

ENERGY EXPENDITURE AND SUBSTRATE UTILIZATION DURING WHOLE BODY VIBRATION



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GASTO DE ENERGIA E UTILIZAÇÃO DE SUBSTRATO DURANTE VIBRAÇÃO DO CORPO TODO

GASTO DE ENERGÍA Y USO DE SUBSTRATO DURANTE VIBRACIÓN DE TODO EL CUERPO

Ravena Santos Raulino¹
(Fisioterapeuta)

Fernanda Meira de Aguiar¹
(Fisioterapeuta)

Núbia Carelli Pereira de Avelar²
(Fisioterapeuta)

Isabela Gomes Costa¹
(Fisioterapeuta)

Jacqueline da Silva Soares¹
(Fisioterapeuta)

Ana Cristina Rodrigues Lacerda¹
(Fisioterapeuta)

1. Federal University of the Jequitinhonha and Mucuri Valleys – Healthy and Biological Sciences Faculty - Exercise Physiology Laboratory, Diamantina, MG, Brazil.
2. Federal University of Santa Catarina – University Araranguá; Araranguá, SC, Brazil.

Correspondence:

Núbia Carelli Pereira de Avelar
Federal University of Santa Catarina (UFSC), Campus Jardim das Avenidas, Rodovia Governador Jorge Lacerda, 3201, Araranguá, SC, Brazil. 88900-000.
nubia.carelli@ufsc.br

ABSTRACT

Introduction and Objective: the aim of this study was to investigate whether the addition of vibration during interval training would raise oxygen consumption (VO_2) to the extent necessary for weight management and to evaluate the influence of the intensity of the vibratory stimulus for prescribing the exercise program in question. **Methods:** VO_2 , measured breath by breath, was evaluated at rest and during the four experimental conditions to determine energy expenditure, metabolic equivalent (MET), respiratory exchange ratio (RER), % Kcal from fat, and rate of fat oxidation. Eight young sedentary females (age 22 ± 1 years, height 163.88 ± 7.62 cm, body mass 58.35 ± 10.96 kg, and VO_2 max $(32.75 \pm 3.55 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1})$ performed interval training (duration = 13.3 min) to the upper and lower limbs both with vibration (35 Hz and 2 mm, 40 Hz and 2 mm, 45 Hz and 2 mm) and without vibration. The experimental conditions were randomized and balanced at an interval of 48 hours. **Results:** the addition of vibration to exercise at 45 Hz and 2 mm resulted in an additional increase of $17.77 \pm 12.38\%$ of VO_2 compared with exercise without vibration. However, this increase did not change the fat oxidation rate ($p=0.42$) because intensity of exercise ($29.1 \pm 3.3\% VO_2$ max, 2.7 MET) was classified as mild to young subjects. **Conclusion:** despite the influence of vibration on VO_2 during exercise, the increase was insufficient to reduce body weight and did not reach the minimum recommendation of exercise prescription for weight management for the studied population.

Keywords: oxygen consumption, heart rate, energy metabolism.

RESUMO

Introdução e objetivo: o objetivo deste estudo foi investigar se a adição de vibração durante o treinamento intervalado do exercício elevaria o consumo de oxigênio (VO_2) até o ponto necessário para controle do peso e para avaliar a influência da intensidade do estímulo vibratório para a prescrição do programa de exercícios em questão. **Métodos:** o VO_2 medido a cada respiração foi avaliado em repouso e durante as quatro condições experimentais para determinar o gasto de energia, o equivalente metabólico (MET), a taxa de troca respiratória, o percentual de kcal da gordura e a taxa de oxidação de gordura. Oito mulheres jovens e sedentárias (idade 22 ± 1 anos, estatura $163,88 \pm 7,62$ cm, massa corporal $58,35 \pm 10,96$ kg, VO_2 máx $(32,75 \pm 3,55 \text{ ml O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1})$ realizaram treinamento intervalado (duração = 13,3 min) para os membros superiores e inferiores com vibração (35 Hz e 2 mm, 40 Hz e 2 mm, 45 Hz e 2 mm) e sem vibração. As condições experimentais foram randomizadas e balanceadas em um intervalo de 48 horas. **Resultados:** a adição de vibração ao exercício a 45 Hz e 2 mm resultou em aumento adicional de $17,77 \pm 12,38\%$ do VO_2 , em comparação com o exercício sem vibração. Contudo, esse aumento não alterou a taxa de oxidação de gordura ($p = 0,42$), porque a intensidade do exercício ($29,1 \pm 3,3\% VO_2$ máx, 2,7 MET) foi classificada como leve para indivíduos jovens. **Conclusão:** apesar a influência da vibração sobre o VO_2 durante o exercício, o aumento foi insuficiente para reduzir o peso corporal e não atingiu a recomendação mínima de prescrição do exercício para controle do peso para a população do estudo.

