



Tai-chi-chuan and yoga onpostexercise hypotension: comparison to aerobic and resistance exercise

*Hipotensão pós-exercício em Tai-chi-chuan e Yoga:
Comparação com exercício aeróbio e resistido*

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Abstract

Introduction: Tai-Chi-Chuan and Yoga have becoming popular practices. However is unclear the cardiovascular effects, and if they present similar behavior to aerobic and resistance sessions. **Objective:** To evaluate the cardiovascular responses during the session and post-exercise hypotension (PEH) of Tai Chi Chuan (TS) and Yoga (YS) in comparison to aerobic (AS) and resistance (SR) exercises. **Methods:** Fourteen young women (22.3 ± 2 years) apparently healthy performed four sessions (AS, RS, TS and YS). The heart rate (HR), systolic (SBP) and diastolic blood pressure (DBP) were recorded at resting, during (every 10 minutes) and until 50 minutes of recovery. **Results:** AS, RS, TS e YS showed significant increase in HR compared to resting.

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AS at 10, 30 e 50 minutes in relation to RS, TS e YS. The RS in relation to TS and YS at 10, 30 and 50 minutes. No significant difference between TS and YS. SBP was significantly increased in AS, RS, TS e YS at 10, 30 e 50 minutes during the session, in relation to rest. AS was significantly higher at 30 e 50 minutes than RS and higher than TS and YS at 10, 30 e 50 minutes. No significant difference in DBP. For PEH, AS, RS and TS significantly reduced at 10, 30 and 50 minutes. YS reduced at 50 minutes. No significant diastolic PEH. **Conclusion:** TS and YS showed as safe alternatives of exercising in the normotensive young adult woman, despite having lower values, they promote similar hemodynamic behavior to AS and RS.

Keywords: Tai Ji. Yoga. Exercise. Physical Fitness. Hypotension.

Resumo

Introdução: Tai-Chi-Chuan e Yoga vem se tornando práticas populares. No entanto não está claro os efeitos cardiovasculares e se apresentam comportamento similar às sessões aeróbicas e resistidas. **Objetivo:** Avaliar as respostas cardiovasculares durante a sessão e hipotensão pós-exercício (HPE) de Tai Chi Chuan (TS) e Yoga (YS) comparando com sessões aeróbica (AS) e resistida (RS). **Métodos:** Catorze mulheres jovens (22,3±2 anos), aparentemente saudáveis realizaram quatro sessões (AS, RS, TS e YS). A frequência cardíaca (FC), pressão arterial sistólica (PAS) e diastólica (PAD) foram mensurados em repouso, durante (a cada 10 minutos) e até 50 minutos de recuperação. **Resultados:** AS, RS, TS e YS mostrou aumento significativo na FC em relação ao repouso. AS aos 10, 30 e 50 minutos em relação a RS, TS e YS. RS em relação a TS e YS aos 10, 30 e 50 minutos. Não houve diferença significativa entre TS e YS. PAS foi significativamente maior em AS, RS, TS e YS aos 10, 30 e 50 minutos durante a sessão em relação ao repouso. AS foi significativamente maior que RS aos 30 e 50 minutos e maior que TS e YS em 10, 30 e 50 minutos. Não houve diferença significativa na PAD. Para HPE AS, RS e TS reduziram significativamente aos 10, 30 e 50 minutos. YS reduziu aos 50 minutos. Sem diferença na HPE diastólica. **Conclusão:** TS e YS mostrou-se alternativa segura de exercício em adultas jovens normotensas, apesar de ter valores mais baixos, promovem comportamento hemodinâmico semelhante ao AS e RS.

Palavras-chave: Tai Ji. Ioga. Exercício. Aptidão Física. Hipotensão.

