelioration of HYP is accompanied by decreases in blood glucose and cholesterol levels, increases in maximal exercise capacity, mechanical efficiency, and quality of life. Other workouts characterized by short intermittent dynamic exercises are equally effective in the reduction of HYP and improvement of $\dot{V}o_2peak$. However, CT appears less effective in the enhancement of mechanical efficiency. Alternative healthcare practices, based on breath control and meditation, are equally successful in the reduction of HYP. However, the latter approach is not an appropriate stimulus to reduce other CVDs risk factors and to enhance indicators of independence. Therefore, the choice of this non-pharmacological treatment has to be recommended in persons that are not predisposed to commence a dynamic exercise program, such as patients with mobility limitations.

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Table 1. Participants characteristics

Group	ET	CT	RT	CTRL
Age (yrs)	68±3	67±4	69±6	66±7
Gender (F/M)	5/5	5/5	5/5	5/5
Comorbidity (n.)				
Diabetes	1	2	1	1
Pharmacological treatments (n.)				
Trazodone	3	2	3	4
Thiazolidinedioe	2	3	2	2
Etofylline	1	1	1	1
Captopril	8	8	9	7
Clortalidone	9	7	7	5

ET = endurance training, CT = circuit training, RT = relaxing training, CTRL = controls, F = female, M = male.

Table 2

	ET		CT		RT		CTRL	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Stature (m)	1.72±0.05	1.72±0.05	1.75±0.06	1.75±0.06	1.73±0.05	1.73±0.05	1.73±0.06	1.73±0.06
BMI (kg/m^2)	27±4	27±5	27±3	27±4	26±5	26±4	27±6	27±6
Wcirc. (cm)	95±9	94±7	95±8	94±5	96±9	96±8	98±10	98±11
Hcirc. (cm)	100±9	100±8	102±8	101±9	99±8	99±9	103±11	104±12
Glucose (mg/dl)	108±11	100±6	112±7	86±4 *†	104±13	100±13	101±9	101±7
HDL (mg/dl)	57±9	66±9 *†	55±14	58±22	64±12	59±20	59±9	56±9
LDL (mg/dl)	140±33	126±13*†	143±30	130±28	153±35	151±33	141±39	138±35
Health related quality of life								
SF-36phys (0-100)	33±4	49±4 *	32±4	48±5 *	34±3	36±5	37 ± 11	37 ± 12
SF-36ment (0-100)	29±2	54±3 *	29±3	53±5 *	29±3	50±4 *	28 ± 8	28 ± 9

ET = endurance training, CT = circuit training, RT = relaxing training, CTRL = controls, BMI = body mass index, Wcirc. = waist circumference, Hcirc = hip circumference, HDL = high-density lipoprotein, LDL = low-density lipoprotein, SF-36phys = physical component of health related quality of life, SF-36ment = mental component of health related quality of life,

* = In-group *P*<0.05; † = between groups *P*<0.05

Figure 1 - *Experimental design:* After baseline evaluations (PRE), participants were assigned to four different groups. ET group, endurance exercise training on treadmill, elliptical, and stepper ergometers; CT group, short bouts of dynamic exercises on knee extension (KE), knee flexion (KF), calf rise (CR), and leg press (LP) ergometers; RT group, relaxing training program; CTRL group, no intervention