Palavras-chave: consumo de oxigênio, frequência cardíaca, metabolismo energético.

RESUMEN

Introducción y objetivo: el objetivo de este estudio fue investigar si el agregado de vibración durante el entrenamiento por intervalos del ejercicio elevaría el consumo de oxígeno (VO_2) hasta el punto necesario para control de peso y para evaluar la influencia de la intensidad del estímulo vibratorio para la prescripción del programa de ejercicios en cuestión. **Métodos:** el VO_2 medido a cada respiración fue evaluado en reposo y durante las cuatro condiciones experimentales para determinar el gasto de energía, el equivalente metabólico (MET), la tasa de cambio respiratorio, el porcentual de kcal de la grasa y la tasa de oxidación de grasa. Ocho mujeres jóvenes y sedentarias (edad 22 ± 1 años, estatura $163,88 \pm 7,62$ cm, masa corporal $58,35 \pm 10,96$ kg, VO_2 máx $(32,75 \pm 3,55 \text{ ml O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1})$ realizaron entrenamiento por intervalos (duración = 13,3 min) para los miembros superiores e inferiores con vibración (35 Hz y 2 mm, 40 Hz y 2 mm, 45 Hz y 2 mm) y sin vibración. Las condiciones experimentales fueron aleatorizadas y balanceadas en un intervalo de 48 horas. **Resultados:** el agregado de vibración al ejercicio a 45 Hz y 2 mm resultó en aumento adicional de $17,77 \pm 12,38\%$ del VO_2 , en comparación con el ejercicio

sin vibración. Sin embargo, ese aumento no alteró la tasa de oxidación de grasa ($p = 0,42$), porque la intensidad del ejercicio ($29,1 \pm 3,3 \%VO_2\text{máx}$, 2,7 MET) fue clasificada como leve para individuos jóvenes. Conclusión: a pesar de la influencia de la vibración sobre el VO_2 durante el ejercicio, el aumento fue insuficiente para reducir el peso corporal y no alcanzó la recomendación mínima de prescripción del ejercicio para control del peso para la población del estudio.

Palabras clave: consumo de oxígeno, frecuencia cardíaca, metabolismo energético.

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INTRODUCTION

Over time, our energy intake has been increasing in combination with a sedentary lifestyle, leading the population to gain body weight¹. To address this high-energy intake and low-energy output, exercise and caloric restriction have been advocated for weight loss. Maintaining sufficient energetic expenditure is important for the management of body weight, and whole body vibration (WBV) has been widely used in esthetic and health centers as an alternative method for this²⁻⁵. During this exercise modality, the individual stands on a platform that generates vertical sinusoidal vibrations. Mechanical stimuli are transmitted to the body that stimulate primary endings of muscle spindles; the spindles then activate α -motor neurons, resulting in muscle contractions comparable to the tonic vibration reflex^{6,7}.

Some companies have been advocating that a 10-min workout on a vibratory platform is equivalent to 1 h of traditional exercise in terms of weight loss and that a vibratory platform session of 5 min at a vibration frequency of 26 Hz is capable of producing 7800 contractions, which is not possible by conventional exercise⁸. However, the literature suggests that this type of training would not be enough to reduce body weight, as it provides only moderate cardiovascular stimuli similar to what is experienced during moderate walking for young^{9,10} and elderly people^{11,12}. These studies evaluated the stress produced by this stimulus only during the squat exercise; there is a gap in the literature about the efficacy of vibration at achieving the minimum standards of intensity required for the prescription of physical exercise for weight management when interval exercises are performed on the vibration platform involving upper and lower limbs, as observed in esthetic and health centers.