Introduction

The ability of exercise to reduce blood pressure (BP) is well established (1, 2). Several studies have been conducted to elucidate the relationship between exercise types and magnitude of the hypotensive response after exercise. These studies show that aerobic (AE) (3) and resistance exercises (RE) (4) promote large BP reductions. Concomitantly these classic exercise types, a large portion of the population has sought forms of exercising that allows physical and mental welfare, and among these modalities, Tai-Chi-Chuan and Yoga have received attention (5, 6, 7, 8).

In this way, several studies that have been conducted show improvements in cardiorespiratory function and cardiovascular risk reduction, as well as in flexibility and balance (9,10). Regarding cardiovascular risk, according to the guidelines of ACSM and AHA, the practice of aerobic and resistance exercises are recommended to either healthy (2) and cardio paths,

due to the phenomenon known as Post Exercise hypotension (PHE) (1, 2).

On this point, some factors may influence the reduction of BP after a training session. A session with static contraction associated to flexibility training during a session can affect hemodynamic responses (11). It is known that muscle fibers recruited activate mechanoreceptors, which elicit cardiovascular adjustments through parasympathetic withdrawal and sympathetic activation (12). Furthermore, small receptors of muscle fiber also react to stretching in humans (13) with a significant impact on the initial heart rate (HR) acceleration. Besides, all of these aspects before-mentioned they are found on a Tai-chi-chuan and Yoga intervention.

It is possible that cardiovascular responses are great enough to be a concern in exercise programs designed for special populations, such as hypertensive population. Given this, the safety of these "new" exercise types should be tested, as well as whether promotes similar PEH in comparison to AE and RE.

Thus, the aim of this study was to verify the cardiovascular responses during the session and analyse hypotension (PEH) after a Tai Chi Chuan and Yoga session in comparison with AE and RE in young adults.

Methods

Subjects of the study

The study was performed with 14 young female adults (20-25 years). Inclusion criteria: be apparently healthy and previously practicing resistance and aerobic exercises. This research project was approved by the Ethics Committee of the Lauro Wanderley Hospital, of Federal University of Paraíba, under protocol, CAAE- 19876413.0000.5188, according to resolution 196/96 of the National Health Council. The determination of sample size was made as proposed by Eng (14), utilizing the Gpower software 3.1.0 (Franz Faul, Universitat Kiel, Germany). For this, it was adopted a statistical power of 0.80 and alpha error of 0.05. It was estimated a reduction in systolic BP of 2 mmHg for residual standard deviation of 2 mmHg after resistance exercise (15). As a result, it was determined a minimum of 12 subjects to form the group. All participants were previously informed about the purposes and procedures of the study, and required to sign the Instrument of Consent (IC).

Study Design

The subjects performed four exercises session: Tai Chi Chuan (TS) and Yoga (YS) sessions and two control sessions: Resistance (RS) and Aerobic (AS) sessions, with 48h interval between them, randomly determined (www.randomizer.org). Heart rate (HR) and BP were measured at rest, during and after (in every 10 minutes) exercises session. To measure the subjective perceived exertion we use the Borg scale (16).

Study prepatation

One week before starting the protocol, participants underwent an adaptation session to TS and YS, with 48 hours of interval between each session. These sessions proved sufficient to all

subjects demonstrate autonomy in the movements performed, with a duration of 40 minutes. After a week of adaptation, the subjects performed an anchoring procedure to find the load between 8-12 maximal repetitions of the resistance exercise, in a way that the adequate load was found in a maximal of 3 attempts, following the protocol of Adams et al. (17). All sessions were performed with the objective in maintain a similar intensity between them. After 48 hours of the Anchoring procedure, it was started the experimental protocols.

Resistance session protocol (RS)

Composed by three series of 10 repetitions with the load found at the anchoring procedure, cadence of two seconds at eccentric phase and two seconds at concentric phase, with no pause between each of these phases and interval of one minute and thirty seconds between the series. The exercises were selected in a mode that may coincide in the same muscles groups at the exercises protocols TS e YS. We followed Delavier's (18) nomenclature: adduction-abduction; leg extension; front lat pulldowns; squat in a guided bar; straight-arm lat pulldowns; lunges; barbell curls with supinated hands; leg extensions; pushdowns, cable hip abductors. All the resistance protocol was performed at the gym of the Federal University of Paraíba.

