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# Moderate Aerobic Training Decreases Blood Pressure but No Other Cardiovascular Risk Factors in Hypertensive Overweight/Obese Elderly Patients

**Raphael Miranda Ramos, GD[1], Hélio José Coelho-Júnior, DSt[2], Raul Cosme Ramos do Prado, MSt[3], Rodrigo Silveira da Silva, MSt[3], Ricardo Yukio Asano, PhD[3,4], Jonato Prestes[5], Alexandre Igor Araripe Medeiros, PhD[6], Bruno Rodrigues[2], and Claudio de Oliveira Assumpção, PhD[6]**

## Abstract

Hypertension and obesity are prevalent diseases in elderly people, and their combination can cause deleterious effects on physiological system. Moderate intensity aerobic training (MIAT) seems to be a beneficial approach to control and treat these diseases separately. However, few studies have investigated the impact of MIAT on cardiovascular risk factors associated with these conditions (i.e., elevated blood pressure values, blood markers, and body composition). Therefore, the present study was designed to investigate the effects of MIAT on blood pressure, blood markers, and body composition in hypertensive overweight/obese elderly patients. Twenty-four hypertensive overweight/obese elderly patients were randomized into control group (CG) and training group (TG), submitted to 12 weeks of MIAT of 50 min, 3 days per week, at 60% of maximal HR (heart rate). There was a decrease in diastolic blood pressure (–10.1 ± 3.3; $p$ = .01; effect size = 1.29) and mean arterial pressure (MAP; –8.2 ± 3.7; $p$ = .04; effect size = 0.94) following 12 weeks of training in the TG as compared with baseline. There was an increase in triacylglycerol levels in the TG (+0.1 ± 0.0; $p$ = .02). There were no significant changes in body composition for both groups. The present study revealed that 12 weeks of MIAT can decrease blood pressure in hypertensive obese elderly patients, with no significant modifications in blood markers and body composition.

## Keywords

hypertension, obesity, aging, exercise, blood pressure

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## Introduction

Projections from United Nations (UN) estimate that 1.5 billion people worldwide will be elderly by 2050 (United Nations, 2012). The aging process and, mainly the old-aged, is accompanied by detrimental alterations to the physiological system, which can collaborate to the development of geriatric syndromes (e.g., sarcopenia, frailty) and chronic diseases (e.g., hypertension; Coelho Júnior, Aguiar, Gonçalves, Sampaio, & Asano, 2015; Sampaio et al., 2014; Sewo Sampaio et al., 2016).

One of the most prevalent diseases in elderly people is hypertension, affecting around 70% of this population (Go et al., 2013). This pathological state is characterized by a chronic increase in systolic blood pressure (SBP) and/or diastolic blood pressure (DBP; Chobanian et al., 2003). The association between hypertension and aging is a public health concern, as high blood pressure values are strongly related with adverse cardiovascular outcomes (e.g., myocardial infarction) and poor diagnosis (Go et al., 2013; World Health Organization [WHO], 2009). In fact, recent reports from WHO, point out

[1]Universidade Anhanguera Leme, Brasil
[2]Universidade Estadual de Campinas, Brasil
[3]Universidade de São Paulo, Brasil
[4]Universidade Ibirapuera, São Paulo, Brasil
[5]Universidade Católica de Brasília, Brasil
[6]Universidade Federal do Ceará, Fortaleza, Brasil

**Corresponding Author:**
Raul Cosme Ramos do Prado, Escola de Artes, Ciências e Humanidades (EACH) — Universidade de São Paulo, São Paulo, SP 08810-040, Brasil.
Email: raulprado@usp.br

hypertension as the main associated factor with deaths around the world (WHO, 2009).

Nevertheless, obesity is a disease characterized by excessive body fat accumulation, generally diagnosed by the body mass index (BMI; Formiguera & Cantón, 2004). The obese state can lead to increases in sodium retention, cardiac sympathetic and renin–angiotensin–aldosterone system activity; which, in turn, increases blood pressure values (Formiguera & Cantón, 2004; Landsberg et al., 2013). Thus, it is not a surprise that hypertension is to be the most common disease state observed in obese patients (Formiguera & Cantón, 2004).