Hazzel and Lemon¹³ used a body vibration (45 Hz and 2 mm) exercise protocol involving several muscle groups to assess cardio respiratory stress in young people. The authors concluded that because WBV increases energy expenditure, this modality could be effective at reducing body fat. However, the authors did not calculate how much that exercise intensity represents in terms of relative (perceptual) exercise intensity; it was not possible to classify the intensity of the exercise to establish whether it would be enough for weight management.

The purpose of this study was to investigate the effects of addition of WBV during a session of interval exercise (multiple dynamic exercises involving the upper and lower body) on the capability to raise oxygen cost, increase energy expenditure and increase fat oxidation to the extent necessary for the prescription of exercise for weight management as well as to evaluate the influence of the intensity of the vibratory stimulus on this exercise prescription. We hypothesized that WBV did not achieve the minimum recommendation for exercise prescription for weight management for the studied population.

METHODS

This study involved eight sedentary young females, age 22.50 ± 1.69 years, height 165.88 ± 8.00 cm, weight 58.91 ± 9.08 kg and body mass index: 21.80 ± 4.76 Kg/m². The subjects visited the exercise physiology laboratory on five separate days with a minimum rest period of 48 hours

between the visits. All individuals selected for the study were considered healthy based on their responses to questionnaires (Par-Q and risk factor), and none of the included participants self-reported neuromuscular or musculoskeletal injuries. The subjects were asked to report the use of any medications. Furthermore, they were instructed to refrain from the following activities prior to testing: participation in strenuous physical activity for 24 h, consumption of caffeine for 48 h, consumption of alcoholic beverages for 24 h and food intake for 2 h. The participants were asked to maintain the same dietary habits, obtain 8 h of sleep, and consume 500 ml of water 2 h prior to each experimental condition.

The participants were notified about the potential risks involved in the study and gave their written informed consent. This study was approved by the Federal University of Jequitinhonha and Mucuri Valleys, Brazil.

The study design included 1 preliminary session followed by 4 randomized and balanced-order experimental conditions, which were separated by 2 days between sessions (figure 1).

The preliminary session included the following measures: a physical examination, anthropometric measurements (height and weight) and peak oxygen consumption evaluation ($VO_{2\text{peak}}$) using a progressive test on a Monark standard ergometer cycle (Maxx, Hidrofit, Belo Horizonte, Brazil). In accordance with the study of Avelar and colleagues¹¹, to avoid any possible effect of anxiety or motor learning on the oxygen consumption during the experimental conditions, each volunteer was familiarized with the vibration platform and the exercise protocol prior to testing. Furthermore, considering that the study was designed in a randomized and balanced order, any possible acquisition/learning of the whole body vibration on physiological variables was minimized during the follow-up.

The test (Balke Protocol) consisted of cycling initially at 25 W and increasing by 25 W every 2 minutes until fatigue. The test was completed when subjects could no longer maintain the required power despite verbal encouragement from the researcher. To measure oxygen consumption, a K4b2 portable gas analysis system (Cosmed, Italy) was used to transmit breath-by-breath data to a computer. The system was calibrated in accordance with the manufacturer's recommendations. Prior to testing, each volunteer was familiarized with the vibration platform and the exercise protocol to avoid any possible effect of anxiety on the physiological variables during the experimental conditions.

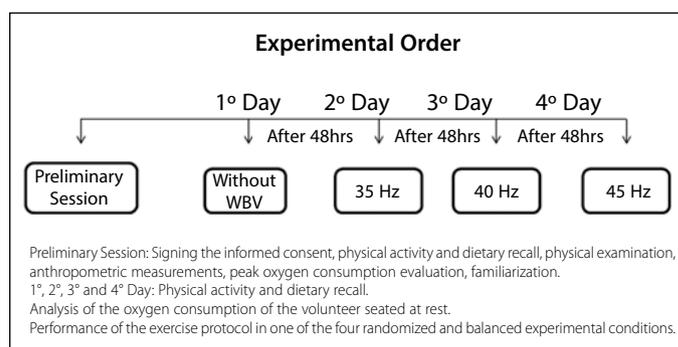


Figure 1. Flow chart of study.