Aerobic session protocol (AS)

Composed by one session in a treadmill (Life Fitness, EUA) of 60 minutes duration. The subjects maintain the heart rate between 60-70% of the maximum heart rate reserve. It was adopted the proposed equation by Karvonen, Kentala e Mustala (19). For the determination of the maximum heart rate, subtracted 220-age of the each subject. The aerobic protocol was performed at the gym of the Federal University of Paraíba.

Tai Chi Chuan session protocol (TS)

Composed by one session of the "Yang Style" class with 24 movements and duration of 60 minutes, following the proposed style by the literature (20,8). The session was constituted by:

- Periods of concentration – attention on the Tan Tien, region 3-5 cm below the navel (5 minutes).
- Warming up – Lian Gong exercises emphasize circular movements of the limbs in a slow and continuous form, associated with breathing and mental concentration. Intensity generally maintained between 6 to 8 of the subjective scale of exertion of Borg (15 minutes).
- Breathing exercise – Therapeutic Chi Kung; breathing exercises with body movements (5 minutes).
- Teaching the bases – with exercise of changing of bases, exchanging the weight bearing between the legs (5 minutes).
- Educative teaching – teaching the movements slowly, harmonic and continuously with the body freely associated with breathing and mental concentration (5 minutes).
- Teaching the form – teaching the principal movements of the Tai Chi Chuan form of the Yang style with 24 movements (5 minutes).
- Training the form - repetition of the previously movements of the Tai Chi Chuan form (10 minutes).
- Concentration – Attention on the Tan Tien, region 3-5 cm below the navel (5 minutes) of diaphragmatic breathing in a slowly and conscient way.
- Finalization – Corporal energization, with self-massage and energetic unblocking of the meridians through the tapotament technique (5 minutes).
- All the Tai-Chi-Chuan protocol was performed at the Dance saloon at the of the Federal University of Paraíba

Yoga session protocol (YS)

Composed by one session of “Hatha style” class with nine activities and body movements with duration of 60 minutes, following the proposed protocol by the literature (6,21). The session was constituted by breathing educative exercises:

- Explanation and execution of diaphragmatic-breathing, initial relaxation in Savasana (Posture of the defunct): Lying in supine position, legs and arms apart, palms of the hand facing upward, closed eyes, concentrating on breathing with the

objective to be among the wakefulness and sleep state (Meditation) (10 minutes).

- Asanas (Postures)*lying/sitting: postures emphasize the stretching of the lower limbs muscles; standing: postures emphasize stretching of the spine and upper limbs muscles; balance: postures emphasize the corporal balance; strength: postures emphasizing muscular endurance; twisting of the spine: postures emphasizing the spine flexibility (25 minutes).
- Pranayamas (breathing exercises): exercises emphasize different ways to breath, including lung retention with full and empty (5 minutes).
- Final Relaxation: Savasana (15 minutes).
- All asanas should be performed with mental concentration, avoiding musings and focus on breathing and on the worked muscle. The transitions are made consciously avoiding sudden movements.
- All the Yoga protocol were performed at the Dance saloon at the of the Federal University of Paraíba.

Cardiovascular measures

The blood pressure (BP), heart rate (HR) and double product were evaluated in rest, during and after the sessions during 50 minutes of recovery in TS, YS and AS, and after two exercises of the RS. By the end, BP and HR were evaluated after exercising at 10, 30 and 50 minutes of recovery, with the subjects in seated position. For the measurement of BP, it was used a sphygmomanometer of Missouri brand (Embu, Brazil), following the recommendations protocols of the VI Brazilian Arterial Hipertension Guidelines (22). The heart rate was analysed by a monitor (Timex SD456 - Middlebury, Estados Unidos). Also, to measure the intensity adopted in the sessions, it was used a subjective perceived exertion by the Borg scale (16).

