Dancing is More Effective than Treadmill Walking for Blood Pressure Reduction in Hypertensive Elderly Women

Francisco Eric Sousa¹, Edilson Francisco Nascimento¹, Luiz Rodrigues Souza¹, Rafael Reis Olher¹, Michel Kendy Souza¹, Rodrigo Vanerson Passos Neves¹, Thiago Santos Rosa¹, Marilda Teixeira Mendes¹, Luiz Henrique Peruchi², Herbert Gustavo Simões¹, Tania Mara Vieira Sampaio¹, Milton Rocha Moraes¹

¹Graduate Program on Physical Education, Catholic University of Brasília, Brazil, ²Department of Physical Education, University of Mogi das Cruzes, Mogi das Cruzes, Brazil

ABSTRACT

Sousa FEV, Nascimento EF, Souza LHR, Olher RR, Souza MK, Neves RVP, Rosa TS, Mendes MT, Peruchi LH, Simões HG, Sampaio TMV, Moraes MR. Dancing is More Effective than Treadmill Walking for Blood Pressure Reduction in Hypertensive Elderly Women. JEPonline 2016;19(1):124-134. The purpose of this study was to investigate the cardiovascular effects of dancing and walking, and the biochemical mechanisms involved in each. Ten hypertensive elderly women (64.5 ± 5.1 yrs) were submitted to three session that consisted of 60 min of intervention with a 72-hr interval between each condition. Systolic blood pressure (SBP) was monitored before, during, and at 60 min post-exercise recovery (Rec). Blood lactate (lac) and nitric oxide (NO₂⁻) were measured at rest and at 60 min Rec. Only the dance session increased lac levels (∆ = + 0.79 mM, P<0.05) and reduced SBP at the 30th-min of Rec (∆ = -15 ± 4 mmHg, P <0.05) when compared to pre-exercise resting values. NO₂⁻ increased immediately post-exercise for both exercise sessions (P<0.05). There were no significant differences within and between the control and walking sessions for the post-exercise NO₂⁻ (P>0.05). The findings indicate that dancing was more effective than treadmill walking in reducing SBP in elderly women with controlled hypertension.

Key Words: Dance, Older, Post-hypotension, Lactate, Nitric Oxide
INTRODUCTION

Although growth of the elderly population is a worldwide phenomenon, the conservative projections indicate that in 2020 Brazil will be the sixth country in the world with the number of individuals >60 yrs of age with a quota of more than 30 million people (23). Currently, there are 26.1 million senior citizens in Brazil and the share of women is greater than that of men, and it increased to 55.8% of the total number of elderly people (23). The sedentary lifestyle and the chronic diseases associated with it affect a considerable share of the elderly population (6). Among the diseases related to aging and the sedentary lifestyle, arterial hypertension (AH) presents major consequences for this population and it is considered a public health problem with high direct and indirect economic impact (1,2).

Regular exercise is considered a potent non-pharmacological treatment for AH (8,24). The phenomenon of post-exercise hypotension (PEH), for example, characterized by an acute decrease in resting blood pressure (BP) after a single session of exercise has been observed after aerobic exercise (26), resistance training exercise (20,21), and a combination of both (11,19). While PEH is considered an important strategy to control BP, especially among elderly patients with hypertension (3,14,22), the effects of dancing on the occurrence of PEH and the mechanisms involved in hypertensive elderly patients remain unclear (15,24).

Dance is an attractive physical activity that can be adjusted according to the age of the target populations, respecting their physical limitations and adapting to their cultural customs (17). However, the studies that have used dance as non-pharmacological strategy to control hypertension have not presented evidence of possible mechanisms involved (17,24). Mendes et al. (19) reported a reduction in BP after a dance session in healthy adults using step aerobics classes that combined strengthening exercises using their own body weight. They found that a single session of exercise was effective in inducing significant PEH. On the other hand, Schenkel and colleagues (28) found no significant difference in middle-aged women BP after a session of ballroom dance Merengue style (28).

While it is reasonable to speculate that the production of nitric oxide during exercise vasodilates the arterial system and, therefore, is involved in the hypotensive response post-exercise (9,15,16), to date there are no studies to our knowledge that have investigated PEH and the physiological mechanisms involved in older hypertensive women engaged in a dance session. Thus, purpose of this study was to analyze the occurrence of PEH and the role of salivary nitric oxide and blood lactate as possible mechanisms involved compared to a walking exercise on a treadmill.