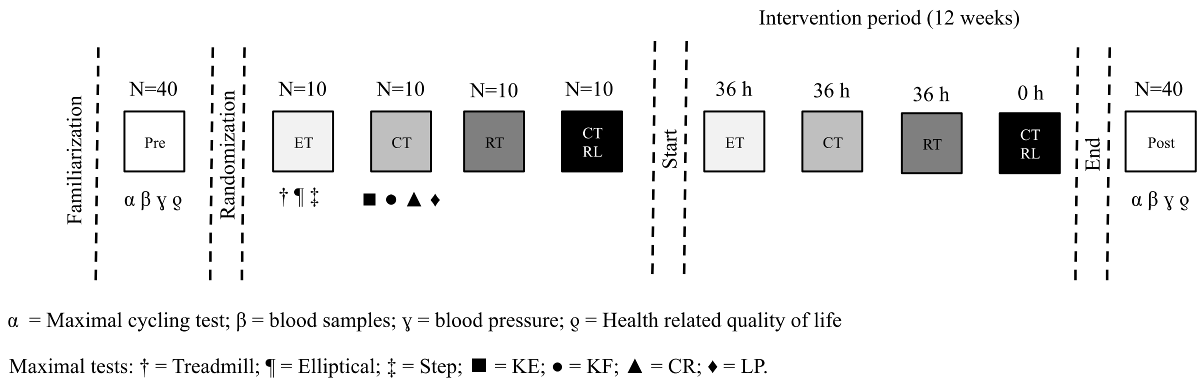

Figure 2 – *Heart rate response*: Average heart rate (HR) response, as a percentage of HR reserve (HRR, panel A), in the four groups during interventions at the beginning (1st week) and at the end (12th week) of treatments. Panel B represents the HR response during an intervention session in representative participants of the four groups. The light and dark grey areas represent the exercise time during ET and CT, respectively. * = in-group P<0.05; † = between groups P<0.05; ‡ P<0.05 *vs* RT and CTRL.