Statistical analysis

The normality and homogeneity of the data and differences between the standard deviation were verified by Shapiro-Wilk and Levene test, respectively. The data was presented as mean and standard deviation. It was utilized the ANOVA Two-way with Newman-keuls post hoc test for location of the difference within

the analyses. The minimum detectable difference was calculated for systolic and diastolic blood pressure according to the following formulas from: a) $MDD = EPM \times \sqrt{2}$; b) $EPM = \text{standard deviation} \times \sqrt{1-ICC}$. ICC (intraclass correlation coefficient) was calculated at the statistical software. For all tests was adopted the value $p < 0.05$ in the interaction. These procedures were performed in the statistical software InStat, 3.06 (GraphPAD software, inc. San Diego, USA).

Results

The subjects completed the study with no adverse effects. These were normotensive and eutrophic. The previous measures for each session revealed that the HR and BP baselines were similar among the four sessions. This data is shown on Table 1.

Table 1 - Anthropometric and hemodynamic characteristics of baseline

Subjects (n=14)				
Age (years)	22.3 ± 2.0			
Height (m)	1.63 ± 4.0			
Weight (Kg)	61.7 ± 6.0			
BMI (Kg/m ²)	23.3 ± 2.0			
	AS (n=14)	RS (n=14)	TS (n=14)	YS (n=14)
SBP (mmHg)	127.5 ± 11.0	123.6 ± 8.0	120.1 ± 7.6	121.6 ± 4.0
DBP (mmHg)	88.0 ± 5.6	88.6 ± 13.7	84.1 ± 7.6	88.5 ± 8.7
HR (bpm)	74.0 ± 8.0	71.0 ± 10.0	76.3 ± 7.6	74.2 ± 4.4

Note: Data presented as mean and standard deviation. BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

The values of perceived exertion are shown in Figure 1 (Panel A). Significant increase in RS compared to YS at 30 and 50 minutes during exercise. The response of HR is shown on Figure 1 (Panel B). All exercise sessions were significantly elevated compared to rest. In AS, was found greater rise in this variable, with values around 150 bpm and remained

stable during all AS. Moreover, their values at 10, 30 and 50 minutes were significantly higher compared to RS, TS and YS. RS showed an increase around 120 bpm, being significantly higher than the TS and YS at 10, 30 and 50 minutes. There was no significant difference between TS and YS.

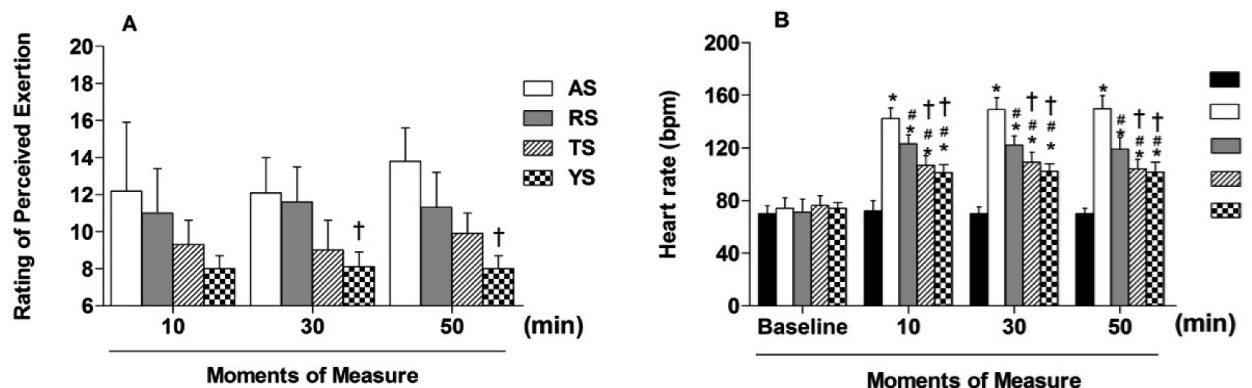


Figure 1 - It shows the values of perceived exertion (Panel A) and heart rate (Panel B) during exercise. Note: *statistical difference between the time of measurement of heart rate during exercise and their resting values. #difference between the values during exercise compared to aerobic exercise. †Difference between the moments of measures compared to resistance exercise. Significant difference with value of $p < 0.05$.

