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Randomized study

Impact of the systemic vibratory therapy using two protocols on gait speed of individuals with obesity: a randomized controlled trial.

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Abstract

Introduction: Obesity can influence several changes in body composition, such as increased adipose tissue and alterations in fat distribution. In addition, associated with the aging process, changes are observed in muscle strength, biomechanics, and gait performance, which could increase motor effort and decrease functional independence. The main treatment for obesity consists of lifestyle changes and physical exercise. Systemic vibratory therapy (SVT) is a therapy modality that uses whole-body vibration exercise (WBVE), which can promote benefits in individuals with obesity, including those in the aging process. This study aimed to evaluate the impact of SVT in two protocols on gait speed in individuals with obesity. **Methods**: Thirty-two individuals with obesity, aged over 50 years were randomized into two groups: fixed frequency group (FFG) (n=16, 63.44 + 10.72 years, body mass index 34.21 + 3.86 kg/m2), or variable frequency group (VFG) (n=16, 62.63 + 10.17 years, body mass index 33.87 +4.76 kg/m2). After the randomization, the individuals performed the determined protocol twice a week, for 6 weeks totaling 12 sessions. Gait speed was evaluated before and after the two interventions protocols. **Results**: The gait speed was reduced after the interventions but did not show significant differences ($p>0.05$) comparing before the first and after the last session of WBVE, with the proposed parameters in both protocols. **Conclusions**: WBVE is a viable therapy, and the speed gait was maintained. No reduction in the speed of the walking speed test was observed for the proposed protocols in individuals with obesity. However, due to the sample characteristics, WBVE is a favorable resource to stimulate the regular practice of this kind of exercise, which promotes weight reduction, bone mineral density, leg muscle strength, and arterial profile improvement as mentioned in the literature and may help to promote the health of these individuals.

Keywords: systemic vibratory therapy, obesity, gait speed, whole-body vibration, aging

1. Introduction

Obesity is defined as an excessive accumulation of body fat mass, a condition with a multifactorial etiology that includes genetic, behavioral, environmental, and socioeconomic factors (1). It is related to the result of an energy balance imbalance (between consumed and expended calories) that generates a chronic positive energy balance (2). The diagnosis of obesity is commonly based on the body mass index (BMI), dividing a person's body mass by the square of their height; and individuals with results greater than or equal to 30 (kg/m 2) are considered and classified as individuals with obesity (3-5).

These clinical conditions can influence several changes in body composition, such as an increase in adipose tissue and changes in fat distribution (6). In addition, associated with the aging process, changes are observed in muscle strength, biomechanics, functionality, functional capacity, and gait performance, which could increase motor effort and decrease the functional and operational independence of these individuals (7).

In the context of functional capacity, walking is a fundamental dynamic activity for carrying out activities of daily living and is necessary for the independence of individuals (8). Gait speed has been recognized as a measure of lower limb muscle function. However, with age, the gait tends to become slow, suggesting that everyone selects the speed most compatible with their functional capabilities. Thus, a slow gait appears as a consequence of the physiological process of aging (8). The usual gait speed has been considered a predictor of functional decline, hospitalization, hospital discharge, need for a caregiver, and mortality; in addiction, studies support that low gait speed is associated with frailty, sarcopenia, and increased risk of falls (8-10).

The main treatment for obesity consists of lifestyle changes through a balanced diet and physical exercise (11). Nevertheless, these individuals tend to have low adherence to conventional physical exercise programs, probably due to physical deconditioning, musculoskeletal pain, and lack of motivation (12). Therefore, it would be important to develop other therapeutic possibilities to better serve these individuals.

