

Effect of one session resistance exercise on skin sensibility in hypertensive and normotensive physically-active older woman

Efeito de uma sessão de exercício resistido na sensibilidade cutânea em idosas hipertensas e normotensas fisicamente ativas

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Abstract – The aim of this study was to analyze the effect of a single session of resistance training on skin sensitivity in physically active, hypertensive and normotensive older women, as well as compare skin sensitivity in both groups. Thirty-two physically active women (mean age 65.8 ± 5.1 years; weight, 69.5 ± 13.7 kg; height, 1.60 ± 0.1 m) participated in this study and were classified as hypertensive ($n = 15$) or normotensive ($n = 17$). All participants answered a clinical history questionnaire and the Modified Baecke Questionnaire for Older Adults. Before and after the resistance training session, the skin sensitivity of the dominant hand was assessed at seven anatomical sites on the dorsal and palmar surfaces by stimulation with a Semmes-Weinstein monofilament esthesiometer. The loads employed during the resistance training session were determined one week before the experimental protocol. The Wilcoxon test showed no statistically significant differences in the skin sensibility test before and after resistance training in either groups. However, the Mann-Whitney U revealed a statistically significant between-group difference in sensitivity at three sites before resistance training and at only site post-training. A single session of resistance training had no effect on the skin sensitivity of hypertensive and normotensive older women. However, hypertensive participants exhibited reduced skin sensibility at some anatomical sites as compared with normotensive women.

Key words: Aging; Hypertension; Tactile sense; Resistance training.

Resumo – O estudo teve como objetivo analisar o efeito de uma sessão de exercícios resistidos na sensibilidade cutânea em idosas hipertensas e normotensas fisicamente ativas, bem como comparar a sensibilidade cutânea entre os dois grupos. Participaram deste estudo 32 mulheres ($65,8 \pm 5,1$ anos; $69,5 \pm 13,7$ Kg; $1,60 \pm 0,1$ m) fisicamente ativas, que foram classificadas em hipertensas ($n = 15$) e normotensas ($n = 17$). Todas as participantes responderam a um questionário de anamnese clínica e Questionário Baecke Modificado para Idosos. Antes e após a sessão de exercícios resistidos, a sensibilidade cutânea da mão dominante foi avaliada em sete pontos anatômicos das regiões dorsal e palmar, por meio da estimulação de seis monofilamentos de Semmes-Weinstein. As cargas empregadas durante a sessão de exercícios resistidos foram determinadas na semana anterior ao protocolo experimental. O teste de Wilcoxon revelou que não houve diferença estatisticamente significativa no teste de sensibilidade cutânea, antes e após a sessão de exercícios resistidos, para ambos os grupos. Contudo, o teste U-Mann-Whitney apresentou diferença estatisticamente significativa entre os grupos, em três pontos, no momento pré e um ponto, no momento pós-sessão de exercícios resistidos. Uma sessão de exercícios resistidos não modificou a sensibilidade cutânea de idosas hipertensas e normotensas. Entretanto, as participantes hipertensas apresentaram sensibilidade cutânea reduzida em alguns pontos quando comparadas com as normotensas.

Palavras-chave: Envelhecimento; Hipertensão; Senso tátil; Treinamento de resistência.

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INTRODUCTION

The somatosensory system comprises a variety of mechanoreceptors distributed throughout the body.¹ These specialized receptors are responsible for receiving various stimuli from within the body (proprioceptors) and from the external environment (exteroceptors).² Skin sensitivity results from the stimulation of a variety of exteroceptors, such as those responsible for sensitivity to touch (Meissner's corpuscles and Merkel's discs), pressure (Merkel's discs and/or Vater-Pacini corpuscles), and pain (free nerve endings or nociceptors).³

The aging process leads to a reduction in the number of sensory receptors (Meissner's corpuscles, Merkel's discs, and Vater-Pacini corpuscles), a lower density and sensitivity of skin mechanoreceptors, and a degeneration of peripheral nerves that can jeopardize the capture of some tactile information.^{4,5} A study by Perry⁶ showed an interaction between decreases sensitivity to pressure and vibration at several sites on the sole of the foot and advancing age. Furthermore, Toledo and Barela² and Kenshalo⁷ have found that healthy older people exhibit decreased skin sensitivity as compared with young adults.

Bearing in mind that reduced skin sensitivity is associated with impaired postural control, imbalance and risk of falls in older adults^{2,8} when affecting the lower limbs and may lead to loss of motor function when affecting the distal upper extremity (the hands),⁹ assessment of this variable in the elderly may be of vital importance.