The values of BP responses are presented in Figure 2. In Panel A is presented SBP, which increased significantly in relation to rest in AS, RS, TS and YS at 10, 30, 50 minutes, with an increase of around 30 to 40 mmHg. The greatest changes were seen in AS,

with values near to 150 mmHg, being significantly higher than the RS at 30 and 50 minutes and greater than TS and YS at 10, 30 and 50 minutes. Regarding DBP (panel B), there was no difference in any of the sessions.

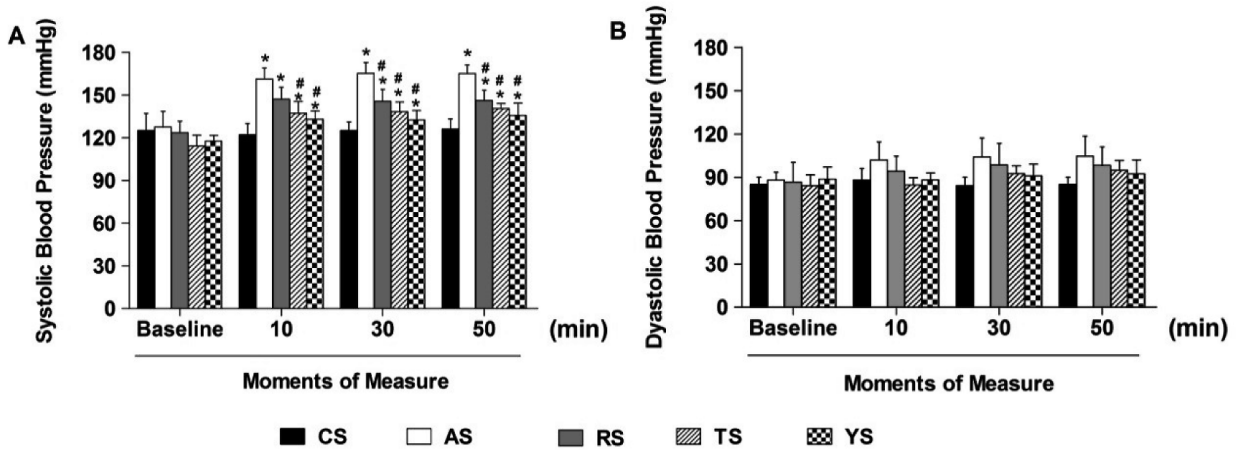


Figure 2 - It shows the values of systolic (Panel A) and diastolic (Panel B) blood pressure during the sessions.

Note: *statistical difference between the time of measurement of heart rate during exercise, and their resting values. #Difference between the values during exercise compared to aerobic exercise. Significant difference with value of $p < 0.05$.

The double product values are shown in Figure 3. It can be seen that in every session this variable increased from rest at 10, 30 and 50 minutes. The AS showed the highest elevations in relation to all

exercise sessions at 10, 30 and 50 minutes, with an increase around 24.000mmHg x bpm. Similarly, RS increased when compared to the YS at 10, 30 and 50 minutes, with increase around 17500mmHg x bpm.