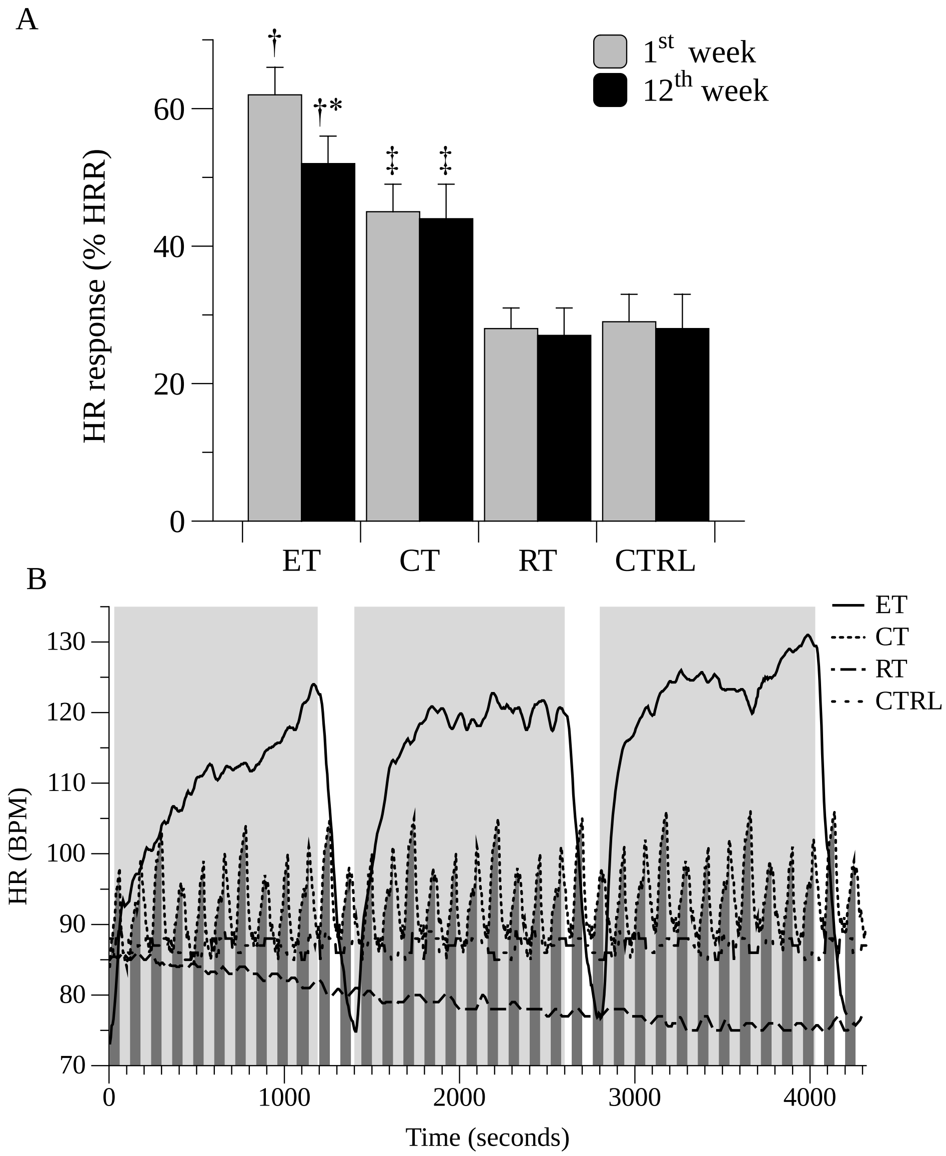

Figure 3 – *Cardiovascular variables at rest*: Average resting systolic (SBP) and diastolic (DBP) blood pressures and heart rate (HR) in the four groups before and after interventions. * = in-group P<0.05.

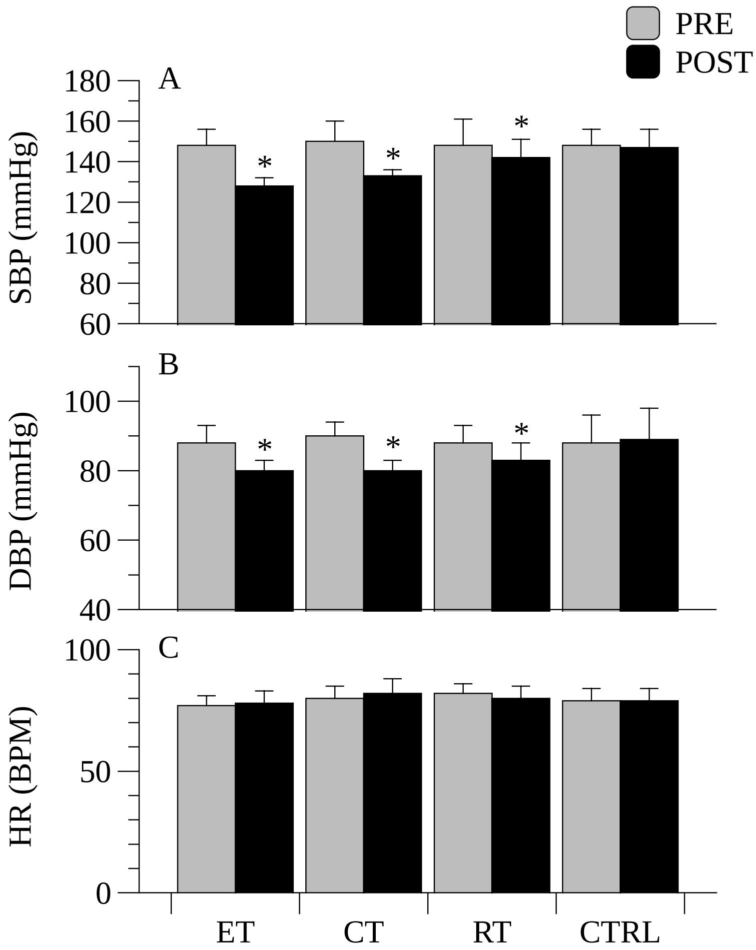

Figure 4 – *Cardiorespiratory response to exercise*: average heart rate (HR), expiratory ventilation ($\dot{V}_E$), CO_2 production ($\dot{V}co_2$), and oxygen uptake ($\dot{V}o_2$) during cycle incremental ramp exercise in the four groups, before and after interventions. * = in-group P<0.05; § = in-group P<0.05 at maximal exercise.

