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Artigo original

Effects of whole body vibration exercises on the flexibility and pain level of women with metabolic syndrome: a pilot study

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Abstract

The metabolic syndrome is characterized by a set of risk factors such as diabetes and/or insulin resistance, abdominal obesity, dyslipidemia, hypertriglyceridemia, and high blood pressure, which increases cardiovascular risk. Regular exercise promotes the reduction of coronary risk factors, as well as of the deleterious effects of metabolic syndrome. Whole body vibration exercises (WBVE) performed on the oscillating/vibrating platform are an easy alternative to improve muscle strength and quality of life. Objective: To evaluate the cumulative effects of EVCI on flexibility and pain in women with SMet. Material and Methods: The acute and cumulative effects of the WBVE on the flexibility and pain of ten women, being five in the control group (CG) and five in the WBVE Group (WBVEG), were evaluated by means of the anterior trunk flexion test (ATF) and the numerical scale of pain, for six weeks. Results: In relation to flexibility, the results suggest that in the cumulative effect there was a tendency of improvement ($p \leq 0.05$) in the WBVEG, while in the acute effect, in each session, a significant change was not observed. Considering the level of pain, there was no tendency to improve, in the acute effect. However, in the cumulative effect, there was a tendency of pain reduction ($p \leq 0.05$). Conclusions: It is possible to conclude that WBVE exercise can be a safe and feasible strategy, inducing physiological responses that improve flexibility and reduce the pain level of individuals with metabolic syndrome..

Keywords: Metabolic syndrome; Whole body vibration exercise; Flexibility; Pain.

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Resumo

Efeitos dos exercícios de vibração de corpo inteiro na flexibilidade e no nível da dor de mulheres com síndrome metabólica: um estudo piloto

A síndrome metabólica (SMet) é caracterizada por um conjunto de fatores de risco, como diabetes e/ou resistência insulínica, obesidade abdominal, dislipidemia, hipertrigliceridemia e pressão arterial elevada, que aumenta o risco cardiovascular do indivíduo. O exercício físico regular promove a redução dos fatores de risco coronariano, bem como dos efeitos deletérios da SMet. Os exercícios de vibração de corpo inteiro (EVCI) executados na plataforma oscilante/vibratória (POV) são uma alternativa de fácil aplicação para a melhora também da força muscular e da qualidade de vida. Objetivo: Avaliar os efeitos cumulativos dos EVCI na flexibilidade e na dor em mulheres com SMet. Material e Métodos: Os efeitos cumulativos do EVCI (seis semanas) sobre a flexibilidade e a dor de dez mulheres, sendo cinco no grupo controle (GC) e cinco no grupo de EVCI (GEVCI), foram avaliados por meio do teste de flexão anterior de tronco (FAT) e do nível de dor pela escala numérica de dor (END). Resultados: Em relação à flexibilidade, os resultados sugerem que no efeito cumulativo houve melhora ($p \leq 0,05$) no GEVCI. Considerando o nível de dor, também foi verificado no efeito cumulativo uma redução da dor. Conclusão: Os EVCI seriam capazes de gerar respostas fisiológicas para melhorar a flexibilidade de mulheres com SMet, assim como alterar o nível de dor, no efeito cumulativo.

Descritores: Síndrome metabólica; Exercício de vibração de corpo inteiro; Flexibilidade; Dor.

Resumen

Efectos de los ejercicios de vibración de cuerpo entero en la flexibilidad y el nivel del dolor de mujeres con síndrome metabólico: un estudio piloto

El síndrome metabólico (Smet) se caracteriza por un conjunto de factores de riesgo como la diabetes y/o la resistencia a la insulina, la obesidad abdominal, la dislipidemia, la hipertrigliceridemia y la hipertensión arterial, lo que aumenta el riesgo cardiovascular de Individuales. El ejercicio físico regular promueve la reducción de los factores de riesgo coronario, así como los efectos nocivos de la SMet. Los ejercicios de vibración del cuerpo entero (EVCE) realizados en la plataforma oscilante/

