

Mat Pilates training reduced clinical and ambulatory blood pressure in hypertensive women using antihypertensive medications



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ARTICLE INFO

Article history:

Received 7 October 2014

Accepted 5 November 2014

Available online 6 November 2014

Keywords:

Pilates
Hypertension
Blood pressure
Exercise
Height
Body mass index

ABSTRACT

Background: Physical exercise has been used in the treatment of hypertension. However, there are few methods researched and shown beneficial for treatment of hypertension. The objective was to evaluate the effect of Mat Pilates training (MP) on blood pressure (BP) of hypertensive women medicated with antihypertensive drugs.

Methods: 44 hypertensive women (50.5 ± 6.3 years age), treated with medication for blood pressure and, uninvolved in structured exercise program were distributed into two groups: Training Group (TG) and Control Group (CG). TG performed 60-minute sessions of MP, twice a week for 16 weeks. CG was requested to maintain daily activities without exercise training. The following variables were evaluated during the pre- and post-experimental periods: clinical and ambulatory BP, heart rate (HR) and double product (DP), besides body mass, height, body mass index, waist and hip circumferences, flexibility, and right and left hand strengths.

Results: TG showed statistically significant improvements ($p < 0.05$) within and between-groups for the systolic, diastolic and mean BP in all moments evaluated (clinical, 24 h, awake and asleep). Besides that, TG showed improvements in height, waist and hip circumferences, flexibility, right and left hand strengths and clinical DP. The other variables in TG, as well as all variables in the CG didn't show significant changes.

Conclusion: In hypertensive women using antihypertensive medications, MP reduces clinical and ambulatory BP. These results support the recommendation of MP as a non-drug treatment for hypertension.

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1. Introduction

The systemic arterial hypertension (SAH) is considered one of the risk factors for developing cardiovascular disease (CVD), mainly cerebrovascular, coronary heart disease and ischemic heart disease [1,2]. The rate of CVD mortality is quite high around the world [3], and hypertension is one of the main causes of CVD [4]. Therefore, it is necessary that SAH is treated, and among non-drug treatments for hypertension is exercise training.

Suitable promotion of exercise training has important clinical implications since regular exercise can lead to progressive reduction of antihypertensive medications, as well as their side effects and the cost to the patient and health care institutions [5].

Several studies have demonstrated that both aerobic and resistance exercises benefit hypertensive subjects, and the reduction in BP is one of the most important changes [6–15]. There are several types of

resistance exercises, and Mat Pilates (MP) is among them. However, to our knowledge, at the present moment there are no studies in the literature that have evaluated the effect of MP on blood pressure in hypertensive individuals.

The demand to this modality for the population and disclosure by the media (magazines, television, newspapers, news, among others) have been growing in recent years, mainly by physiological, emotional and social benefits that this method can provide [16]. Although Joseph Pilates and Miller [17] claim that the exercises of MP are able to provide improvements to the cardiovascular system, there is no consensus in scientific literature about such benefits.

Therefore, the objective of this study was to evaluate the effect of MP on BP in hypertensive women controlled by medications.

2. Methods

2.1. Subject

We evaluated 44 women, mean age 50.5 ± 6.3 years, classified as hypertensive by their respective doctors. All subjects were treated for high blood pressure with blood pressure lowering medication and were not engaged in exercise training.

The volunteers were recruited through newspaper and internet advertisement. All women who fulfilled the inclusion criteria were invited to participate in the study. The

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¹ This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

inclusion criteria for the study were hypertension, age between 30 and 59 years old, use of antihypertensive medication of any class, not physically active for at least 6 months, medical permission for exercise training. The exclusion criteria were presence of musculoskeletal disease, other diseases that could compromise the cardiovascular response to exercise, drug treatment changes during the trial period and frequencies at exercise sessions below 75%.