The study consisted of four experimental conditions that included the administration of an exercise protocol without vibration or with vibration (amplitude: 2 mm) at different frequencies (35 Hz, 40 Hz or 45 Hz) (figure 1). To minimize the circadian influence, the participants were tested for all experimental conditions at the same time each day¹². The distribution of experimental conditions was randomized and balanced and separated by 48 hours between sessions.

Before the start of the experimental procedures, the subjects completed a dietary recall and were questioned regarding compliance with the pre-test guidelines.

The exercise session consisted of dynamic exercises involving the major muscle groups of the arms (triceps), abdominals and legs (quadriceps, calves and gluteus); ten repetitions were performed for each muscle group. The subject was instructed to perform a 3-second isometric contraction of the muscle in two pre-set angles using 1 second to change position, so that each bout of exercise lasted 8 seconds and was repeated 10 times. Therefore, each muscle group was exercised for 80 seconds. Between sets, the participant was instructed to rest for 80 seconds on the vibration platform in the standing position. The total exercise session, including the exercise and rest between sets, lasted 13.3 minutes. The choice of this protocol was based on clinical reports stating that a session of 10-min on a vibration platform is equivalent to one hour of traditional exercise⁸.

Before initiating the exercise series, the joint angle was measured for each volunteer using a universal goniometer, and a barrier was imposed to limit the angle of the completion of the exercise (Triceps: 0-90°, abdominals: 45-90°, quadriceps: 10-60°, calves: 0-20° and gluteus: supine hip extension). For temporal control of each exercise, an examiner, through verbal command, was instructed to indicate the maintenance of each predetermined angle. In addition, participants were instructed on proper body positioning (i.e., the correct positioning of the feet, spine, arms and head) during the exercises.

The vibratory exercise was performed using a commercial-model vibration platform (FitVibe, GymnaUniphy NV, Bilzen, Belgium), which produces vertical synchronous vibration in both legs while the platform moves predominately in the vertical direction. This results in simultaneous and symmetrical movement of both sides of the body during exposure⁹. Even for the exercise modality in which vibration was not used, the individual was asked to stand on the vibration platform; however, in this case, the device was switched off.

Exercises

Triceps: The volunteer sat on a mat that was positioned in front of the platform, with the hands placed beside the body, supported on the base of the platform and with legs extended. The movement was performed to achieve 90° flexion and full extension of triceps in a closed kinetic chain, holding for 3 seconds in each position (3 seconds in extension and 3 seconds in flexion).

Quadriceps: The subject stood on the vibratory platform with bare feet separated by a distance of 14 cm from the axis of vibration. The squat exercises consisted of a semi-full knee flexion (10° to 60°) and the maintenance of each posture in isometric contraction for 3 seconds.

Calf: The subject stood on the vibration platform, with hands placed on the control panel, with feet 28 cm apart and with knees flexed at 20°. The volunteer performed the plantar flexion of approximately 20° and remained in position for 3 seconds, returning to neutral position for another 3 seconds.

Abdominal: The subject sat on the vibration platform with feet resting on the floor and to perform voluntary isometric trunk flexion between 90° and 45°, holding the isometric contraction for 3 seconds in each position.

Gluteus: Lying on a mat in front of the vibration platform with feet

resting on the base unit of vibration platform (28 cm between the feet) and with hands beside the body, the subject performed hip extension until the gluteus aligned with the femoral diaphysis; the isometric contraction was held for 3 seconds before returning to the starting position and holding for another 3 seconds.

Oxygen consumption (VO_2) was measured at rest and during the four experimental conditions. To measure oxygen consumption, a K4b2 portable gas analysis system (Cosmed, Italy) was used to transmit breath-by-breath data to a computer. The system was calibrated in accordance with the manufacturer's recommendations.