On the other hand, people with hypertension are known to experience reduced pain sensitivity¹⁰; physical exercise also appears to blunt sensitivity to pain.¹⁰⁻¹² Although the skin receptors for sensitivity and pain are independent, depending on the intensity of the stimulus, one receptor may alter the other's input threshold,¹³ with interpretation of the stimulus itself occurring in the cerebral cortex.¹ While a relationship presumably exists between pain sensitivity and skin sensitivity, the potential effect of physical exercise and hypertension on skin sensitivity has yet to be investigated.

The objective of the present study was to analyze the effect of a single session of resistance training on the skin sensitivity of physically active, hypertensive and normotensive older women and compare skin sensitivity in these two groups.

METHODS

The initial sample comprised 38 older women.

Three participants withdrew from the study during training, but prior to data collection, and three were excluded from analysis due to uncertainty as to the stimulated sites during skin sensitivity testing. Therefore, 32 physically active older women (mean age, 65.8 ± 5.1 years) completed this study. Using clinical criteria, participants were classified as hypertensive ($n = 15$) or normotensive ($n = 17$).

As a criterion for inclusion, participants were required to have engaged in resistance training, with the following characteristics, for at least 7 weeks preceding the study: a) three sets of 15 repetitions of exercises targeting different muscle groups; b) three times a week. Patients were excluded from the sample if they a) had diabetes mellitus; b) were taking medications (analgesics, anti-inflammatory agents, or antidepressants) that might interfere with skin sensitivity; c) exhibited any mental, neurologic, musculoskeletal, or articular limitations that would preclude adherence to the assessment protocol.

After receiving verbal clarification as to the procedures of the study and agreeing to take part, all subjects provided written informed consent. The present study was approved by the Research Ethics Committee of the State University of São Paulo (UNESP) at Rio Claro Institute of Biosciences.

Anthropometric assessment

Body mass was measured using a mechanical scale with 100 g resolution (R-110, Welmy®) and height was measured with a stadiometer precise to 0.1 cm, according to the procedures described by Gordon et al.¹⁵ These measurements were used to calculate the body mass index (BMI), defined as the body mass in kilograms (kg) divided by the square of the height in meters (m).

Modified Baecke Questionnaire for Older Adults (MBQ)

The MBQ, as proposed by Voorrips et al., was used for characterization and quantitation of physical activity among the study participants. This questionnaire covers three basic areas: household activities, sports, and leisure time activities.¹⁶

Esthesiometer

Pre- and post-training assessment of skin sensitivity was conducted with a Semmes-Weinstein monofilament esthesiometer. This instrument consists of six nylon monofilaments of similar length that stimulate the exteroceptors alone. Each filament

has a different color, so the operator may select the desired diameter and pressure (0.05g–300g).

According to manufacturer instructions (SORRI - Bauru[®])¹⁷, sensitivity testing was performed as follows: the filament was a) placed at a 90° angle to the subject's skin, b) made to bear down on the skin until the filament bent, c) and drawn away from the skin in a manner so as to prevent sliding. Seven anatomical sites on the dorsal and palmar surfaces of each participant's dominant hand were tested (Figure 1).

Participants were instructed to keep their eyes closed throughout the test and tell the examiner where and when they felt the filament touching the skin. Assessment progressed from the lightest monofilament to the heaviest one. The thinner filaments (0.05g and 0.2g) were applied up to three times at each anatomical site, whereas the thicker filaments (2g, 4g, 10g, 300g) were applied only once per site. A single positive response was considered sufficient to confirm skin sensitivity at the corresponding pressure level; the test was then discontinued without further application of the larger monofilaments. When calluses were present over any of the defined anatomical sites, testing was performed on an area of undamaged skin as close as possible to the original point.

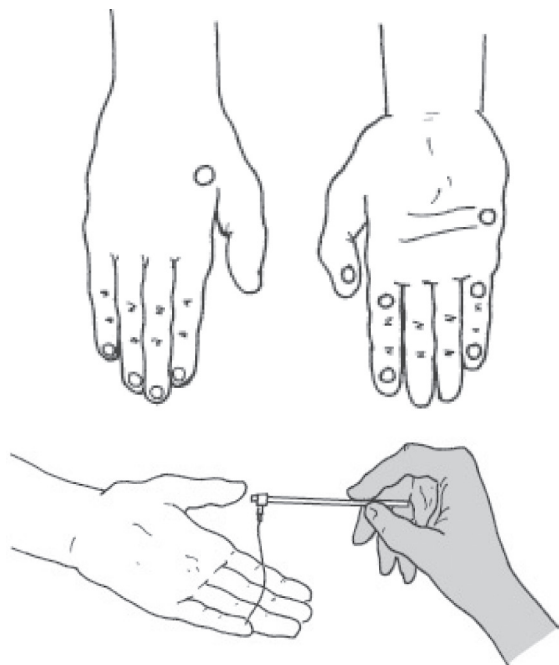


Figure 1: Tested anatomical sites and operation of the esthesiometer (Lehman et al.¹⁸).