2.2. Study design

The volunteers were distributed for convenience into two groups: Trained Group (TG = 22), where the volunteers performed MP training and Control Group (CG = 22), where the volunteers remained without exercise training during the experimental protocol. The BP was assessed by clinical and ambulatory forms before and after the experimental period in the same way in both groups. The volunteers were instructed to maintain the same antihypertensive treatment throughout the period. All subjects included in the study gave written consent to participate in this study, which was approved by the Ethics Committee of the Federal University of São Paulo, SP, Brazil, (#60717). The MP training was registered on Clinical Trials (www.clinicaltrials.gov) under protocol number NCT02118350.

2.3. Measures

Height (m) was measured using an anthropometer (Professional Sanny®) and body weight (kg) was measured using a calibrated precision scale (Welmy® W200/5 model). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Waist and hip circumferences were measured using an anthropometric tape at the last floating rib and the top of the iliac crest and at largest circumference over the buttocks, respectively.

Flexibility was measured by bank of Wells test (Banco de Wells Instant Flex Sanny®). Handgrip strength, expressed in kilograms was measured by a hand-held dynamometer (JAMAR®, Nottinghamshire, UK). Volunteers had to perform a maximum voluntary isometric contraction of finger flexor muscles in both hands. The protocol used to measure this variable was the Adams [18].

Measurements of BP were made according to technical recommendations of the VI Brazilian Guidelines on Hypertension [4]. The resting auscultatory BP was measured on the dominant arm, three times after 10 min of seated rest, taken at intervals of 1-min. BP was measured through the semi-automatic pressure Microlife System (Model BP-A 3BTO), validated by the British Hypertension Society and the American Association of Medical Instrumentation and resting HR was measured using a heart rate monitor (Polar® FT1 training computer, Kempele Finlan).

Ambulatory BP was measured every 15 min during awake period and every 30 min during asleep period, for 24 h by an oscillometric device (Dyna-MAPA® ABP Monitor, Cardio Sistemas, São Paulo, Brazil).

The Dyna-MAPA ABP Monitor was placed on the non-dominant arm of volunteer, after completion of BP measurement in the clinical examination.

The volunteers were instructed to perform daily activities normally and avoid drinking alcohol while they were wearing the device. In addition, they filled out a report of all activities conducted during the 24 h, trying to keep the daily routine during all days of the experiment. The ambulatory BP data was analyzed for the following periods: 24 h (mean of all measurements taken during the 24 h), awake (mean of all measurements taken while the subjects reported to be awake) and asleep (mean of all measurements taken while the subject reported to be sleeping).

These procedures before and after the experimental period were performed in both groups (Trained and Control). Pre evaluations were conducted before the experimental period and post assessments were performed 48 h after the end of the experimental period, therefore, in the days when the subjects didn't perform exercise session with the objective to evaluate the chronic effect of MP.

Double product (DP) variable was estimated by multiplying systolic BP by HR.

2.4. Mat Pilates training

Voluntary TG participated in MP training for 16 weeks, twice a week. The MP sessions consisted of 60 min, divided into 10 min of warming up and stretching, 40 min of MP exercise and 10 min of stretching and cooling down. Each session consisted of about 12 exercises and was performed to sounds of calm and relaxing music.

The exercises that were applied are the most basic exercises contained in the books of Joseph Pilates [17], Siler [19] and handout Merrithew [20]. They were performed according to the 7 principles of the MP: concentration, control, centering, fluid movement, precision, axial alignment and breathing. Only one set of each exercise was performed and repetitions ranging from 5 to 10, that is, as few repetitions as recommended [17].

The breathing, which is a principle of the MP, was performed in a forced manner, where individuals tapered ribs to exhale, while at the same time contracting and pulling in the abdomen. This breath was taken for a prolonged period and the inspiration was normally performed without force.

The intensity was monitored using the original Borg scale of perceived exertion [21]. For weeks 1 to 8 perceived exertion was to range from 11 to 13 and for weeks 9 to 16 the range was 13–15. The intensity increase was done by increasing the number of repetitions and the degrees of difficulty and complexity of the exercise.