To measure resting VO_2 , the volunteers were rested, awake and in a seated position and remained in a closed room with the lights off and the curtains drawn for ten minutes¹¹. The VO_2 data were collected breath-by-breath during this period; however, the data used in analysis consisted of the mean values recorded in the final five minutes of the resting period. Immediately afterwards, the volunteers were asked to assume the correct position on the vibration platform where they remained until VO_2 had returned to their resting values. After the data had been collected during the resting phase, the volunteers were asked to perform one of the four experimental conditions: 1). exercise without whole body vibration, 2). exercise with whole body vibration at 2 mm of amplitude and 35 Hz of frequency, 3). exercise with whole body vibration at 2 mm of amplitude and 40 Hz of frequency, 4). exercise with whole body vibration at 2 mm of amplitude and 45 Hz of frequency.

The energy expenditure (kcal/day), respiratory exchange ratio (RER), % Kcal from fat (%) and rate of fat oxidation (g/min) were calculated from VO_2 and RER, assuming that protein breakdown contributes little to energy metabolism¹⁴. The metabolic equivalent (MET) was estimated by considering that 1 MET corresponds to $3.5 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$.

Statistical Analysis

The statistical software program SPSS® (IBM®, Chicago, IL, USA) version 18.0 was used for statistical analysis. The significance level was defined as $p \leq 0.05$. First, the Shapiro-Wilk test was used to verify the normalcy of the data. Next, the differences between conditions were tested using repeated measures ANOVA. Tukey's post hoc test was used to verify the differences among the conditions. To assess the size of the differences among experimental conditions, we analyzed the magnitude of the effects.

RESULTS

The energy expenditure and mean oxygen consumption at rest were $1.30 \pm 0.11 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ and $4.74 \pm 0.74 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, respectively.

During the exercise protocol without whole body vibration, energy expenditure and oxygen consumption increased significantly to $2.32 \pm 0.37 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ and $8.14 \pm 1.29 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, respectively, compared with the resting values ($p < 0.05$) (table 1).

To quantify the percentage of maximal oxygen consumption during the interval exercise protocol without and with whole body vibration at three different intensities, oxygen consumption was measured during a progressive test until fatigue; a mean value of $32.75 \pm 3.55 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ was obtained that represented 100%. The addition of WBV with a frequency of 45 Hz and an amplitude of 2 mm to the exercise protocol resulted in $29 \pm 3\%$ of the maximal oxygen consumption, and only this intensity of whole body vibration promoted an additional increase in energy expenditure ($p = 0.04$) and in VO_2 ($p = 0.00$) compared to the exercise protocol without vibration (table 1). However, this increase did not change the rate of fat oxidation ($p = 0.42$), respiratory exchange ratio ($p = 0.80$), energy expenditure ($p = 0.14$) or percent of calories from fat ($p = 0.17$) compared to the exercise protocol without vibration, as the exercise intensity (approximately 2.7 MET) was classified as light for young people (table 2).

Table 1. Mean \pm standard deviation and percentage (%) of energy expenditure (kcal.kg⁻¹.h⁻¹) and maximum oxygen consumption (ml.kg.min⁻¹) at rest and during different experimental conditions (N = 8). * P <0.05 compared with rest. † P <0.05 compared to the exercise protocol without whole body vibration (WBV).

	Energy expenditure (kcal.kg ⁻¹ .h ⁻¹)	Oxygen consumption (mL.Kg.min ⁻¹)	
	Mean \pm Standard deviation (minimum-maximum)	Mean \pm Standard deviation (minimum-maximum)	% of maximum value
Maximum Value	9.36 \pm 1.01 (7.73-11.34)	32.75 \pm 3.55 (27.06-39.07)	100
Rest	1.30 \pm 0.11 (0.99-1.43)	4.74 \pm 0.74 (4.02-5.35)	13 \pm 3
Without WBV	2.32 \pm 0.37* (1.93-3.06)	8.14 \pm 1.29* (6.95-10.77)	24 \pm 2*
WBV (35 Hz, 2mm)	2.65 \pm 0.40* (2.17-3.28)	9.27 \pm 1.41* (7.58-11.48)	28 \pm 5*
WBV (40 Hz, 2 mm)	2.64 \pm 0.35* (1.99-3.06)	9.24 \pm 1.22* (6.95-10.44)	28 \pm 3*
WBV (45 Hz, 2 mm)	2.71 \pm 1.01* † (2.30-3.25)	9.49 \pm 3.55* † (8.06-11.36)	29 \pm 3* †