Moreover, obesity with central body fat accumulation is generally accompanied by metabolic alterations (e.g., insulin resistance), which can lead to hyperglycemia, hyperinsulinemia, higher cholesterol levels, and atherosclerosis, which are closely associated with higher cardiovascular risk (Formiguera & Cantón, 2004; Landsberg et al., 2013). Subjects affected by both conditions (i.e., hypertension and obesity) exponentially increase the risk to develop cardiovascular (e.g., myocardial infarction) and metabolic (e.g., diabetes mellitus type II) diseases, as well as early death (Landsberg et al., 2013).

Considering these data, it is possible to infer that therapies, which act controlling or even decreasing blood pressure values and/or body fat accumulation, can lead to a better diagnosis in hypertensive obese older people.

Health care associations around the world recommend physical exercise as a tool to control and regulate cardiovascular risk factors (Chobanian et al., 2003; Pescatello et al., 2004). In fact, chronic physical exercise practice can collaborate to a positive modulation in SBP and DBP in normotensive and hypertensive patients (Cornelissen & Smart, 2013; Mota et al., 2013), and lead to decreases in body fat accumulation in obese people (Donnelly et al., 2009). Furthermore, results from meta-analytic regressions demonstrate a potential of physical exercise to decrease blood markers of cardiovascular risk (Kelley & Kelley, 2012a, 2012b; Kelley, Kelley, & Tran, 2005a, 2005b; Kelley, Kelley, Roberts, & Haskell, 2011). However, the impact of physical exercise *per se* on body composition and blood markers of cardiovascular risk is not totally clear.

Regarding exercise modality, moderate intensity aerobic training (MIAT) seems to be the most recommended, due its safety and effectiveness to cause decreases in cardiovascular risk factors (e.g., blood pressure values), especially in sedentary subjects with different diseases (Eckel et al., 2014; Pescatello et al., 2004). To note, a limited number of studies investigated the effects of MIAT on blood markers and body composition risk factors in hypertensive obese elderly subjects (Blumenthal et al., 2000; Duncan et al., 1985; Georgiades et al., 2000).

Thus, the aim of the present study was to evaluate the effect of a 12-weeks MIAT on blood pressure, body composition, and blood markers of cardiovascular risk (i.e., triglycerides, glycemia, and cholesterol) in hypertensive overweight/and obese elderly subjects. The initial hypothesis is that MIAT decreases blood pressure and improves metabolic profile in elderly obese subjects.

## Material and Methods

This was an experimental study with random sample distribution. Participation in the present study was voluntary and began after signing an informed consent. Ethics and research committee of the local university approved this research protocol. This study was developed in accordance with the Declaration of Helsinki, and according to the Resolution 196/96 of the National Health Council.

### *Subjects*

Twenty-four (20♀; 4♂) hypertensive overweight/obese elderly patients (60.6 ± 0.3 years; SBP = 141.0 ± 5.0 mmHg; DBP = 93.5 ± 3.4 mmHg; BMI = 31.4 ± 1.3 kg/m$^2$) were recruited to compose the sample of the present study. All participants had hypertension controlled by beta blockers.

Adopting methods are previously described (Coelho Júnior et al., 2015). Exclusion criteria were use of psychotropic drugs and/or hormone replacement, neurological or psychiatric disorders (e.g., Alzheimer's disease or Parkinson's disease), musculoskeletal disorders, cardiovascular diseases (e.g., transient ischemic disease, myocardial infarction acute myocardial infarction, peripheral artery disease, and stroke), metabolic diseases (e.g., diabetes mellitus type II), recent history of tobacco use or abuse of alcohol, and comorbidities associated with an increased risk of falls. To be eligible for the present study, patients should be hypertensive, BMI equal or higher than 28 kg/m$^2$ (WHO, 2000), and complete all measurements and exercise sessions. Previously to evaluations, volunteers were authorized by a physician to participate in the trial.

### *Procedures*

Following the initial evaluation of blood pressure, anthropometrics and blood sampling, subjects were blinded for treatment allocation and were randomized into two groups: training group (TG; $n$ = 10♀; 2♂) and control group (CG; $n$ = 10♀; 2♂). The CG remained their regular lifestyle habits during all study period, without engaging in regular physical exercise programs. All evaluations were performed 1 week before the beginning and 12 weeks after the end of the treatment protocol (i.e., training or control).

In the measurement days, subjects were asked to refrain from physical exercise in the previous 96 hr. In addition, they could not drink alcohol, caffeine, or any stimulating beverage 24 hr before testing. Although the diet of the subjects was not controlled, they were asked to maintain their usual dietary intake throughout the study period. Volunteers were asked to avoid participation in other physical exercise programs. All tests and experimental sessions occurred between 07:00 a.m. and 10:00 a.m.