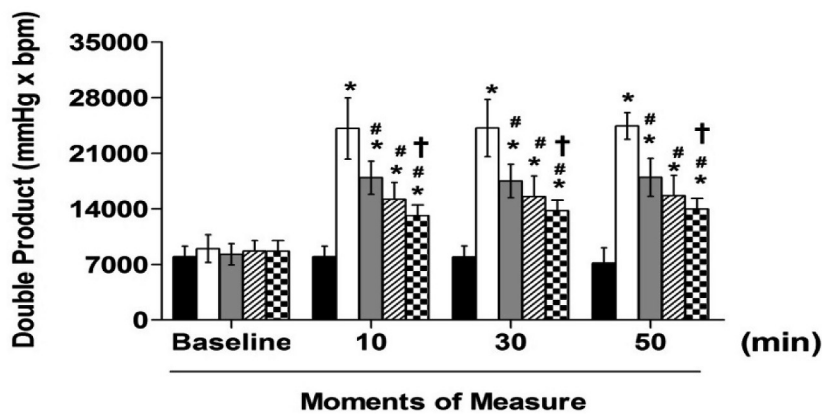


Figure 3 - It shows the values of the double product of the sessions.

Note: *statistical difference between the time of measurement of heart rate during exercise and their resting values # difference between the values during exercise compared to aerobic exercise. †difference between the moments of measures compared to resistance exercise. Significant difference on value of $p < 0.05$.

The magnitude of the systolic (Panel A) and diastolic (Panel B) hypotension are shown in Figure 4. All sessions showed significant systolic hypotension (SPEH) compared to rest. The protocol AS shown the greatest systolic reductions in comparison to rest

on value near to 12 mmHg. It was found that AS, RS and TS reduced their values in relation to rest at 10, 30 and 50 minutes. While YS, reduced at 50 minutes. No significant diastolic hypotension (DPEH) was observed on the sessions, although AS shown the greatest reduction around 6.5 mmHg.

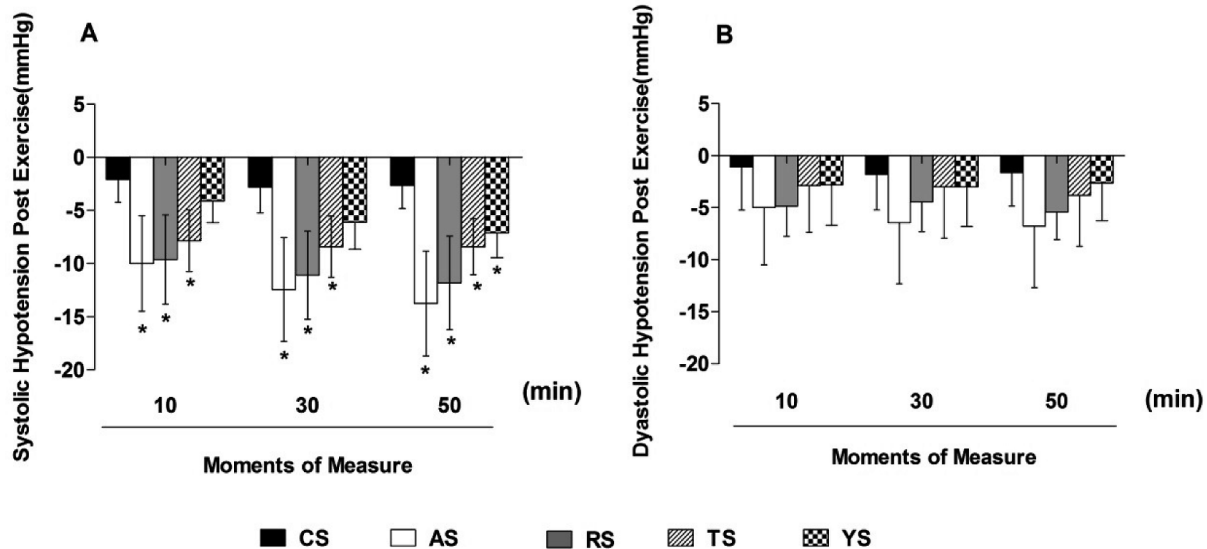


Figure 4 - It shows the values of post-exercise hypotension of the sessions.

Note: *statistical difference between the time of measurement of heart rate during exercise, and their resting values. Significant difference with value of $p < 0.05$.