Systemic vibratory therapy (SVT) is an innovative modality of therapy, produced through a vibrating platform, usually of two models: i) vertical vibrating platform (base oscillates in an up and down movement), and ii) alternating vibrating platform (base makes a lateral movement similar to a seesaw) (13-15). The mechanical vibration produced by the vibrating platform turn-on is transmitted to the whole body of the individual and generates the exercise, which is known as whole-body vibration exercise (WBVE) (14-16). The intensity of this exercise is performed by adjusting the biomechanical parameters: (peak-to-peak displacement or amplitude in millimeters (PPD), frequency in hertz (f), and peak acceleration in multiples of Earth’s gravity (g) or root mean squared acceleration (m/s2) (17). WBVE provides a neuromuscular stimulus that has been used to improve muscle mass in diverse populations, including patients with obesity (16, 18-20). Feng Yang et al. 2017 (20) reported that vibration- based training may be a promising alternative or additional modality to active exercise- based fall prevention programs for individuals with obesity, which can be attributed to the increase in strength caused by vibration training.

A systematic review identified that vibrating devices placed on the feet or ankles were able to improve gait parameters in elderly patients with greater baseline variability (21). Nevertheless, so far, no study has evaluated the impact of SVT on the gait speed of older individuals with obesity. This study aims to evaluate the impact of two whole- body vibration protocols on gait speed in individuals with obesity.

2. Materials and Methods

2.1 *Participants and Ethical Considerations*

The recruitment of the participants occurred from January 2019 to January 2021, at the Universidade do Estado do Rio de Janeiro (UERJ). The WBVE was performed in the Laboratório de Vibrações Mecânicas e Práticas Integrativas (LAVIMPI), Policlínica Universitária Piquet Carneiro, UERJ.

This project was approved by the Research Ethics Committee of HUPE-UERJ with the number CAAE 54981315.6.0000.5259, the registry in the Brazilian Registry of Clinical Trials (ReBEC) with the number RBR 2bghmh and UTN: U1111-1181-1177. The participants of both groups signed a consent form. Consolidated Standards of Reporting Trials (CONSORT) was used to report the steps of the interventions utilized in this study (22).

2.2 *Inclusion and Exclusion Criteria*

The inclusion criteria were individuals of both sexes, over 50 years of age, with obesity according to the classification by body mass index (BMI) > 30 kg/m2 (3,5).

The exclusion criteria were individuals with metallic prostheses, unable to carry out the proposed evaluations and/or interventions, infectious-contagious, neuro-degenerative, pulmonary, or other diseases that disable the performance of the protocol, and those who refuse to sign the consent.

2.3 *Study Design and Randomization*

This investigation is an intervention, longitudinal, and randomized controlled trial study with blinded analysis. In the randomization, a blinded envelope was used for the drawing of the cards with the names of the groups: fixed frequency group (FFG) or variable frequency group (VFG). After the randomization, the individuals were allocated into one of these two groups (FFG or VFG), and performed the protocols twice a week, for 6 weeks, totaling 12 sessions.