The volunteers, who had systolic BP above 160 mm Hg and/or diastolic BP above 105 mm Hg before the session, were exempted from the session and had to make up for the lost class at some other time [1].

The CG was advised to maintain daily activities without exercise training during the 16-week period, and after the protocol they were invited to participate in the exercise training program.

2.5. Statistical analysis

The data were normally distributed after their examination by the Shapiro–Wilk's test.

To study the behavior of the volunteers for the variables of interest over time, by checking the possible effect of MP training on such characteristics, we employed the model of analysis of variance, two-way repeated measures ANOVA and ANCOVA analyses of covariance, using the GLM – General Linear Models, using post-hoc Newman–Keuls in the two analyses. In the comparison between the groups was the covariate premoment.

For all analyses were adopted as significance $p < 0.05$, effect size (η^2) ≥ 0.30 and the power observed (ω) ≥ 0.80 .

The statistical software used was STATISTICA Version 12.

Data are shown as mean $\pm$ standard deviation in the tables and as mean $\pm$ standard error in the graphs.

3. Results

Initially, 70 volunteers met the inclusion criteria and were included in the experimental protocol. During the 1st month, 21 gave up and in the 4th month, 5 were excluded, because less than 75% was obtained in training frequency. Therefore, data from 44 participants, 22 from each group were analyzed (Fig. 1).

The two groups had similar pre-experimental period variables, such as age, body mass index, BP, HR and DP at rest (Table 1). Furthermore, the use of drugs and the number of women who were already in

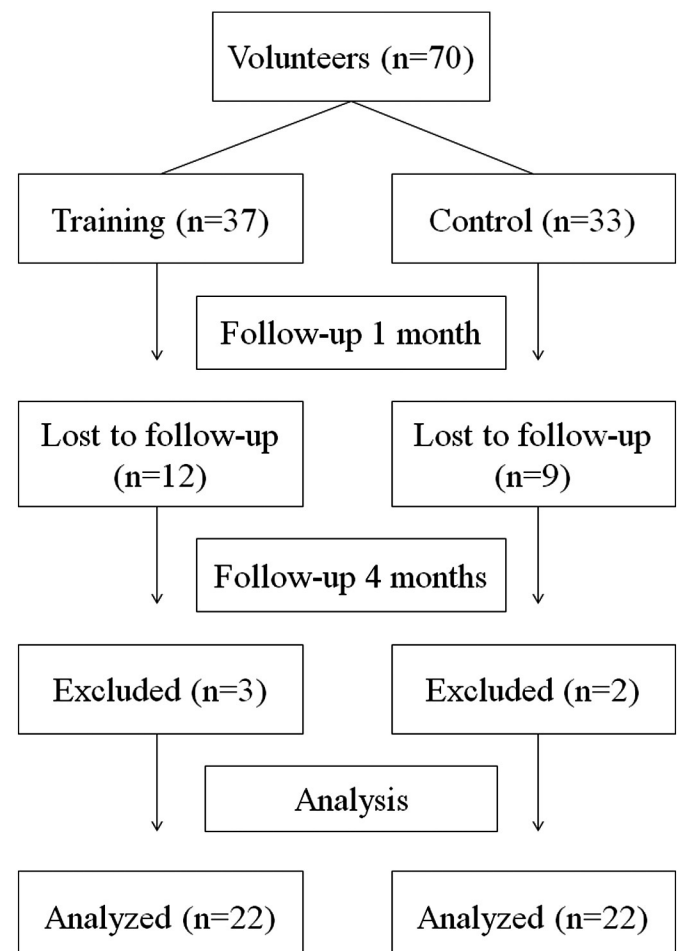


Fig. 1. Study design.

Table 1

Baseline characteristics of the women hypertensive patients of Control Group (CG) and Training Group (TG).