vibrante (POV) son una alternativa fácil de aplicar a la mejora de la fuerza muscular y la calidad de vida. Objetivo: evaluar los efectos de la EVCE sobre la flexibilidad y el dolor en las mujeres con SMet. Material y Métodos: los efectos agudos y acumulativos del EVCE (ses semanas) sobre la flexibilidad y el dolor de diez mujeres, siendo cinco en el grupo de control (GC) y cinco en el grupo EVCE (GEVCE), fueron evaluados por medio de la prueba de flexión anterior del tronco (ATF) y del nivel del dolor. Resultados: en relación a la flexibilidad, los resultados sugieren que en el efecto acumulativo hubo una tendencia de mejoría ($p \leq 0,05$) en el GEVCE, mientras que en el efecto agudo, en cada sesión, no se observó un cambio significativo. Considerando el nivel de dolor, no hubo tendencia a mejorar, en el efecto agudo, sin embargo, en el efecto acumulativo, hubo una tendencia de la reducción del dolor. Conclusión: el EVCE sería capaz de generar respuestas fisiológicas con influencia para mejorar la flexibilidad de las mujeres con SMet, así como cambiar el nivel de dolor en el efecto acumulativo.

Palabras clave: Síndrome metabólico; Ejercicio de vibración de cuerpo enterro; Flexibilidade; Dolor.

Introduction

According to the International Diabetes Federation (IDF), the metabolic syndrome (MetS) is characterized by a set of risk factors that increase the cardiovascular risk of an individual.[1] This grouping of risk factors also includes the increase of pro-inflammatory cytokines.[2] For a diagnosis of metabolic syndrome, the individual must have increased abdominal circumference (> 80 cm for women and > 90 cm for men) associated with at least two other risk factors, such as as dyslipidemia, hyperglycemia, or hypertension.[3] The increase on blood pressure is associated with body mass gain, and it is estimated that 60-70% of hypertensive adults are obese.[4] Insulin resistance is a metabolic disorder that reflects a low ability to displace glucose into target tissues, which raises the risk of cardiovascular complications.[5]

The International Association for the Study of Pain (IASP) has considered pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage".[6] Stefani and Galanti, 2017 reported that the occurrence of osteoarthritis in non-load bearing joints suggests that chronic inflammation in individuals with MetS may alter cartilage metabolism, regardless of excess of body mass.[7] In addition, one of the complications of type 2 diabetes mellitus is diabetic neuropathy that can affect peripheral nerves, including pain fibers.[8] Obesity and overweight increase the risk of vertebral fracture, disc degeneration, and low back pain due to the change in the biomechanics of the vertebral column caused by the new distribution of weight, mainly in the abdominal region.[9] Elderly women with MetS present reduced flexibility and difficulty in performing daily activities compared to those without the disease.[10]

The American College of Sports Medicine (ACSM) reported that flexibility is related to the ability of a joint to perform a complete range of movement. It is dependent on the distensibility of the joint capsule and muscle viscosity.[11] Moreover, it is described that the reduction in the joint amplitude is positively associated with MetS. This would be regardless of age, gender, body composition and functional measures.[12]

Regular exercise is also associated with the improvement of the flexibility[13] and the reduction of the pain level.[14] Furthermore, exercise promotes the reduction of coronary risk factors, as well as the deleterious effects of MetS.[15] An easy, feasible, effective and inexpensive kind of exercise that does not require extensive physical activity of the participant is the whole body vibration exercise (WBVE). WBV is generated when the vibratory stimulus (mechanical vibration) is transferred from an oscillating/vibratory platform (OVP) to the human body or part of it. These mechanical vibrations are sinusoidal and determinist.[16] Parameters such as frequency, peak-to-peak displacement, intensity, and correct positioning of the individual during the WBVE should be properly established in the intervention protocol.[17]

WBVE performed in the OVP shows several beneficial effects on health, including improvement of muscular strength and flexibility in the elderly[18] and pain reduction in young people.[19] In addition, it's recommended for improving balance and to reduce pain in individuals with chronic low back pain.[20]

Improvements were reported on flexibility and pain reduction with ten sessions of WBVE (2 to 3 times per week, 10 to 15 minutes each session) in youngsters.[21] Sometimes, prolonged exposure can induce fatigue and consequent reduction of muscular performance.[22] The vibratory stimulus would act on the neuromuscular system providing acute and chronic adaptations to increase flexibility.[23]

Individuals with overweight or obesity present greater risk of joint lesions and the excess of abdominal fat can adversely alter the levels of flexibility

mechanically restricting the execution of anterior trunk flexion.[12] In addition, diabetics can present chronic pain in the muscles and joints as a result of hyperglycemia.[8]

The aim of this study was to evaluate the cumulative effects of WBVE on flexibility and on the pain level in MetS women.