2.4 *Interventions*

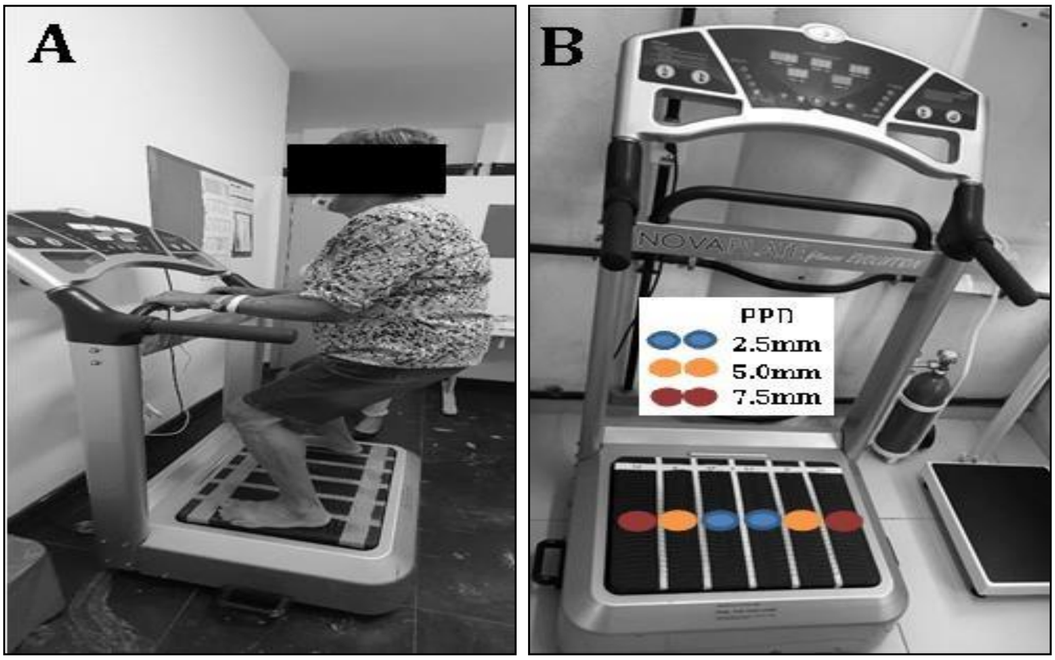
2.4.1 *Fixed Frequency Group (FFG)*

In the FFG protocol, the individuals were positioned in a squat position, barefoot and with 130° knee flexion (Figure 1A). The biomechanical parameters of the mechanical vibration were a frequency of 5 Hz in all sessions; 2.5, 5.0, and 7.5-mm peak-to-peak displacement (PPD) (Figure 1B); and individuals performed static and dynamic squats, interspersed on session days. During the intervention, the work time was 60 seconds (10 seconds of vibration and 50 seconds without vibration, totaling 1 minute), followed by 1 minute of rest in each PPD, totaling one series. From 1 to 4 weeks, the individuals performed 3 series in each session, a total time of 18 min. From 5 to 8 weeks, 4 series were performed in each session, a total time of 24 min. From 9 to 12 weeks, they performed 5 series in each session, a total time of 30 min.

2.4.2 *Variable Frequency Group (VFG)*

In the VFG protocol, the individuals were positioned in a squat position, barefoot, and with 130º knee flexion (Figure 1A). The biomechanical parameters of mechanical vibration were a frequency of 5 Hz in the first session, increasing by one Hz at each session, totaling 16 Hz in the last session; 2.5, 5.0, and 7.5 mm PPD (Figure 1B); and the individuals performed static and dynamic squats, interspersed on session days. During the intervention, the individual performed 1 minute of vibration (work time) and1 minute without vibration (rest time) was performed at each PPD, totaling one series. From 1 to 4 weeks, they performed 3 series in each session, a total time of 18 min. From5 to 8 weeks, were performed 4 series in each session, a total time of 24 min. From 9 to 12 weeks, five series were performed in each session, with a total time of 30 min.

Figure 1. Body and foot positions at each peak-to-peak displacement.



(A) Positioning adopted on the vibrating platform;
(B) Feet position and each peak-to-peak displacement (PPD).

2.5 *Measured Variable*

2.5.1 *Gait Speed Test*

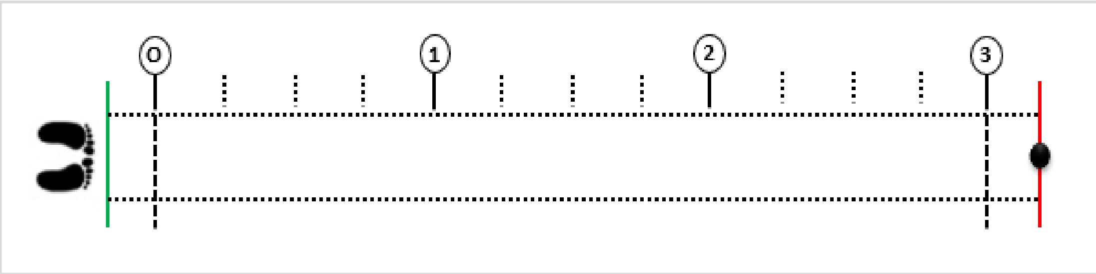
In the current study, the individuals were subjected to the gait speed test (23) for functional assessment before the first and after the twelfth session. In the gait speed test (Figure 2), individuals are instructed to walk a defined distance (3 meters) with normal and usual walking speed from a specific point and to come back. A chronometer was used to measure accurately the gait time. This test was performed twice, and the score considers the smallest time of the 2 attempts: 1, more than 6.52 seconds; 2, between 4.66 and 6.52 seconds; 3, between 3.62 and 4.65 seconds; and 4, less than 3.62 seconds. If the individual was unable to perform the walk, the score is 0. A chronometer (Cronobio SW2018, Brazil) was used in the test.