	CG (n = 22)	TG (n = 22)
Age (years)	49.0 SD 7.5	51.8 SD 4.3
BMI (kg/m ²)	30.2 SD 6.3	30.0 SD 4.7
SBP rest (mm Hg)	122.6 SD 11.5	124.0 SD 12.3
DBP rest (mm Hg)	78.4 SD 13.7	78.0 SD 9.6
MBP rest (mm Hg)	93.1 SD 11.2	93.3 SD 10.1
HR rest (bpm)	75.8 SD 10.4	76.3 SD 8.7
DP rest (mm Hg × bpm)	9323.1 SD 1742.3	9458.0 SD 1413.1
Menopausal — yes/no	11/11	10/12
N° de antihypertensive drugs	1 (1–2)	1 (1–2)
Diuretics	28%	23%
Calcium channel blocker	5%	9%
Beta-blocker	9%	18%
Antagonists of angiotensin II receptor (AT1 type)	41%	82%
ACE inhibitor	28%	9%

BMI: body mass index; SBP rest: systolic blood pressure at rest; DBP rest: diastolic blood pressure at rest; MBP rest: mean blood pressure at rest; HR rest: heart rate at rest; DP rest: double product at rest; ACE: angiotensin-converting enzyme.

menopause were similar between groups. It is important to emphasize that, none of the volunteers was on hormone replacement therapy.

TG showed significant improvements in the variables: height, waist and hip circumferences when comparing pre- and post-experimental periods. Significant changes were also found in these same variables when comparing both groups at the post-experimental period (Table 2).

Table 3 shows the results of physical tests of the two groups. TG presented a significant improvement in flexibility, right hand strength, left hand strength when compared pre- and post-experimental period as well as when comparing both groups at post-experimental period.

TG showed significant reductions in DP, systolic, diastolic and mean BP at rest when compared with pre-experimental period and with post-experimental data of CG. Regarding HR at rest, TG presented no significant alterations but CG presented a significant increase when compared with pre- and post-experimental periods and when compared with the post-experimental period of both groups (Fig. 2).

Regarding ambulatory data, TG presented significant reductions in systolic, diastolic and mean BP during 24 h, awake and asleep periods (Tables 4–6) when compared with pre-experimental period and with CG. However, HR and DP during the 24 h, awake and asleep times presented no significant changes in any of the groups analyzed (Tables 4–6).

4. Discussion

The most important finding of our study is that MP training provides a significant decrease in clinical systolic, diastolic and mean BP at rest, as well as in 24 h, awake and asleep periods in hypertensive women. Besides that MP decreases waist and hip circumferences and increase height, flexibility and strength in these subjects.

Many studies have observed a decrease on blood pressure after a period of resistance exercise training [31–35]. In the present study, to our

Table 3

Physical data of Control Group (CG) and Training Group (TG) pre- and post-experimental periods.

	CG		TG	
	Pre-	Post-	Pre-	Post-
Flexibility (cm)	22.5 SD 9.2	22.4 SD 9.4	25.7 SD 8.4	30.0 SD 7.4*†
Right hand strength (kg)	27.6 SD 6.0	27.2 SD 5.8	27.3 SD 5.6	30.4 SD 4.6*†
Left hand strength (kg)	25.9 SD 5.8	25.3 SD 5.6	26.0 SD 6.2	29.8 SD 5.3*†

* Within-group differences ($p < 0.05$).

† Between-group differences ($p < 0.05$).

knowledge, we observed for the first time a significant decrease on BP and DP at rest in hypertensive women who participated in MP training.

Guimarães et al. [31] observed a significant decrease in diastolic BP at rest in patients with heart failure after 16 weeks of MP training. The reduction found by them was 6 mm Hg, exactly the same value found in the present study. However, they found no reductions in systolic BP at rest. At this time, this was the only study in the literature that evaluated the effect of MP training on BP of the individuals with a cardiovascular disease.

Regarding ambulatory data, significant decreases in systolic, diastolic and mean on 24 h, awake and asleep periods were found in the present study. There are in the literature, some studies that have evaluated these variables after a period of resistance training conducted with weights, but these studies did not observe BP alterations in 24 h BP or awake periods [36,37].