Sensitivity testing was performed prior to and immediately following a single session of resistance training.

Resistance training

Participants performed three sets of 15 repetitions of each of the following strength training exercises (muscle group): behind-the-neck lat pulldown (latissimus dorsi), triceps pushdown (triceps brachii), fly (pectoralis), leg press (quadriceps femoris), bilateral bicep curl (biceps brachii), lateral raise or row (shoulder) and calf raises (triceps surae). The recovery period between sets and exercises was 30 seconds and 1 minute respectively. Each session lasted approximately 45 minutes. For hypertensive and normotensive subjects, training volume for each exercise was calculated by multiplying the number of repetitions by the load, and the total training volume, by adding the training volume of each exercise.

Statistical analysis

Data (anthropometric parameters, level of physical activity, and total training volume) were assessed for normality using the Shapiro-Wilk test. If normality was confirmed, the Student *t*-test for independent samples was employed for between-group comparison (hypertensive vs. normotensive subjects). In view of the scalar nature of skin sensitivity testing results and of the nonparametric distribution of total training volume, the following procedures were carried out: a) Wilcoxon test for intra-group comparison of total training volume and skin sensitivity before and after the resistance training session; b) Mann-Whitney *U* for between-group comparison of skin sensitivity and training volume (total and of each exercise). The significance level was set at $P < 0.05$ for all analyses. Data were processed in the SPSS 16.0 software package.

RESULTS

Comparison of training volume (both total and for each exercise) in hypertensive and normotensive subjects showed no significant between-group differences ($P > 0.05$).

There were no significant between-group differences ($P > 0.05$) in age, anthropometric parameters, or level of physical activity (Table 1). MBQ scores ranged between 1.1 and 7.7 points in hypertensive subjects (median, 4.9 points) and 2.8 to 9.0 points in normotensive participants (median, 4.9 points).

There were no statistically significant differences ($P > 0.05$) between pre- and post-training skin sensitivity in either group. Comparison of skin sensitivity in hypertensive and normotensive subjects revealed significant differences ($P < 0.05$) in sensitivity at anatomical sites 2, 3, and 5 before training and at point 3 after training (Table 2).

Table 1. Age, anthropometric parameters, and level of physical activity of hypertensive (n = 15) and normotensive (n = 17) older women. All values expressed as mean \pm standard deviation.

Condition	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m ²)	MBQ
Hypertensive	65.5 \pm 5.1	73.6 \pm 14.1	158.4 \pm 7.0	30.8 \pm 3.7	5.0 \pm 1.8
Normotensive	66.1 \pm 5.3	65.8 \pm 12.6	157.6 \pm 8.2	26.2 \pm 3.9	5.1 \pm 1.5

Note: MBQ, Modified Baecke Questionnaire for Older Adults.

Table 2. Comparison of results of skin sensitivity testing at seven anatomical sites of the dominant hand, before and after resistance training, in hypertensive (n = 15) and normotensive (n = 17) older women. All values expressed as mean \pm standard deviation.

Anatomical site	Hypertensive		Normotensive	
	Pre-training (g)	Post-training (g)	Pre-training (g)	Post-training (g)
1	0.2 \pm 0.5	0.1 \pm 0.1	0.2 \pm 0.5	0.2 \pm 0.5
2	1.0 \pm 1.2	0.6 \pm 0.9	0.1 \pm 0.1*	0.1 \pm 0.1
3	0.3 \pm 0.5	0.2 \pm 0.5	0.1 \pm 0.1*	0.1 \pm 0.0†
4	0.2 \pm 0.5	0.1 \pm 0.1	0.1 \pm 0.1	0.1 \pm 0.1
5	1.0 \pm 1.0	1.1 \pm 1.2	0.3 \pm 0.9*	0.4 \pm 0.6
6	0.1 \pm 0.1	0.1 \pm 0.1	0.1 \pm 0.0	0.1 \pm 0.0
7	0.2 \pm 0.1	0.4 \pm 0.7	0.4 \pm 0.8	0.3 \pm 0.6

Note: g, grams. *significant difference as compared with hypertensive subjects, before training ($P < 0.05$). †significant difference as compared with hypertensive subjects, after training ($P < 0.05$).

DISCUSSION

Comparison of training volume for each exercise and of the total training volume of the entire session showed no significant between-group differences, which indicated that the workload of training was similar in both groups. The main finding of this study was the fact that a single session of resistance training had no apparent effect on the skin sensitivity of hypertensive and normotensive subjects. However, hypertensive participants had different sensitivity at three anatomical sites (2, 3, and 5) before training and at one anatomical site (3) after training when compared to normotensive participants.