Material and methods

It is a blind randomized and transversal study that was approved by the Committee of Ethics in Research and registered on the Plataforma Brasil with the number CAAE 0025.0.228.000-11 and registration in the REBEC RBR-2BGHMH.

Ten women aged 18 or above were evaluated with diagnostic criteria for metabolic syndrome, according to the IDF of the Departamento de Clínica Médica of the Hospital Universitário Pedro Ernesto, Universidade do Estado do Rio de Janeiro (UERJ).

The individuals were randomically divided in two groups. Two brown envelopes were offered to the participants and, depending on the chosen, they were included in the control group (CG) or whole body vibration exercise group (WBVEG).

Clinical evaluation

An interview was performed to collect data such as age, height, body mass index, and waist circumference. Comorbidities, medication, smoking, and amount of physical exercise were also noted. The analysis of blood biomarkers was performed to confirm the diagnostics of MetS. Body mass index was obtained by dividing total body mass (kg) by height (m2). Abdominal circumference was verified with a flexible tape measure passing over the umbilical scar.

Anterior trunk flexion

The anterior trunk flexion was determined before and after each session. The individual was asked to perform a previous trunk flexion. In the initial position she stood, then flexed the trunk as much as possible, without flexing the knees and/or extending the neck. The distance from the middle finger to the floor was measured.

The cumulative effect was a result of mean of the differences between the distance from the middle finger to the floor before the interventions (control or WBVE) in all the sessions and the first measure of session number 1.

Pain level

The pain level was verified with a numeric scale of pain. The individuals reported on the level of discomfort or pain by observing a numerical scale from 0 to 10, where zero represented absence of pain and ten, the maximum degree of pain.

The cumulative effect was a result of mean of the differences of the pain perception before the interventions (control or WBVE) in all the sessions and the measure before session number 1.

Interventions

The individuals of the CG were submitted to 5Hz frequency in all stages of the procedure, during 12 sessions (twice a week) on the side alternating oscillating/vibratory platform (Novaplate fitness evolution, DAF Produtos Hospitalares Ltda, from Estek As, São Paulo).

The individuals of the WBVEG performed the whole body vibration exercise on the side alternating oscillating/vibratory platform, during 12 sessions (twice a week), starting with 5 Hz and increasing 1Hz of each session, ending with 16 Hz.

Whole body vibration exercise group

The WBVEG performed the sequence: (a) 1 minute on the marking with peak-to-peak displacement of 2.5mm, followed by 1 minute of rest; (b) 1 minute on marking in 5mm, with 1 minute rest; and (c) 1 minute, at 7.5mm, with 1 minute rest. This sequence was held three times from the 1st to the 4th session, four times from the 5th to the 8th session and five times from the 6th to the 12th session.

Control group

The CG conducted the study with frequency set at 5Hz throughout the intervention period and with the same biomechanical parameters. The time of each exposure was set to 10 seconds.

All individuals adopted the standing position (barefoot) on the basis of the side alternating oscillating/vibratory platform, supporting the hands on the side alternating oscillating/vibratory platform sides and with knees flexed at 130º, alternating between the static position and performing the squatting.

In the CG, the individuals were submitted to 10 seconds of whole body vibration exercise, plus 50 seconds in the static position with the side alternating oscillating/vibratory platform turned off. In the next

session, they performed the squatting, for 10 seconds and 50 seconds with the platform turned off, and rest for 1 minute, at peak-to-peak displacement of 2.5; 5 and 7.5mm. This sequence was held three times from the 1st to the 4th session, four times from the 5th to the 8th session and five times from the 6th to the 12th session.

Statistical analysis

The data of the present study was analysed by using the statistical analysis software of GraphPad Prism 6.0 for windows (GraphPad Software, San Diego, CA, USA). A non-normal distribution was confirmed. The nonparametric Wilcoxon-Mann-Whitney test was applied. The significance level was $p \leq 0.05$.