## Evaluations

*Anthropometrics.* A weight scale with a stadiometer Filizola® (Brazil) was used to determine body mass (kg) and height (cm), respectively. BMI was determined by the following reviewed formula: body mass (kg)/(height [cm])² (Keys, Fidanza, Karvonen, Kimura, & Taylor, 1972). A body fat percentage was captured by skinfold tweezers (Sanny®) by a single avaluator and was averaged one out of three evaluations. The skinfolds were thoracic, average axillary, tricipital, subscapular, supra-iliac, abdominal, thigh and was determined by the Siri equation (Siri, 1993).

*Hemodynamic measurements.* All cardiovascular parameters were analyzed during rest. Procedures for the measurement of blood pressure were adapted from *VII Joint National Committee of High Blood Pressure* (JNC7; Chobanian et al., 2003). Before and after 12 weeks, elderly subjects remained sited in a comfortable chair during 15 min in an artificial light control and quiet room. After this period, a cuff with adequate size was placed approximately on the mid-point of the upper left arm (heart level). After the measurement of the circumference of the arm, the size of the cuff was selected (Sanny®, Sao Paulo, Brazil). Blood pressure was recorded by the auscultatory method utilizing a stethoscope and sphygmomanometer (Pressure®, Brazil). Phases I and V of the Korotoktof sounds were utilized to determine SBP and DBP, respectively. Heart rate (HR) was evaluated by a HR monitor (Oregon®, Brazil). An experienced evaluator performed all measurements. Mean arterial pressure (MAP), rate pressure product (RPP), and pulse pressure (PP) were evaluated according to the following equations: MAP = (SBP + [2 ×DBP])/3; RPP = SBP ×HR; PP = SBP – DBP (Coelho Júnior et al., 2015; Coelho Júnior et al., 2016; Moraes et al., 2012; Silverthorn, 2010).

*Blood sampling and biochemical analysis.* In the morning (between 7 a.m. and 9 a.m.)—based on established methods (Uchida et al., 2009) after a 12 hr overnight fast and 96 hr of the last physical exercise session—blood samples (10 mL) were drawn from the antecubital vein by venipuncture. The blood samples were separated into two vacutainer tubes (5mL; Becton Dickinson, Brazil) after collection, the first containing EDTA (ethylenediaminetetraacetic acid) to highlight the plasma and second to highlight the serum. The samples were centrifuged at 2,500 rpm for 15 min at −4°C, with plasma and serum aliquots, then deposited at −20°C until analysis. Total cholesterol, plasma glycemia, and triacylglyceride levels were evaluated by *enzymatic colorimetric method* (Labtest®).

*MIAT.* The TG was submitted to 36 MIAT sessions, which occurred 3 days per week, with a 48-hr minimal interval between sessions during 12 weeks. Exercise sessions were composed by two moments: (a) warm-up (10 min) and main part (50 min). Warm-up consisted of 5-min of technical exercises (e.g., dribbling, skipping) and 5-min of light jogging. The subjects were oriented and did the aerobic training together in an athletics track of 400 m. Main part was characterized by 50 min of a MIAT at 60% of maximal HR ($HR_{max}$). $HR_{max}$ was determined by the following formula: 205 – (0.42 × age; Sheffield, Holt, & Reeves, 1965). A OMINI Perceived Exertion Scale (Borg, 1998) was utilized to monitor and ensure the proposed intensity. The subjects were asked to always carry out the exercises from 4 to 6 points in the scale. These data were collected at 30 min and 60 min. For the tests the participants were oriented geared to travel at the highest possible speed. All exercise sessions occurred in athletics track of the sports laboratory.

## Statistical Analyses

The Shapiro–Wilk test was used to calculate data normality. Blood markers of cardiovascular risk (i.e., glycemia, total cholesterol and triglycerides) did not show Gaussian distribution and underwent normalization by log10. Comparisons between the groups (CG × TG) in the baseline moment and after the intervention protocol—regarding the body composition parameters, blood pressure and blood markers of cardiovascular risk—were performed by unpaired student's *t* test. Comparisons intragroup (pre × post) were performed by paired student's *t* test. The magnitude-based inference was interpreted through the method proposed by Hopkins, Marshall, Batterham, and Hanin (2009). Effect size (ES) was defined to be medium for values for Cohen's $d$ of more than 0.2 but less than 0.5, good for values between 0.5 and 0.8, and large for values $\geqslant 0.8$. Level of significance was 5% ($p < .05$) and all procedures were performed using Statistical Package for the Social Sciences (SPSS) Version 20.0 (New York, The United States). The power of the sample size was determined using G ×Power version 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009) for a power (β) of 0.80 and a 6.0 (ES).