Table 2. Mean \pm standard deviation of the respiratory exchange ratio (RER), energy expenditure (EEM), rate of fat oxidation, energetic expenditure from fat and percentage of calories from fat, measured at rest and during experimental conditions (N = 8). * P <0.05 compared with rest. ** P <0.05 compared with exercise protocol without whole body vibration (WBV).

Variables	Rest	Without WBV (minimum-maximum)	WBV 35 Hz (minimum-maximum)	WBV 40 Hz (minimum-maximum)	WBV 45 Hz (minimum-maximum)	p value	Effect size
RER	0.85 \pm 0.03 (0.82-0.03)	0.84 \pm 0.05 (0.79-0.92)	0.85 \pm 0.07 (0.74-0.96)	0.83 \pm 0.04 (0.76-0.9)	0.85 \pm 0.04 (0.79-0.89)	0.80	0.17
EEM (Kcal/day)	2.06 \pm 0.38 (1.54-2.67)	2.29 \pm 0.37 (1.93-2.88)	2.60 \pm 0.46 (1.90-3.12)	2.60 \pm 0.50 (2.00-3.34)	2.68 \pm 0.47 (2.02-3.28)	0.14	0.64
Rate of fat oxidation (g/day)	124.11 \pm 29.01 (75.12-169.64)	177.23 \pm 58.36 (95.06-258.40)	214.95 \pm 114.01 (65.43-395.88)	223.48 \pm 71.03 (102.91-331.28)	212.13 \pm 62.14 (134.68- 299.77)	0.42	0.41
Fat (Kcal/day)	1184.68 \pm 267.33 (1043.13-1594.61)	1484.00 \pm 803.92 (893.56-2428.95)	2020.52 \pm 1071.72 (615.08-3721.29)	2124.38 \pm 668.12 (968.52-3114.06)	1994.04 \pm 584.09 (1266.04-2817.86)	0.17	0.61
% of calories from fat	50.71 \pm 13.75 (29.81-66.62)	53.12 \pm 16.68 (25.22-72.04)	52.29 \pm 21.09 (22.79-87.79)	56.51 \pm 14.51 (31.86-79.74)	51.69 \pm 13.07 (36.68-70.70)	0.80	0.17

DISCUSSION

The main finding of this study was that the intensity of the vibratory stimulus increased energetic expenditure and oxygen consumption during an interval exercise protocol involving multiple dynamic exercises in the upper and lower body, but this augmentation failed to reach the minimum levels of intensity for exercise prescription for weight management for the studied population and was limited to approximately 2.7 METs.

The addition of whole body vibration was able to significantly increase oxygen consumption only at the intensity of 45 Hz and 2mm. These results are in agreement with the data obtained in the study of Wakeling *et al.*¹⁵ in which the authors tested the hypothesis that the increase in muscle activity of the lower limbs produced by the whole body vibration minimizes tissue resonance in response to vibration at frequencies of 10 Hz to 50 Hz (natural frequency of sural triceps, quadriceps and anterior tibial in the relaxed state and active, respectively). The authors showed that the peaks of EMG activity occurred when the frequency of vibration produced by vibrating platform was near the natural frequency values of muscle tissue in activity (approximately 50 Hz). These results suggest that the frequency of 45 Hz may have increased muscle activity in order to promote the spread of vibration damping and, therefore, have produced a significant increase in oxygen consumption compared to the same exercise performed without the addition of whole body vibration. Furthermore, data from our group¹⁶ demonstrated a dose-response curve of the effectiveness of vibratory stimulation on muscular performance (muscular strength and anaerobic performance) only for the frequency of 45 Hz.