Recently, Guimarães et al. [38] also evaluated hypertensive patients who have undergone a period of resistance training. However, they used water as resistance. Just as the present study, this other one didn't use the traditional weight exercises.

The protocol training of the study by Guimarães et al. [38] relied on training in warm water (heated water-based exercise training) for 12 weeks in subjects with resistant hypertension. The sessions were held 3 times a week, 60 min per day and consisted of 5 min of warm up, 20 min of calisthenic exercise against the resistance of water (upper and lower limbs), 30 min of walk into the swimming pool and 5 min of cooling down and stretching. The water temperature varied between 30 and 32 °C. The authors observed a significant reduction in systolic and diastolic BP at rest (36 mm Hg and 12 mm Hg, respectively), 24 h (19 mm Hg and 11 mm Hg), awake (22 mm Hg and 13 mm Hg) and asleep (17 mm Hg and 8 mm Hg). The decreases of these variables were much higher in Guimarães study when compared to decreases found in the present study (at rest: 10 mm Hg and 6 mm Hg, systolic and diastolic BP, respectively; 24 h: 6 mm Hg and 4 mm Hg; awake: 8 mm Hg and 6 mm Hg and asleep: 4 mm Hg and 6 mm Hg). The hypothesis is that some variables have contributed to this sharp decrease as the combination of two types of aerobic and resistance exercise (hypotensive effects may have a different result), the exercise performed in water (effect of hydrostatic pressure) and temperature water (effect of heat on BP). The intensity doesn't appear to have contributed to this difference in results, since it was similar to the present study.

The mechanisms by which MP training decreases BP in hypertensive women is beyond the scope of the present study, but it is undoubtedly

Table 2

Anthropometric data of Control Group (CG) and Training Group (TG) pre- and post-experimental periods.

	CG		TG	
	Pre-	Post-	Pre-	Post-
Body mass (kg)	79.1 SD 17.3	79.9 SD 17.2	79.0 SD 14.8	78.7 SD 15.0
Height (cm)	161.9 SD 7.4	161.9 SD 7.5	161.9 SD 6.0	162.7 SD 6.0*†
BMI (kg/m ²)	30.2 SD 6.3	30.5 SD 6.3	30.0 SD 4.7	29.6 SD 4.8
Waist circumference (cm)	93.5 SD 16.0	95.0 SD 14.4	93.2 SD 13.5	89.9 SD 13.2*†
Hip circumference (cm)	109.0 SD 14.1	110.7 SD 12.7	110.8 SD 11.0	107.9 SD 10.1*†

* Within-group differences ($p < 0.05$).

† Between-group differences ($p < 0.05$).