# Results

Table 1 shows the anthropometric, hemodynamic, and biochemical measurements for both groups before the 12 weeks of the experimental program. The mean

**Table 1.** Anthropometrical, Hemodynamic, and Biochemical Parameters of the CG and TG and Intensity Control.

| | CG (10♀; 2♂) | TG (10♀; 2♂) | *p* |
|---|---|---|---|
| Age (years) | 60.7 ± 0.4 | 60.5 ± 0.2 | .78 |
| Body mass (kg) | 91.7 ± 10.1 | 81.8 ± 4.9 | .33 |
| Height(cm) | 1.65 ± 0.4 | 1.63 ± 0.8 | .63 |
| Body mass index (kg/m²) | 33.1 ± 2.8 | 30.5 ± 1.5 | .39 |
| Body fat (%) | 30.1 ± 2.1 | 28.6 ± 4.4 | .28 |
| SBP (mmHg) | 134.1 ± 5.5 | 147.8 ± 8.2 | .18 |
| DBP (mmHg) | 87.8 ± 4.5 | 99.2 ± 4.8 | .09 |
| MAP (mmHg) | 103.3 ± 4.4 | 115.4 ± 5.8 | .11 |
| HR (bpm) | 77.4 ± 3.2 | 69.7 ± 4.6 | .19 |
| RPP (mmHg.bpm) | 10,524 ± 823 | 10,342 ± 915 | .88 |
| PP (mmHg) | 46.2 ± 4.3 | 48.5 ± 4.0 | .69 |
| Glycemia (mg/dL) | 131.0 ± 32.4 | 109.4 ± 16.8 | .57 |
| Total cholesterol (mmol/L) | 7.8 ± 0.4 | 8.4 ± 0.3 | .35 |
| Triacylglyceride (mg/dL) | 97.3 ± 27.2 | 86.7 ± 15.0 | .71 |
| Rating of Perceived Exertion 30 min | 4.2 ± 0.7 | | |
| Rating of Perceived Exertion 60 min | 5.1 ± 0.8 | | |

*Note.* Data are presented as *M* ± *SD*. CG = control group; TG = training group; SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; HR = heart rate; RPP = rate pressure product; PP = pulse pressure.

intensity control over 12 weeks is also presented. Unpaired *t* test did not show significant differences between the groups before training.

Table 2 shows hemodynamic measurements before and after 12 weeks of the experimental program for both groups (delta values [Δ] and ES). There was a decrease in DBP (–10.1 ± 3.3; $p$ = .01; ES = 1.29) and MAP (–8.2 ± 3.7; $p$ = .04; ES = 0.94) for the TG in comparison with baseline, with no differences in SBP, HR, RPP, and PP. There was no significant alteration in the CG during the study.

Table 3 shows anthropometric measurements before and after 12 weeks of the experimental program in both groups (Δ and ES). There was no significant alteration in the TG and CG.

Table 4 presents biochemical measurements before and after 12 weeks of the experimental program in both groups (Δ and ES). There was no significant differences in glycemia and total cholesterol for the TG and CG. However, triacylglyceride levels increased (+0.1 ± 0.0; $p$ = .02) after 12 weeks in the TG as compared with baseline.

**Table 2.** Hemodynamic Parameters of the CG and TG.

| | CG | TG |
|---|---|---|
| SBP (mmHg) | | |
| Δ | 6.1 ± 3.5 | −4.4 ± 5.2 |
| *p* | .10 | .42 |
| ES | 0.36 (medium) | 0.31 (medium) |
| DBP (mmHg) | | |
| Δ | 1.3 ± 3.4 | −10.1 ± 3.3[a,b] |
| *p* | .70 | .01 |
| ES | 0.12 (trivial) | 1.28 (large) |
| MAP (mmHg) | | |
| Δ | 1.1 ± 2.9 | −8.2 ± 3.7[a,b] |
| *p* | .70 | .04 |
| ES | 0.23 (small) | 0.94 (large) |
| HR (bpm) | | |
| Δ | 8.2 ± 4.6 | −0.2 ± 3.4 |
| *p* | .10 | .94 |
| ES | 0.16 (trivial) | 0.45 (small) |
| RPP (mmHg.bpm) | | |
| Δ | 1,571 ± 890 | −355.4 ± 535.6 |
| *p* | .10 | .52 |
| ES | 0.00 (trivial) | 0.27 (small) |
| PP (mmHg) | | |
| Δ | 7.5 ± 3.7 | 5.7 ± 3.4 |
| *p* | .07 | .12 |
| ES | 0.24 (small) | 0.11 (trivial) |