2.6. *Statistical Analysis*

Data are given as mean and standard deviation (SD). The Shapiro-Wilk normality test was used to assess the distribution of the variable. The total time of execution of the gait speed test was presented through mean and SD. Unpaired and paired t-tests were used. The results were analyzed with the GraphPad Prism 6 program and $p \leq 0.05$ was considered statistically significant.

The sample size was calculated using the GPower ® software (Franz Faul, Universitat Kiel, Germany). Based on the study by Paineiras-Domingos et al. 2018 (23), a sample size of 28 participants was required for an error probability set at 5%, a power of 80%, with 14 participants for each group. However, we consider a 15% loss possibility; 32 participants were recruited, with 16 participants for each group. Data, when necessary, were analyzed by intention to treat.

Figure 2. Illustrative scheme of the gait speed test performed on a track.



The gait speed test performed before and after the two protocols with WBVE.

3. Results

The flow diagram with the enrolment of the study is shown in Figure 3. It is observed that thirty-seven individuals were recruited, and five were excluded in the initial evaluation from the study because met the eligibility criteria or withdrew from participating and not realized the intervention. Consequently, 32 individuals participated in this study, FFG (n = 16) and VFG (n = 16).

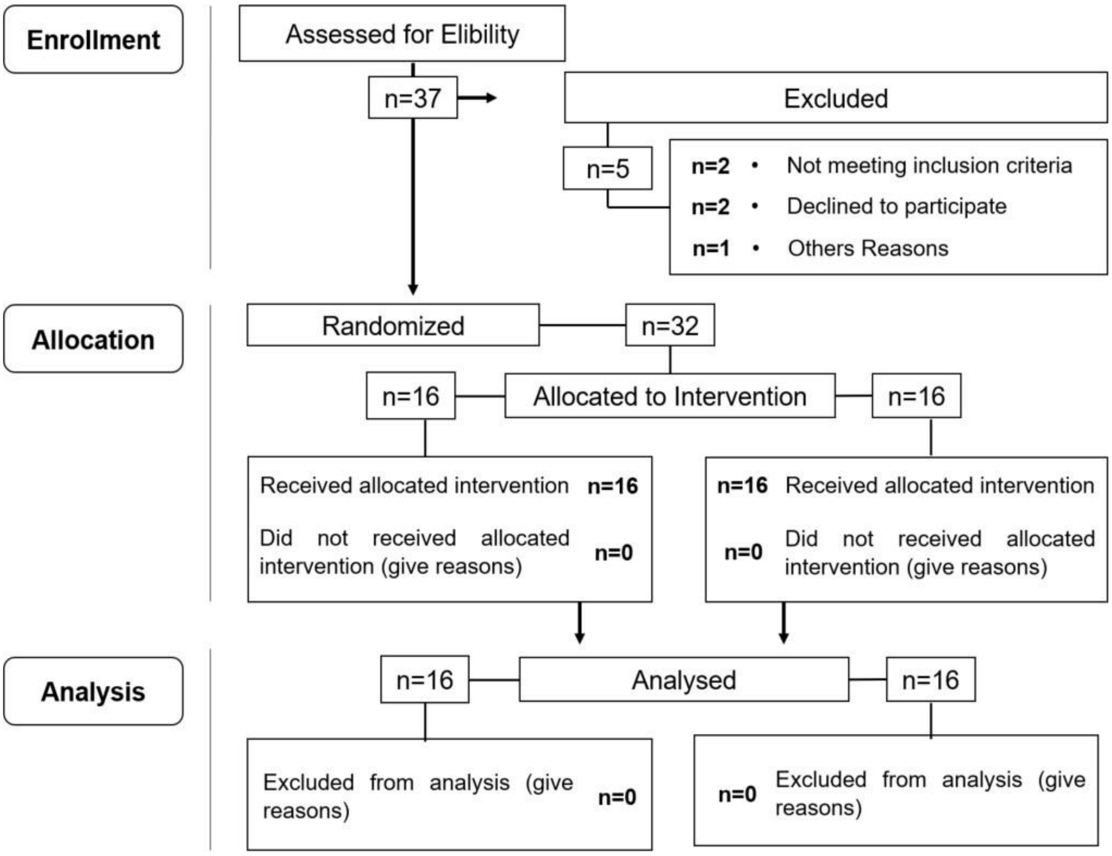
Table 1 shows the characteristics of the volunteers. Homogeneity was observed between groups for all parameters evaluated (sex, age, height, body mass, and BMI).