METHODS

Study Design
The volunteers were subjected to three experimental sessions (dance, treadmill, and control), with at least a 72 hrs interval between sessions. Blood pressure and heart rate (HR) were evaluated at rest, immediately at the end of a session, and post-exercise at 5, 10, 15, 30, 45 and 60 min. Blood and saliva samples were taken at rest, at the end of exercise, and post-exercise at 30 and 60 min.
Subjects
The subjects consisted of 10 elderly hypertensive women (≥60 yrs). These subjects were physically active with no diabetes or target organ damage, and no bone, muscle, and joint problems or lesions that would prevent them from practicing the dance. The subjects were either using antihypertensive medication or they had resting BP values ≥140 and/or ≥90 mmHg for systolic BP (SBP) and diastolic BP (DBP), respectively (1). The general characteristics of the elderly are presented in Table 1. The subjects were part of a community group, which holds cultural and physical activities (~2 hrs·wk⁻¹) in the elderly center of Ceilândia, - Federal District. All subjects signed an informed consent form. This study was approved by the Ethics Committee of the Catholic University of Brasília (CEP/UCB 0767022014) and followed the rules of the agreement of the Declaration of Helsinki.

Experimental Protocol
The subjects were familiarized with the measurement of BP and HR using a clinically validated (30) oscillometric blood pressure monitor (3A-BP 1PC, Microlife, Switzerland). The measurement process followed the standards of the American Heart Association (25). The subjects were also informed of the procedures of exercise, including the blood and saliva sampling protocols. Body mass and height were measured according to the World Health Organization standards (4). Body composition was determined using the Durnin and Womersley-skinfold sites protocol (12) by Lange skinfold calipers (Santa Cruz, Santa Cruz, CA, USA).

Cardiovascular Measurements
On the day of the sessions, the subjects were instructed not to consume alcohol and coffee or engage in physical activity for a period of at least 24 hrs. Blood pressure and HR (Polar FT-10, Finland) were measured after a 10-min rest period, during exercise, immediately after the exercise session, and during post-exercise recovery at 5, 10, 15, 30, 45, and 60 min in the supine posture. There were three separate sessions separated by a minimum of 72 hrs: (1st) dance; (2nd) treadmill, and (3rd) control (no exercise). The 2nd and 3rd sessions were randomized. The average intensity of the dance session was considered light at 57 ± 0.1% of the subjects' HR max [(206 - 0.88 (aged)) (13), which was in accordance with the American College of Sports Medicine in which an intensity between 50% and 70% of HR max was considered suitable as a safety recommendation for exercising hypertensive patients (24).

The dance session utilized Brazilian folklore songs containing jumps, spins, squats, changes of direction, light running, feet stomping, hands clapping, and arms lifting. The dance had an average duration of 60 min, which was divided into 5 min of stretching, 10 min of warming-up, 40 min of dancing, and 5 min of cooling down. On average, the music cadence resulted in an average HR of 128 ± 4 beats·min⁻¹ during dancing. In order to make comparisons to walking, the treadmill speed was adjusted to reach the same average intensity observed during dancing (i.e., ~60% HR max). Thus, the treadmill exercise required a 1% slope that lasting 50 min with a 5 min warm-up and a 5 min cool down. The subjects’ 3rd session was the control period in which there was no exercise. All sessions took place between 8:00 am and 9:00 am in the same environment with the same music used during dancing. During exercise, the elderly received 15 ml of water per kg of body weight to replace water loss due to sweating.
Blood Lactate and Nitric Oxide Analyses

Blood and saliva samples were collected during fasting, immediately after exercise, and post-exercise recovery sessions at 30 min and 60 min. Using surgical gloves, after asepsis of the earlobe with alcohol, 25 μl of blood was collected and blood lactate concentration was estimated (Accutrend™ Plus, Roche, USA) on the pulp of the finger. The results of lactate are expressed in units of mmol·L⁻¹. For metabolic measurement, saliva was collected with a cotton swab (Sarstedt Salivette®, Nümbrecht, Germany) that was chewed for 1 min. Then, it was centrifuged according to the manufacture instructions and stored in -20°C for later analysis. Dosage of nitrite (NO₂⁻) as a NO⁻ metabolite was done through the Griess colorimetric method (27). Briefly, N-(1-naphthyl)-ethylenediamine (NED) (Sigma-Aldrich®, St. Louis, USA) was prepared at 0.1%, whereas sulfanilamide (Sigma-Aldrich®, St. Louis, USA) at 1%, both with phosphoric acid at 2.5% as diluent. Saliva (50 μL) and the Griess reagent (50 μL) were mixed and placed in microplates. Absorbance was measured at 490 nm in Versamax tunable® (Molecular Devices, Sunnyvale, California, USA), and sodium nitrite (NaNO₂) was used as the standard. The data were analyzed using the Microplate® software. The analyzer remained stable so that linearity was maintained over the test period to <1% with a coefficient of variation <10%. The results are expressed as micromolar (μM) units. All subjects were instructed to maintain the nitrite or nitrate-restricted diet for the 24 hrs before testing, given that NO⁻ can be affected by diet.