*Note.* CG = control group; TG = training group; SBP = systolic blood pressure; ES = effect size; DBP = diastolic blood pressure; MAP = mean arterial pressure; HR = heart rate; RPP = rate pressure product; PP = pulse pressure.
[a]$p$ < .05 versus baseline.
[b]$p$ < .05 versus control.

## Discussion

The main finding of the present study was that 12 weeks of MIAT induced a decrease in DBP of hypertensive overweight/obese elderly subjects, with no additional effects on body composition and biochemical parameters, thus partially confirming the initial hypothesis.

Clinically randomized trials demonstrated strong evidences regarding the capacity of MIAT to decrease on blood pressure, even in the absence of anthropometrical changes (Blumenthal et al., 2000; Cooper, Moore, McKenna, & Riddoch, 2000; Duncan et al., 1985; Georgiades et al., 2000; Tsai et al., 2002). Results of the present study are in agreement with the experiments from Tsai et al. (2002) and Braz et al. (2012), which submitted hypertensive patients to 12 weeks of MIAT. DBP (5 mmHg-18 mmHg) and MAP

**Table 3.** Anthropometrical Parameters for CG and EG.

| | CG | EG |
|---|---|---|
| Weight (kg) | | |
| Δ | 0.0 ± 0.8 | 0.8 ± 0.6 |
| *p* | .94 | .22 |
| ES | 0.04 (trivial) | 0.00 (trivial) |
| BMI (kg/m$^2$) | | |
| Δ | 0.0 ± 0.3 | 0.3 ± 0.2 |
| *p* | .96 | .16 |
| ES | 0.27 (small) | 0.06 (trivial) |
| Body fat (%) | | |
| Δ | 0.07 ± 0.2 | 0.12 ± 0.7 |
| *p* | .89 | .91 |
| ES | 0.10 (trivial) | 0.49 (small) |

CG = control group; EG = exercise group; ES = effect size; BMI = body mass index.

**Table 4.** Biochemical Parameters for CG and EG.

| | CG | EG |
|---|---|---|
| Glycemia (mg/dL) | | |
| Δ | 5.0 ± 12.1 | 3.6 ± 7.2 |
| *p* | .61 | .83 |
| ES | 0.06 (trivial) | 0.24 (small) |
| Total cholesterol (mmol/L) | | |
| Δ | 1.8 ± 9.1 | 0.0 ± 0.0 |
| *p* | .53 | .56 |
| ES | 0.25 (small) | 0.46 (small) |
| Triacylglyceride (mg/dL) | | |
| Δ | 22.8 ± 19.0 | 0.1 ± 0.0[a] |
| *p* | .83 | .02 |
| ES | 0.47 (small) | 0.08 (trivial) |

*Note.* Parameters were log adjusted; CG = control group; EG = exercise group; ES= effect size.
[a]$p < .05$ versus baseline.

(5 mmHg) showed significant decrease in the exercise groups, however, body composition was not altered during the protocols.

Similarly, Blumenthal et al. (2000) and Georgiades et al. (2000) submitted hypertensive obese patients to two 26-week lifestyle intervention protocols. Both protocols composed of MIAT; however, a nutrition education program was aggregated in the second group. After the intervention protocols, significant decreases in body mass (–7.8 kg) were observed only in the exercise plus nutrition education program. Regarding blood pressure, both protocols were capable to decrease DBP. Thus, it seems clear that important biochemical and body composition changes will occur with combined exercise and nutrition interventions while exercise alone may limit more pronounced improvements in these variables. Data of the present study also corroborate with meta-analytic data, which demonstrated a decrease of blood pressure in hypertensive patients, even in the absence of body composition changes (Cornelissen & Smart, 2013).