As there are no cutoff values for MBQ scores, it is somewhat difficult to classify participants as active or inactive based on this instrument alone. One of the strategies that have been employed for classification consists of comparing MBQ scores of the sample to those reported in the literature. Nascimento et al.¹⁹ sought to investigate the level of physical activity in a sample of older adults from the same municipality where the present study was conducted. The authors found a mean MBQ score of 3.6, with the lower bound of the upper quartile at 3.2 points. In the present study, mean MBQ scores were 5.0 in hypertensive and 5.1 in normotensive participants (Table 1). In addition, all subjects had been taking part in a Physical Activity Program for Senior Citizens (PROFIT) for at least 7 weeks prior to the study, three times a week in 50-minute

sessions, for a total of 150 minutes of exercise per week. According to United States Department of Health and Human Services (USDHHS)²⁰ criteria, people who engage in a minimum of 150 minutes of physical activity per week are considered physically active.¹⁹ Thus, taking into account their MBQ scores and the USDHHS criteria,²⁰ all participants in our sample were considered physically active.

As we were unable to find any studies in the literature that assessed the purported relationship between high or normal blood pressure and skin sensitivity in the elderly, and that reduced skin sensitivity may lead to serious issues such as loss of motor functions,⁹ one of the novel contributions of this study was to clarify this relationship (which is particularly important due to the potential risk it may pose to older adults) and attempt to ascertain whether resistance training can influence sensitivity. It has been established that, depending on the intensity of the external stimulus, touch and pain receptors may activate simultaneously¹⁴; therefore, some prior research focused specifically on pain assessment may help explain the findings of the present study. Several studies have suggested that normotensive people are more sensitive to pain²¹⁻²³ and experience reductions in pain sensation after resistance training and aerobic exercise.¹⁰⁻¹²

Koltyn and Arbogast¹² assessed the influence of resistance training on pain threshold and pain scores in young adults. Subjects took part in a 45-minute strength training session consisting of three sets of 10 repetitions at 75% of 10RM. Pain

stimulus consisted of the application of a Forgiione-Barber pressure stimulator over the middle finger of the left hand (3000 g of force). Results showed that exercise was able to reduce the perception of experimentally induced pain after the strength training session.¹²

In this study, however, there were no significant changes in pre- and post-training skin sensitivity in either group. The pressure exerted by the esthesiometer (0.05g–300g) was probably not sufficient to produce pre- and post-training changes in skin sensitivity, unlike the high load (3000 g) applied in the Koltyn and Arbogast study,¹² perhaps because the esthesiometer does not elicit pain.

In the present study, hypertensive older women had reduced skin sensitivity at some anatomical sites in comparison to normotensive participants, particularly before resistance training (Table 2). Differences in pain sensitivity between hypertensive and normotensive individuals have been associated with greater release of endogenous opioids (sensitivity-modulating factors) and increased activation of baroreceptors in the former group.^{10,14}

Another interesting finding of this study is that hypertensive participants experienced increased sensitivity at point 2 and decreased sensitivity at point 5 after training, whereas skin sensitivity at these two sites remained constant in normotensive women. Both groups thus came to exhibit similar sensitivity values in the aforementioned anatomical sites after training, which suggests that the baseline skin sensitivity of hypertensive and normotensive women may differ.

Koltyn and Umeda¹⁰ recently reported a significant association between resistance training, pain sensitivity, and blood pressure. Although no differences in blood pressure were found after a session of resistance training in a sample of hypertensive and normotensive middle-aged women,²⁴ this absence of effect may not hold true in older women. Therefore, the lack of pre- and post-training BP measurement may be considered a limitation of the present study. Conversely, the similar total training volume of both subject groups (hypertensive and normotensive) may have minimized the potential effects of resistance training on BP in our sample.

Although the results of the present study will help provide a better understanding of the effect of resistance training on skin sensitivity, sensitivity was only assessed in the hand, which precludes extrapolation of our findings to other areas of the body. In addition, the effect of exercise on skin sensitivity may have been influenced by continuous

pressure on the hands (due to contact with exercise machines and free weights) during the training session. Therefore, we suggest that skin sensitivity should also be assessed in other areas of the body.

A major association exists between skin sensitivity and risk of falling, postural control, and motor function.^{2,8,9} The findings of the present study show that older women with hypertension experience reduced skin sensitivity in some areas of the palmar aspect of the dominant hand (Table 2) as compared with normotensive women in the same age range. Depending on the level of skin sensitivity impairment, the efficacy of object handling and the execution of some activities of daily living may be affected.

CONCLUSION

We conclude that a single session of resistance training does not appear to modify skin sensitivity in hypertensive and normotensive older women. However, as compared with normotensive participants, hypertensive subjects exhibited reduced skin sensitivity at three anatomical sites (2, 3, and 5) before resistance training and one anatomical site (3) after resistance training. This study may serve to inform future research seeking to clarify the association between resistance training, blood pressure, and skin sensitivity in older adults.

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