Standard Breakfast

In attempt to minimize the influence of nutrients consumed on glucose, lactate, and nitric oxide, the subjects received the standard breakfast (SB) after fasting. This was their only meal consumed on the morning of the 3 sessions, which was recommended to be consumed 30 min before the start of the experiments. The SB kit consisted of a 160 g chocolate mini-cake (Bauducco®, Bonsucesso, Brazil) and a 200 ml orange juice (Ades®, Pouso Alegre, Brazil). In total, 227 kcal were offered from 33 g of carbohydrate, 9.1 g of fat, 3.4 g of protein and 88 mg of sodium.

Statistical Analyses

The data were analyzed using descriptive statistics via the Statistical Package for the Social Science (SPSS, version 13, USA). The data were expressed as means and standard deviations. A one-way analysis of variance (ANOVA) for repeated measures was applied, followed by the Tukey post hoc for comparisons between and within groups. For the analysis of salivary concentration of NO₂⁻ a one-way ANOVA followed by the post hoc Fischer was used. Statistical significance was set at 5% (P<0.05) in all analyses using the Statistical Package for the Social Sciences (New York, USA) and G*Power software version 3.1.9.2. Based on the magnitude of the mean differences for SBP, DBP, and MAP variables, the calculated sample size of 10 subjects was required to provide power of analysis (β) ≥0.80 at P=0.05.
RESULTS

The anthropometrical and cardiovascular characteristics of the subjects, and the frequency of their use of antihypertensive drugs are presented in Table 1.

Table 1. Subject Characteristics.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTHROPOMETRIC</strong></td>
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<tr>
<td>Age (yrs)</td>
<td>64.5 ± 5.1</td>
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<tr>
<td>Body Mass (kg)</td>
<td>66.48 ± 8.41</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>29.08 ± 3.22</td>
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<tr>
<td>Fat-free mass (kg)</td>
<td>43.72 ± 5.53</td>
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<tr>
<td>Fat mass (kg)</td>
<td>22.76 ± 3.49</td>
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<tr>
<td>Body fat (%)</td>
<td>34.17 ± 2.54</td>
</tr>
<tr>
<td><strong>CARDIOVASCULAR</strong></td>
<td></td>
</tr>
<tr>
<td>Hypertension (yrs)</td>
<td>10.7 ± 2.7</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>121.6 ± 14.27</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>70.9 ± 11.65</td>
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<tr>
<td>MAP (mmHg)</td>
<td>87.9 ± 9.4</td>
</tr>
<tr>
<td>HR (beats·min⁻¹)</td>
<td>70.7 ± 15.92</td>
</tr>
<tr>
<td><strong>MEDICATION (%)</strong></td>
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</tr>
<tr>
<td>Diuretic</td>
<td>76</td>
</tr>
<tr>
<td>ACEi</td>
<td>34</td>
</tr>
<tr>
<td>ARB</td>
<td>20</td>
</tr>
<tr>
<td>CaCl</td>
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</tr>
<tr>
<td>Monotherapy</td>
<td>56</td>
</tr>
<tr>
<td>Combination Therapy</td>
<td>44</td>
</tr>
</tbody>
</table>

*BMI = body mass index; ACEi = enzyme inhibitor angiotensin; ARB = type 1 angiotensin II receptor blockers; CaCl = calcium channel blocker. Monotherapy = patients receiving single-drug therapy; Combination Therapy = patients receiving multiple-drug therapy*
The SBP and DBP measurements at the rest period did not differ between the protocols tested [session control (SBP = 121.6 ± 14.3 mmHg and DBP = 70.9 ± 11.6 mmHg); dance session (SBP = 126.8 ± 13 mmHg and DBP = 73.4 ± 7.2 mmHg); and walking (SBP = 123.7 ± 11.6 mmHg and DBP = 70 ± 8.3 mmHg)]. The subjects' hemodynamic and biochemical responses during the three experimental sessions are depicted in Figure 1 and Figure 2, respectively. In comparison to the pre-exercise resting, only the dance session demonstrated a reduction in SBP during the post-exercise recovery period (specifically, 30 min after exercise) (P<0.05; Figure 1A). There were no significant differences within and between the control and walking sessions for SBP (P>0.05; Figure 1A). No differences were found among the three sessions for DBP or MAP (P>0.05; Figure 1B and Figure 1C, respectively). While HR was significant increased after the dance and treadmill walk sessions when compared to the pre-exercise resting period (P<0.05), there was no difference between the dancing session and the walking session (P>0.05; Figure 1D).