The gait speed evaluated before and after the intervention with the two different WBVE protocols (FFG and VFG). The gait speed did not show significant differences ($p>0.05$) comparing baseline and the last WBVE session, with the proposed parameters, intragroup and intergroup. However, seems to have a moment effect (pre and post), when we think about the gait time, observed from the mean reduction of 0.35 seconds and 1.45 seconds in the time spent to perform the 3-meter walk, comparing the moments before and after each intervention protocol (FFG and VFG respectively), suggesting a trend towards a significant difference in test performance for the VFG.

4. Discussion

The current findings suggest that systemic therapy through the WBVE did not promote a favorable reduction in the walking speed of the walking speed test in individuals with obesity. However, WBVE is a favorable resource to stimulate the regular practice of this kind of exercise, which promotes body weight reduction, bone mineral density, leg muscle strength, and arterial profile improvement (24, 25) and its regular practice probably may help to promote the health of these individuals.

Figure 3. Flow chart of this study



CONSORT flow diagram of the study.

As well as the results of the current study, Saucedo *et al*. 2021 (26) used a 6-week WBVE protocol in older adults and found no change in walking speed however they used the Time Up and Go (TUG) test and 2-minute and 10-minute walk tests to evaluate the gait speed (26). In the same way, Genest *et al*. 2021 observed no significant decrease in TUG test time in men with osteoporosis that were training WBVE for 6 months (27). Demonstrating that the protocols used in these studies may not have been sufficient to promote a statistically significant change in this indicator of global functional capacity.

However, on the other hand, other studies with WBVE have shown that SVT can be effective in decreasing gait speed in elderly individuals. Kawanabe *et al*. 2007 (28) showed significant improvement in walking speed time after a 2-month intervention with WBVE associated with conventional exercises, through 10-minute walking time. Corroborating with these findings, Simão *et al*. 2012 (29) also showed a significant decrease in gait speed time using the 10-meter walk test after a 12-week WBVE protocol in elderly individuals with osteoarthritis.

Nevertheless, this difference in the Kawanabe *et al*. 2007 (28) and Simão *et al*. 2012 (29) results, when compared to our findings, may be related to the use of different tests to assess the gait speed of the evaluated individuals, as well as tests with longer walking time. However, as the current study was carried out with individuals with obesity and aging individuals, the gait speed test used was over a short distance, simulating everyday walking.

Furthermore, the divergence between these results can be attributed to the type of protocol used, the duration of time and number of series, the number of sessions, and the periodicity of intervention, besides the acceleration or intensity of exercise. The current study used frequencies ranging from (5 to 16 Hz and PPD of 2.5 to 7.5 mm); Sauced *et al*. 2021 (26) (5 to 25 Hz and PPD of 1.3) and Genest *et al*. 2021 (27) (25.5 Hz and PPD of 1 to 3mm). But Kawanable *et al*. (28), although they used a frequency similar (12 to 20 Hz and PPD not reported), the authors added a series of 30 minutes of conventional resistance exercises associated with the WBVE, thus providing an extra stimulus to the vibration and it probably to make a difference in the face of the results found. While Simão *et al*. 2012 (29) used higher frequencies throughout the study (35 to 40 and PPD 4mm).

Table 1. Sample characteristics.