Moreover, this effect seems not to be time-dependent, as Blumenthal et al. (2000), Duncan et al. (1985), and Georgiades et al. (2000) submitted patients to a longer intervention program (i.e., 26 weeks), but did not observe significant changes in body composition.

In fact, guidelines from the American College of Sports and Medicine (ACSM) recognize that MIAT seems not to be the best tool to lead to clinical weight loss in obese patients. Thus, additional tools, such as diet programs, combined exercise, and higher intensity training, are necessary to collaborate with higher magnitude of body composition changes (>3%; Donnelly et al., 2009).

The increase in triacylglyceride levels observed in the TG may be related with diet behavior, not controlled in the present study. Triacylglyceride is a molecule composed by glycerol and fatty acids (Kohli & Cannon, 2012; Welty, 2013). Increase in triacylglyceride blood levels are associated with an inflammatory state, oxidative stress, and arteriosclerosis, causing decrease in vascular repair capacity, and leading to the development of endothelial dysfunction and micro- and macrovascular injury; thus, collaborating with the genesis of the cardiovascular disease (Kohli & Cannon, 2012; Welty, 2013).

Meta-analytic regressions investigating the effect of physical exercise on triacylglyceride levels were published by Professor's George Kelly laboratory (2005, 2012a, 2012b, 2011, 2005). Results demonstrated that physical exercise is capable to decrease (~11%) in triacylglyceride levels in obese and non-obese adults. However, when the meta-analysis was performed with older adults (Kelley et al., 2005a, 2005b), physical exercise benefits on triacylglyceride levels were not evident. Moreover, two meta-analytic regressions (Kelley & Kelley, 2012a, 2012b) compared the effect of physical exercise, diet—most studies with caloric restriction and physical exercise plus diet on triacylglyceride levels. Results revealed that physical exercise plus diet and diet groups were more effective to decrease blood lipid profile than physical exercise alone. Furthermore, higher decrease in triacylglyceride levels was associated with longer interventions and initial baseline triacylglyceride levels (Kelley & Kelley, 2012a, 2012b).

Thus, the absence of hypertriacylglyceridemia and diet control, short intervention time, and elderly condition may have contributed to the increase of triacylglyceride levels in the present study.

Some evidence in the literature supports the hypothesis of a shift in cardiac autonomous control in elderly hypertensive patients after chronic aerobic training (Mostarda et al., 2009; Wichi, De Angelis, Jones, & Irigoyen, 2009). Stein, Ehsani, Domitrovich, Kleiger, and Rottman (1999), for example, submitted elderly patients to 1 year of aerobic training and found an improvement of cardiac autonomous control. Unfortunately, the data from the present study are limited and unable to identify the exact mechanisms related with blood pressure decrease. However, it is important to consider that some subjects have extreme difficulties in following dietetic modifications, due to cultural and lifestyle habits. Thus, a decrease in blood pressure in overweight/obese elderly subjects has important clinical relevance, especially considering the practical and costless characteristic of the exercise intervention.

Despite the beneficial results of the present study, there are some limitations to be considered. Prescription of exercise intensity was controlled by an indirect method, which can lead to limitations. Besides that, was not the same as checking the volume (time traveled) fact that was only aroused after an application of the training program. However, the $HR_{max}$ method is a useful tool for clinical practice, making the methodology of the present study ease to apply. Diet was not standardized, which could collaborate to a better understanding of the effect of MIAT on blood pressure, anthropometrics, and blood lipid profile. Nevertheless, future research should investigate possible mechanisms related with blood pressure decrease after chronic aerobic training.

Thus, the present study increases the number of evidence about the benefits of MIAT in decreasing blood pressure in hypertensive overweight/obese elderly subjects, even in the absence of blood lipid profile and body composition changes, in hypertensive. These results have clinical relevance, as high DBP and MAP values are associated with peripheral vascular resistance, aortic and brachial arterial stiffening, and hypertensive emergencies (Franklin, 2007).

## Conclusion

The results of present study show that 12 weeks of Moderate intensity aerobic training can cause significant decrease in DBP in hypertensive obese elderly patients, even after the increase in triacylglyceride and no changes in body composition.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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### ORCID iDs

Hélio José Coelho-Júnior https://orcid.org/0000-0001-7482-9514

Raul Cosme Ramos do Prado https://orcid.org/0000-0001-7895-6019

Rodrigo Silveira da Silva https://orcid.org/0000-0001-6330-1669

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