The ICC: 0.163 found at the statistical software was used to find the MDD for SPEH, which present values of 7mmHg of minimum detectable difference. The ICC: 0.06 to find MDD for DPEH present values of 7.9mmHg to detectable clinical differences.

Discussion

Assuming the hypothesis that the Tai-Chi-Chuan and Yoga interventions may reduce systolic and diastolic blood pressure as much as aerobic and resistance exercises, according to the results of this study in normotensive young adults, one single session of Tai-chi-chuan and Yoga are able to promote PEH and impose an effort on cardiovascular system (as observed by increased BP and DP) but with small changes on perception of exertion (RPE).

Analysing the data from the PEH of the sessions compared acutely, AS in comparison to other sessions

showed greater reduction in SBP (10.0 ± 4.5 mmHg to 13.8 ± 4.9 mmHg) and diastolic (5.0 ± 5.5 mmHg to 6.8 ± 5.9 mmHg). Where as, the resistance exercise session was observed significant systolic reductions of 9.6 ± 4.2 to 11.1 ± 4.2 mmHg and diastolic of 4.4 ± 2.9 to 5.4 ± 2.6 mmHg. Thus, it was found similar values compared in the literature for aerobic (23, 24, 3) and resistance exercise sessions (3, 4). In TS and YS, the present study observed that there were significant systolic hipotension range of 7.8 ± 2.9 to 8.4 ± 2.6 mmHg and diastolic of 2.8 ± 4.4 to 3.8 ± 4.9 mmHg in the TS post-exercise hypotension. For YS, significant reductions of 4.1 ± 2.0 to 7.1 ± 2.3 mmHg of the systolic PEH and 2.6 ± 3.6 to 3.0 ± 3.8 mmHg of the diastolic PEH. Corroborating with the acute studies above, which shows that TS and YS can promote similar hypotensive range to aerobic and resistance sessions, and similar values to the results found in the study itself about the hypotension found in the AS and RS (in addition, SPEH from TS and YS shown clinical relevance; -7mmHg).

Therefore, although was verified a convergence in the literature about the PEH for aerobic and resistance sessions, on our knowledge there are no investigations analyzing acutely if a session of TS and YS would be able to reduce the systolic and diastolic blood pressure, and if these sessions would be similar to aerobic and resistance exercises sessions responses. Thereby, in addition to many positive effects associated to these exercises modalities described in the literature, blood pressure is also a variable that can be modulated.

In this sense, was observed a smaller reduction in systolic and diastolic PEH in relation to AS and RS, they may be considered clinically important. It is known that minimal decreases such as 2mmHg in blood pressure (less than observed in the present study) are associated with reduction of approximately 6% in mortality by stroke and 4% in coronary artery disease (25). Thus, these forms of intervention may be considered as equivalent to use one class of the anti-hypertensive medication (26). If the practitioner does not enjoy perform physical activity such as aerobic or resistance sessions, a single session of Tai Chi Chuan or Yoga presented as an excellent alternative of hypotension promotion. Therefore, being another form of drilling that is capable to provide to the practitioner's BP control.

In fact, the acute analysis of the magnitude of PEH is very important since high BP levels are associated with increased morbidity from all causes (27), but they are also important because they may present a high correlation with reductions in a chronic analysis (1). From previous data, it has been verified that some studies analyse the cardiovascular changes in Tai-chi Chuan and Yoga chronically. Thornton, Sykes & Tang (20), submitted 17 healthy women (33-55 years) to Tai chi Chuan (Yang Style) training of three sessions per week for 12 weeks. They observed a significant reduction in SBP of 9.7 mmHg and DBP of 7.5 mmHg, while the control group had no significant change. The same by Tsai et al.(24), after three sessions per week during 12 weeks (Yang Style) with 37 subjects (men and women - normotensive e hypertensive level 1), they had a mean reduction in SBP and DBP of 15.6 mmHg and 8.8 mmHg. However, the hypertensive population may have helped to provide greater reduction in blood pressure, because this population have higher inotropic response³.