Characteristics	FFG (n=16)	VFG (n=16)	*p*-value
Sex			
F	13 (81,2%)	12 (75%)	--
M	3 (18,8%)	4 (25%)	
Age (years)	63.44 ± 10.72	62.63 ± 10.17	0.827
Height (cm)	160.81 ± 9.68	162.00 ± 7.19	0.696
Body Mass (kg)	76.89 ± 9.71	82.82 ± 10.40	0.105
BMI (kg/m²)	34.21 ± 3.86	33.87 ± 4.76	0.827

BMI, Body Mass Index. Data are presented as mean + SD.

Table 2. Gait speed in baseline (before) and after the last session (12th session) of two SVT protocols in a comparison of intragroup (moments) and intergroup (groups).

Variable	Groups		*p*-value	*p*-value
Gait speed (m/s)	**FFG** (n=16)	**VFG** (n=16)	(moments)	(groups)
Baseline	1.587±0.025	1.593±0.020	0.317	0.423
After protocols	1.581±0.013	1.581±0.014	0.052	0.999

FFG, Fixed Frequency Group; VFG, Variable Frequency Group. Unpaired and paired ***t***-tests were used (groups and moments)

Additionally, a score of <1.0m/s can be considered a slow gait speed (30), and the obese individuals included in this study (Table 2) had a gait speed higher than 1.0m/s, that considered normal (31). In this sense, it can be suggested that the significant improvements observed, with the increase in gait speed may also be related to the profile of populations that may already present impaired gait speed.

In this context, studies suggest that reduced walking speed, with reduced cadence and step length, indicates reduced survival when compared to individuals of the same age and with adequate walking speed (32), which was not observed in our study. Based on this assumption, although obese and aging individuals are already more likely to develop cardiovascular events, Durmurgier *et al*. (33) observed that older with slower walking speeds are three times more likely to die from cardiovascular diseases than older who walked faster. Therefore, the findings of the present study are important for assessing the gait speed of these individuals before and after two different intervention protocols with SVT, using an easy-to-perform and useful measure to assess the effectiveness of the intervention, as well as using a tool capable of early detection of adverse health events.

This study has some limitations. Participants were limited to individuals with obesity (>50 years) who agreed to participate in the study at the time, therefore, it is not possible to generalize the findings to all individuals with obesity. Only one test was used to assess the individual's gait speed. Also, the short distance of the walking speed test selected to simulate everyday walking, might not be enough distance for the obese participants accelerate their gait, showing the true gait speed gain.

The strength of the current study is to identify a therapy strategy using WBVE that is relatively well accepted by the population and does not promote adverse effects on functional capacity. It also allowed the early observation of gait alterations, as an important prevention factor as well as a suggestive factor of possible risks. And, finally, it was able to establish the effects of the intervention, thinking of reducing mortality and future disabilities, inherent in the aging process and the presence of obesity.

Individuals with obesity aged over 50 years did not show a reduction in gait speed. But even so, the intervention with SVT was well tolerated and was an efficient strategy to maintain the walking speed after the intervention period in both used protocols. As perspectives, it would be interesting to evaluate these individuals with a larger sample, as well as to carry out a more refined analysis of the gait components; in addition, gait speed tests with longer tracks and the use of other tests capable of assessing this performance during gait for these individuals are recommended. And finally, to identify the ideal SVT protocol for these individuals.

5. Conclusion

In conclusion, the protocols proposed in this study showed that SVT through WBVE is a viable therapy and the speed gait was maintained. No reduction in the speed of the walking speed test for the proposed protocols in individuals with obesity was observed. However, due to the sample characteristics, WBVE is a favorable resource to stimulate the regular practice of this kind of exercise, which promotes weight reduction, bone mineral density, leg muscle strength, and arterial profile improvement as mentioned in the literature and may help to promote the health of these individuals. Further studies with larger and higher quality trials and longer speed walking tracks are needed to determine the factors that influence gait speed and what the ideal SVT protocol capable of promoting these improvements.

Conflicts of Interest

The author declares no conflict of interest.

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