Results

The ten participants of this study had, according to the interviews, age of 62±12 years old, body mass index of 31,45±5,17 kg/cm^2, and the waist circumference of 110,4±9,32 cm. In comorbidities, 70% reported varicose veins, 90% were on medication for hypertension. They didn't smoke and did low amounts of physical exercise. The analysis of blood biomarkers contributed to the confirmation of the diagnostic of MetS.

Figure 1 shows the cumulative effect of the interventions in the anterior trunk flexion flexibility of women with MetS. A significant ($p \leq 0.05$) improvement in the anterior trunk flexion flexibility of individuals that were exposed to the WBVE (WBVG) was observed in comparison to the participants of the control group.

Discussion

MetS is a multifactorial syndrome that results from the interaction of sedentary behavior, physical inactivity and genetic factors.[24] The current study demonstrated beneficial effects of WBV exercises on individuals with metabolic syndrome. Although this is a pilot study with ten individuals and it has evaluated the cumulative effect, a 6-week (12 sessions) program, twice per week, involving WBVE, improved the anterior trunk flexibility and reduced the pain level of the participants.

Considering the ATF, the intervention with WBVE showed a significant change ($p \leq 0.05$), in cumulative effect (Figure 1). These findings are in agreement with Sá-Caputo et al, who showed improvements in flexibility after a WBVE protocol in individuals with metabolic syndrome.[25] Chang et al described improvements in arm-shoulder flexibility in older people during 12 weeks. In the current study, the protocol had 6 weeks.[26] Moreover, studies have described that WBV exercises could reduce tendon stiffness and hysteresis, alter properties of the intramuscular connective tissue, and possibly modify those of other passive skeletal structures related to the range of motion for a given joint.[27,28]

In relation to the pain level, in the cumulative effect (Figure 2), the results showed a significant pain reduction ($p \leq 0.05$). Neto et al, 2017 reported a significant decrease of the level of pain in the participants with knee osteoarthritis treated with WBVE.[29] Moreover, some studies suggest that WBVE may improve the anti-inflammatory status of elderly individuals,[30] with significant reductions of the plasma concentrations of two inflammatory markers, soluble tumour necrosis factor receptor (sTNFR1) and (sTNFR2),[31] and that WBV

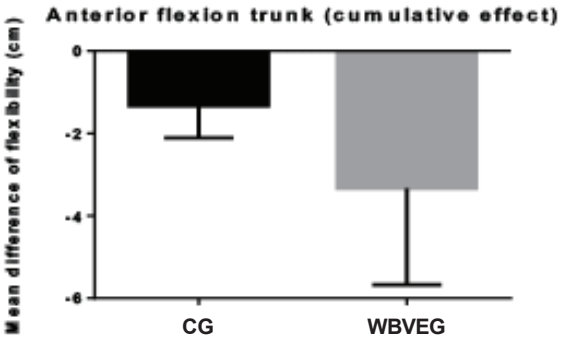

Figure 1. Mean of the differences in distance between middle finger to the floor of the control group (GC) and the whole body vibration exercise group (GWBVE), during anterior trunk flexion (ATF), before and after the WBVE, in the cumulative effect

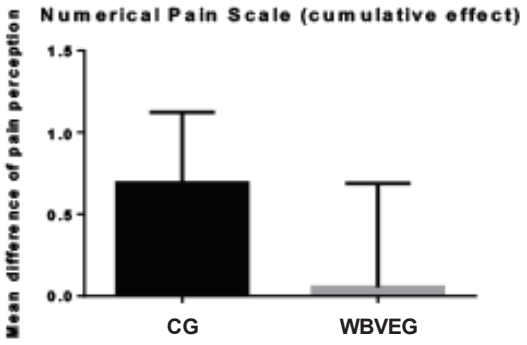

Figure 2. Mean of the differences in pain perception levels of the individuals of the control (CG) and whole body vibration exercise (WBVEG) groups in cumulative effect

may have an effect on the excitability of the peripheral nervous system.[32]

This study has some limitations and must be improved, such as the total of 6 weeks of the protocol of the WBVE and the small sample size. Moreover, only women with metabolic syndrome were evaluated in this study.

It is possible to conclude that WBVE exercise can be a safe and feasible strategy, inducing physiological responses that improve flexibility and reduce the pain levels of individuals with metabolic syndrome.

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