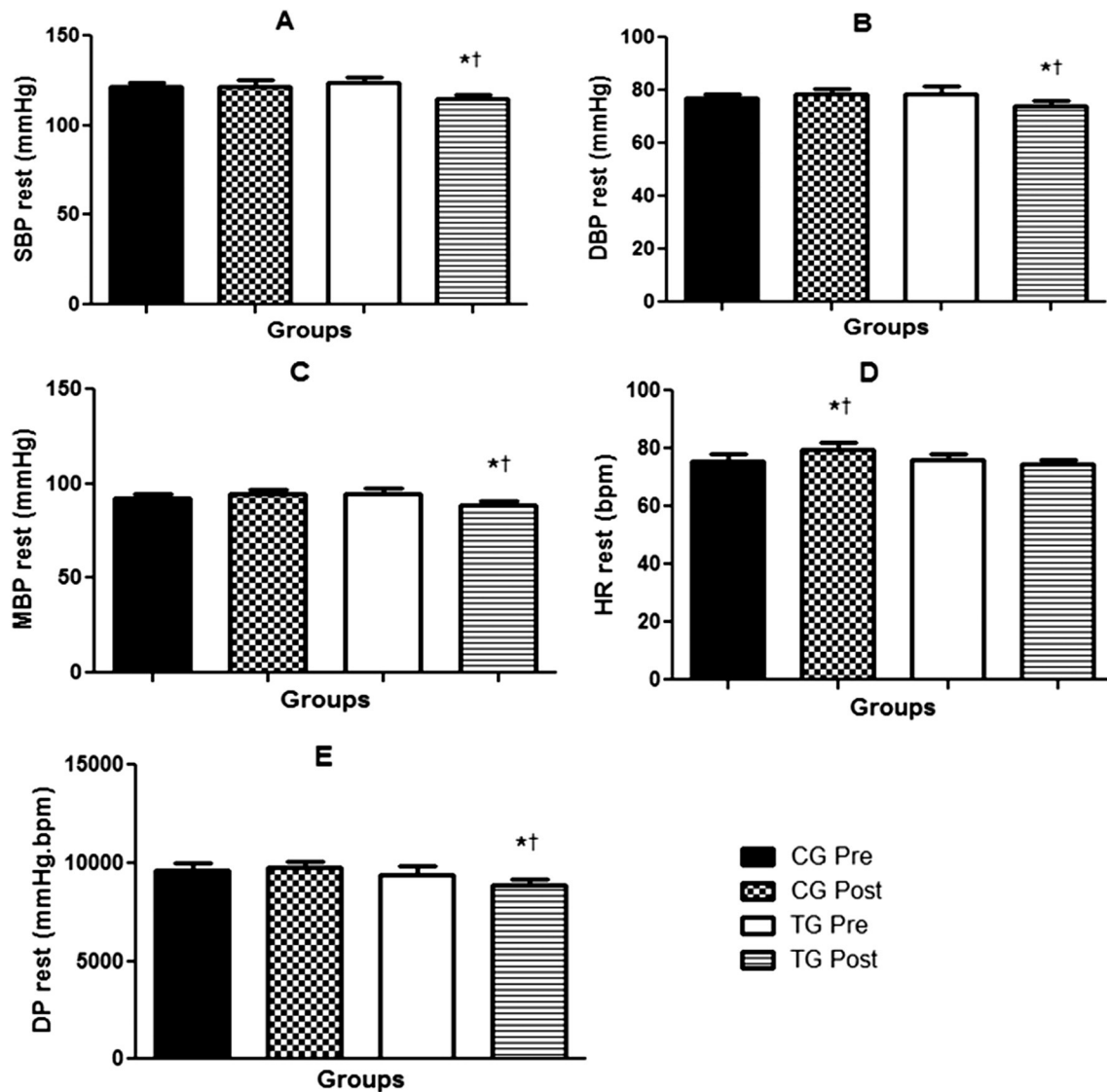


Fig. 2. Data of Control Group (CG) and Training Group (TG) at rest, pre- and post-experimental periods. A, Systolic blood pressure at rest (SBP rest); B, Diastolic blood pressure at rest (DBP rest); C, Mean blood pressure at rest (MBP rest); D, Heart rate at rest (HR rest); and E, Double product at rest (DP rest). *: within-group differences ($p < 0.05$) and †: between-group differences ($p < 0.05$).

an interesting topic for future investigations. Despite hemodynamic mechanisms responsible for the hypotensive response after resistance training are still not well understood in the literature, it is speculated that some hypotheses could explain this response such as decrease of systemic vascular resistance (SVR), cardiac output (CO) and muscle sympathetic nerve activity (MSNA).

One possible hypothesis for the results obtained in the present study, is that the BP decrease occurred following the reduction in SVR and/or CO. Studies evaluating the mechanisms after a single resistance

exercise session with normotensive individuals, observed that the reduction in CO was the mechanism responsible for post exercise hypotension [39–41], and that the decrease of this variable was not offset by an increase in SVR. On the other hand, another study showed that normotensive women subjected to a single bout of resistance exercise presented hypotension associated with decrease in SVR and not the CO [31]. Therefore, gender can influence the hemodynamic determinant.

Although the present study has evaluated the effect of different resistance trainings of the previously mentioned studies, it is speculated

Table 4

Data of hemodynamic variables during 24-hour period of Control Group (CG) and Training Group (TG) pre- and post-experimental periods.