**Figure 1. Hemodynamic Parameters.**

Only the dancing session elicited an increase in blood lactate concentration when compared to rest (P<0.05; Figure 2A). The bioavailability of NO$_2^-$, as estimated by saliva NO$_2^-$, increased in both exercise protocols (P<0.05 End and 60 min post-exercise vs. Rest), but there was no difference between the treadmill walking session and the dancing session (P>0.05; Figure 2B).
DISCUSSION

The findings in this study show that a single session of recreational dance resulted in PEH in hypertensive elderly women. However, BP levels showed no decrease when they walked on the treadmill at the same relative intensity of the dance session. Lactate levels increased significantly at the end of exercise in relation to pre-exercise rest only when the elderly performed the dance session. The NO$_2^-$ increased at the end and at 60 min post-exercise in relation to rest for both sessions, but there were no significant differences between sessions.

Mendes et al. (19) investigated the effects of a dance session (step aerobics) combined with bodyweight resistance exercise on BP of young healthy adult women. They observed that PEH occurred at 30 min of post-exercise recovery period. However, the combination of two models of exercise (aerobic and strength) and the sample used in that study (young people), make impossible any kind of direct comparison with our findings. Our study verified PEH only at the 30th-min post-dance, when the SBP was reduced about 15 mmHg. This is relevant since a reduction of 2 to 7 mmHg decreases the risk of an acute myocardial infarction by 40% (24).

When the elderly women exercised on the treadmill at the same intensity of the dance session, there was no significant change in post-exercise BP. A possible explanation for these different pressure responses is that the dance session used a greater muscle mass during the choreography of the dancing rhythms. With various types of muscular contraction (concentric, eccentric, and isometric), the stimulation of a greater number of muscle groups may have resulted in possible peaks of higher intensities efforts during the dance session in comparison to the session on the treadmill that maintained a stable HR, thus resulting in a greater cardiometabolic overload while dancing. MacDonald et al. (18) showed that muscle mass involved during exercise could influence in the response of PEH.

With respect to metabolic overload, Santana and colleagues (27) found that hypertensive elderly women performing an incremental high-intensity exercise (IT) on a cycle ergometer and another session with moderate-intensity (90% IT) showed a larger fall in PEH in response to aerobic exercise of greater metabolic overload. In addition, in this study, corroborating our findings, both sessions increased the concentrations of NO$_2^-$ in relation to
the control session. We believe that the reduction in BP post-dance can be triggered by increased central nervous system activation during exercise (15).

In addition, a possible vasodilation stimulated by increasing concentrations of lactate (5,9,16) may be related with occurrence of PEH in this session. It has been shown that lactate stimulates the NO⁻ synthase activity and generates an increased bioavailability of vasodilators in plasma (7,27), thus enabling a reduction in BP levels post-exercise. In elderly hypertensive subjects, studies suggest that the acute decrease in BP is related to reductions in peripheral resistance rather than cardiac output. According to the authors (3,14), two prominent mechanisms have been proposed to explain the decrease in peripheral resistance: sympathetic inhibition and altered vascular responsiveness after exercise.

Regarding walking, it is still one of the most recommended physical activities, especially for the elderly (6). On the other hand, Hwang and Braun (17) found that dance is a very enjoyable and motivating physical activity for the elderly that increases their adherence to physical activity (17). In addition, Solomon and Solomon (29) suggested that elderly subjects who practice various types and rhythms of dance improve physical, cognition, social, and psychic aspects, which help to preserve their functional skills, self-esteem, and socialization. In agreement, Cruz-Ferreira et al. (10) demonstrated in elderly subjects that 24 wks of creative dance, characterized by the interpretation of ideas, feelings, and sensorial impressions expressed symbolically in the movement were enough to improve significantly the perception of life satisfaction and the components of physical fitness.

CONCLUSIONS

A single session of the recreational dance acutely reduces BP in elderly women with controlled hypertension, and may be considered as an important non-pharmacological strategy to control arterial hypertension in this age group. The post-dance hypotension in the hypertensive elderly women may be related to the increase in blood lactate and nitric oxide release.

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Address for correspondence: Milton Rocha Moraes, PhD, Catholic University of Brasilia, Brasília, DF, Brazil, 71966-700, Email: milton.moraes@ucb.br
REFERENCES


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