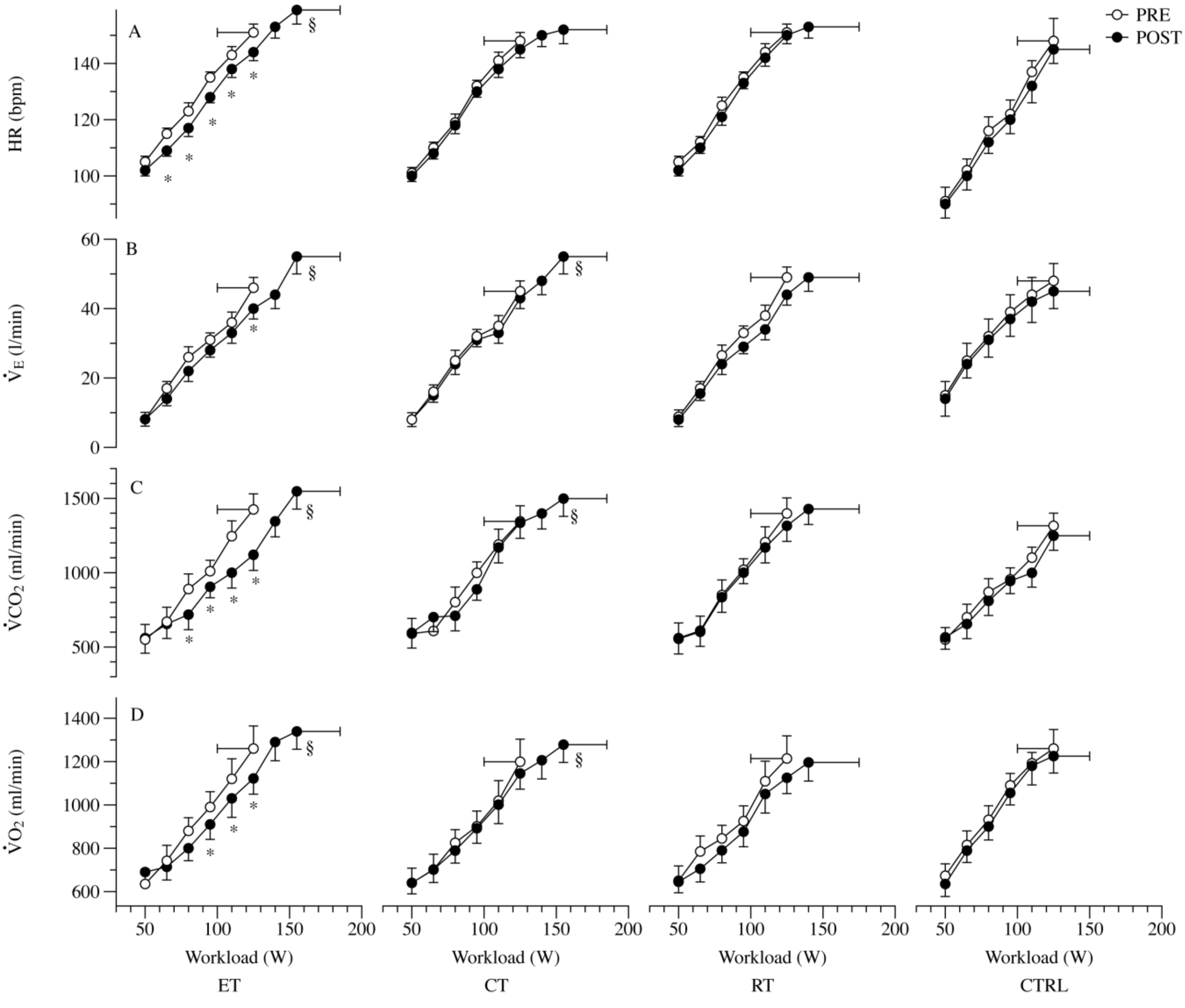

Figure 5 – *Exercise efficiency*: Δ efficiency (Δη), calculated on the first part of the cycle ramp exercise, in the four groups, before and after interventions. * = in-group P<0.05.