		CG		TG	
		Pre-	Post-	Pre-	Post-
24-hour	SBP (mm Hg)	122.2 SD 11.4	125.1 SD 13.4	125.6 SD 18.3	118.5 SD 10.3*†
	DBP (mm Hg)	76.5 SD 8.4	77.8 SD 10.0	78.2 SD 14.2	74.9 SD 9.4*†
	MBP (mm Hg)	91.8 SD 8.9	93.6 SD 10.7	94.0 SD 15.3	89.4 SD 9.4*†
	HR (bpm)	78.9 SD 10.6	78.0 SD 10.1	73.5 SD 8.6	75.7 SD 9.1
	DP (bpm × mm Hg)	9646.8 SD 1592.6	9775.6 SD 1643.0	9263.3 SD 1939.4	8983.6 SD 1376.4

* Within-group differences ($p < 0.05$).

† Between-group differences ($p < 0.05$).

Table 5

Data of hemodynamic variables during awake of Control Group (CG) and Training Group (TG) pre and post-experimental period.

		CG		TG	
		Pre-	Post-	Pre-	Post-
AWAKE	SBP (mm Hg)	124.8 SD 12.0	128.2 SD 13.9	129.1 SD 18.8	121.5 SD 10.9*†
	DBP (mm Hg)	78.8 SD 8.9	80.8 SD 10.2	81.2 SD 14.9	77.9 SD 9.7*†
	MBP (mm Hg)	94.1 SD 9.4	96.6 SD 11.0	97.2 SD 15.9	92.4 SD 9.7*†
	HR (bpm)	81.7 SD 11.6	81.0 SD 10.8	76.7 SD 9.6	79.1 SD 9.8
	DP (bpm × mm Hg)	9938.1 SD 2131.3	9619.9 SD 1489.9	9938.1 SD 2131.3	9619.9 SD 1489.9

* Within-group differences ($p < 0.05$).† Between-group differences ($p < 0.05$).

that the BP decrease provided for a period of resistance training may be the result of the summation offered by acute exercise responses. Thus, the mechanisms responsible for BP decrease after a single session of exercise could be responsible for the same BP decrease after a training period. In this way, the present study might have a decrease in CO due to reduced stroke volume (SV) since no decrease in HR was observed. Furthermore, because the study population was female, it doesn't rule out the hypothesis that a decrease in SVR might be primarily responsible for the reduction in BP.

Another hypothesis is that the attenuation of MSNA could be responsible for the decrease in BP, since studies have observed this relationship with hypertensive patients who have undergone a period of isometric handgrip training [42,43]. As the MP contains many isometric exercises, this hypothesis seems to be viable. However, more studies are needed to evaluate the effect of MP training on MSNA, as well as to evaluate other possible mechanisms responsible for these alterations observed.

It is supposed that some characteristic factors of the MP may also have contributed to the reductions observed in this study, such as the work of breathing together with the exercises and exercises with music. In fact, studies show that regular and isolated practices of breathing exercises can decrease BP in hypertensive patients [44–46] and normotensive individuals [47]. There are also studies in the literature that found that individuals who listened to classical music and relaxing for a few months showed decreases in BP [46,48,49].

Considering that MP training was able to provide a decrease in BP in hypertensive women and a 5 mm Hg decrease in BP levels can decrease the risk of stroke by 40% and the risk of acute myocardial infarction by 15% in hypertensive [50], the results found in this study appear to be quite relevant. It is worth noting that there is still a need for confirmation of the information in hypertensive men.

Regarding the DP, although in the present study was only observed decrease at rest (clinical form), which was also found in the study of Terra et al. [34], this response is significantly important since the decrease of DP decrease the risk of cardiovascular disease [51].