In Yoga, Chung et al.(28), after Sahaja Yoga meditation with hypertensive and non-hypertensive men and women (between 18 – 65 years), there was a reduction in SBP of 9.4mmHg and 6.1mmHg, respectively, after the treatment. According to findings from meta-analysis on these effects, the Yoga intervention, similar to this study that proposes the use of posture, breathing and meditation, in a chronic form, may reduce up to 11.8 mmHg for SPB and 7.4 mmHg in DBP after intervention. If we have consolidated answers about the acute analysis, the professionals may modulate the chronic blood pressures responses to be a safe alternative to find better reduces of BP with these two other forms of exercising.

Some possible factors may explain the reduced hypotension in TS and YS sessions when compared to AS and RS. First, the population studied (normotensive). Hypertensive population used on the long-term studies present a greater vascular response, being hyperactive, resulting in a higher hypotension when compared to normotensive (3), and in the present study we used only normotensive. Secondly, as consequence, subjects presenting BP values closest to the base range of normal blood pressure 120 - 129 mmHg (systolic) and 80 - 84 mmHg (diastolic) are biased to have smaller magnitudes of hypotension post-exercise compared to those with higher BP values (hypertensives) (22). Whereas our volunteers showed SBP at rest with values of 120.1 ± 7.6 e 121.6 ± 4.0 mmHg in TS and YS respectively in the days of the experiment, may have limited the observation of PEH.

It must be emphasized that some components of the exercise as duration, intensity and type of exercise can influence the PEH. Among these variables, it is assumed that the intensity is one that has a greater influence in acute and chronic exercise responses as well as the risk of their practice (29,30). Thereby, the HR was analyzed during the entire session as a form to measure the heart effort. It was found the AS and RS intensity remained with values of 71-75% and 60-62% of the maximum heart rate, respectively. Furthermore, when analyzing the double product (HRvs SBP), during the sessions, the AS had the highest values, followed by RS. Unlike the sessions that use movements of relaxation during the protocol, the intensity range between 52-55% in TS and a stable average range of 51% of the maximum heart rate in YS, which may possibly have influenced their

hypotensive magnitude. About the double product of TS and YS with lower magnitude values, also it was presented significantly difference compared to the AS and RS, in some moments of measurement.

Still on intensity, knowing the useful tool of The Rating of Perceived Exertion (RPE) that provides a global quantification of an individual's effort or fatigue, considering physiological, psychological, and performance factors (16). RPE may be an important modifier of what a person does versus what the person can do during certain protocol of exercise. The impact of interventions on participation may be influenced by a patient's perception of the ability to exercise. Thus, if TS and YS are perceived to be effortful, then an adult may limit physical activity for recreation and promotion of good health. In TS e YS was observed the lower values, another time. Thereby, overall aspect shave shown that TS and YS sessions proposals have not reached the same level of intensity as AS and RS. Nevertheless, even with an inferior intensity of the myocardium and lower perceived effort to AS and RS, because it is the characteristic of these sessions, the hypotensive magnitude of TS and YS showed significant differences in relation to rest and general hemodynamics similarly with the consolidated interventions in the literature, aerobic and resistance exercises.

Finally, in the present study, the only session style used of Tai Chi Chuan was *Yang style* and in Yoga was the *Hatha style*. Future studies can be performed to analyze the cardiovascular changes in different populations and practitioners in many styles of practice of these types of exercises. Better explaining these factors to become a more safe and useful tool not only to practitioners, but also for professionals at this area that will propose the intervention to the general population and in special cases of diseases.

Conclusion

Therefore, although Tai Chi Chuan and/or Yoga session did not reduce as much as an aerobic and resistance session, they can be used as a safe alternative of exercising in the normotensive young adult woman population, by promoting during and after session, a similar hemodynamic response in comparison to the compared sessions.

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