Another interesting finding in this study was the significant increase in height, a fact that is not reported in other studies. The MP promotes muscle balance that is the equilibrium of strength and flexibility, the two centering principles of MP. Both principles are essential in the execution of the exercises [22]. Thus, one hypothesis for the increase in height is the improvement in posture, which has probably occurred due to the increased flexibility and strength of the trunk region provided by the MP. In fact, in this study a significant increase in the flexibility

of the posterior region of the trunk and legs was observed. These data corroborate the results found in the study by Sekendiz et al. [23] and Segal et al. [24] that also observed significant improvement on the same muscle groups in healthy individuals who have gone through a training period of the MP.

Although the strength of the trunk has not been evaluated in this study, previous studies have observed increased functional strength in upper, lower and especially the posterior region of the spine and abdomen in individuals who practiced MP [23,25,26]. In the present study we evaluated only the handgrip, which was increased in both hands after the training period. The handgrip is not only a measure of the strength of the upper limb hand. The handgrip strength has many clinical applications, for example, it is an indicator of total body strength, and has a proportional relationship with the muscle strength of the overall structure of the individual. In addition, a longitudinal study of elderly observed an association between handgrip strength and mortality risk [27], so the measurement of this variable is quite relevant.

In relation to BMI and body weight there were no significant differences found in this study. However, significant reductions occurred in the waist and hip circumferences, indicating a possible reduction in body fat percentage. This is an important finding, given that obesity is a risk factor for cardiovascular disease and central/abdominal obesity is associated with important metabolic abnormalities such as dyslipidemia, glucose intolerance or diabetes, hypertension, being a cardiovascular risk factor [28–30].

5. Study limitation

The distribution of the volunteers was done for convenience, so that hypertensive women, who showed the medical permit formed the TG and those who would take time to get the document with the cardiologist, formed the CG. Although this distribution has been that way and not randomly, as would be ideal, it is believed that it does not have influenced the results, since the volunteers of both groups wanted to train and trained, early on, or after making part of the CG.

The present study assessed only middle-aged women, so we cannot say that the same responses happen to men or women of other age groups. However, studies that evaluated men and women and compared the results found that there was no difference in BP between the sexes in the pre- and post-results of a trial period and a workout session.

Table 6

Data of hemodynamic variables during sleep period of Control Group (CG) and Training Group (TG) pre and post-experimental period.

		CG		TG	
		Pre-	Post-	Pre-	Post-
ASLEEP	SBP (mm Hg)	114.6 SD 17.8	116.2 SD 14.3	117.1 SD 17.8	111.3 SD 10.5*†
	DBP (mm Hg)	70.8 SD 8.1	69.8 SD 10.3	71.1 SD 13.2	67.5 SD 9.8*†
	MBP (mm Hg)	85.4 SD 8.6	85.3 SD 11.2	86.4 SD 14.4	82.1 SD 9.7*†
	HR (bpm)	71.0 SD 10.7	70.6 SD 9.9	66.3 SD 9.4	67.7 SD 8.5
	DP (bpm × mm Hg)	8732.9 SD 1427.2	8226.9 SD 1640.1	7779.0 SD 1720.4	7552.9 SD 1292.0

* Within-group differences ($p < 0.05$).† Between-group differences ($p < 0.05$).

6. Conclusion

According to the results obtained in the present study, in hypertensive women receiving antihypertensive medication, Mat Pilates training decreases DP at rest and systolic, diastolic and mean BP at rest, 24 h, awake and asleep. Besides that, Mat Pilates training promotes improvements in height, waist and hip circumferences, flexibility, and right and left hand strengths.

7. Clinical implications

There are many modalities of exercise offered in gyms, clinics, clubs, and among others, to the general population, however, few are evaluated and demonstrate benefits to the hypertensive population.

The results of this study demonstrate a significant decrease in BP in hypertensive women, consequently decreasing the risk of cardiovascular events.

In this way, the results of this study support the recommendation of Mat Pilates training on a regular basis as a non-drug treatment for the prevention, treatment and control of hypertension, provided that the same will be applied in accordance with the criteria and appropriate care and by a trained and qualified professional for this modality and population.

Acknowledgments

This work was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo — FAPESP (2012/17735-0). We thank Nina Zisko for providing language help.

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