The increase in oxygen consumption during whole body vibration exercise at a frequency of 45 Hz was also obtained in the study of Hazell and Lemon¹³, in which the authors used an exercise protocol involving the same muscle groups and at the same vibratory intensity as the present study. The authors observed that the vibratory stimulus was sufficient to increase VO₂ and heart rate in young sedentary participants and inferred that this type of training could reduce body fat.

However, as the authors did not calculate exercise intensity in terms of relative (perceptual) exercise intensity, it was not possible to classify the intensity of exercise to establish whether it would be enough for weight management.

The current literature has indicated exercise intensities around 45% to 65% of the maximal oxygen consumption for weight management¹. Since the addition of whole body vibration with a frequency of 45 Hz and amplitude of 2 mm to the interval exercise protocol resulted in an intensity of only 29% of the maximal oxygen consumption, which is classified as light-intensity [37-45% of maximal oxygen consumption], this method, even when associated with interval exercise, would not reach the intensity threshold for weight loss¹. Moreover, considering that the addition of whole body vibration during a session of interval exercise did not modify the proportion of used energy substrates, this addition probably did not provide additional benefit to increased mobilization of body fat and consequently reduction of fat percentage compared to a session of interval exercise without vibration. However, since light-intensity exercise uses predominantly fat as energy substrate, longer duration of light-intensity exercise could mobilize free fatty acids to the supply of substrate used contributing for the maintenance of fat balance¹⁷.

Current ACSM¹ guidelines on intervention strategies for weight management suggest that moderate-intensity [3.0-5.0 metabolic equivalents, 46-63% of maximal oxygen consumption] aerobic exercise of 150 to 250 min/week results in modest weight loss. Given this, even the addition of WBV with a frequency of 45 Hz and amplitude of 2 mm to the interval exercise protocol resulted in an intensity of only 2.7 metabolic equivalents and 29% of the maximal oxygen consumption, which is classified as light-intensity [2.0 - 2.9 metabolic equivalents, 37-45% of maximal oxygen consumption]. Thus, this method, even when associated with interval exercise, would not promote a sufficient exercise intensity to lose weight¹.

According to McArdle *et al.*¹⁸, moderate-intensity exercise (65% VO_{2max}) elicits a higher rate of fat oxidation compared to exercise at 25% VO_{2max} and 85% VO_{2max}. The exercise intensity in the current study was classified as

very-light (< 37% VO_{2max}) in all experimental situations, and the rate of fat oxidation was not modified by the vibratory stimulus. Furthermore, there was no difference in the respiratory exchange ratio, energy expenditure or percent of calories from fat among experimental conditions (free fatty acids being the predominant energetic supply mobilized)¹⁷. The addition of whole body vibration to interval exercise did not bring additional benefit to the mobilization of body fat and, consequently, a reduction in percentage of fat when compared to exercise without vibration.

In relation to the daily energetic cost needed for weight management, ACSM¹ guidelines recommend an additional energetic expenditure from exercise of 400 or more kcal*day⁻¹. The additional caloric expenditure from the use of vibration (45 Hz and 2mm) was 15.74 kcal/session; it would be necessary to perform interval exercise with vibration (45 Hz and 2 mm) for approximately 6 hour/day meet the standards recommended for weight loss. Therefore, the data from this study do not support the speculations advocated by some companies that a 10-min workout on a vibratory platform is equivalent to 1 h of traditional exercise⁸, suggesting that practitioners should opt other therapeutic modalities for this purpose.

This study has limitations, and the results should be interpreted within the context of these limitations. First, the number of participants does not permit generalization of the results. Thus, we recommend caution in the generalization of our results. Second, it is important to emphasize that

specific frequencies and amplitudes were used, and the results cannot be extrapolated to other parameters of vibration. Future studies are needed to assess the effectiveness of vibration training on body fat loss as well as in other populations, such as overweight and obese individuals.

CONCLUSION

In conclusion, despite the impact of the vibratory stimulus on the intensity and energy expenditure of the proposed interval exercise protocol, the increase obtained was insufficient to reduce body weight and did not achieve the minimum recommendation for an exercise prescription for weight management for the studied population. The reported increase in energy metabolism was via increased oxygen uptake level, which equates to a very light- to light-intensity level. However, future studies are needed to assess the effectiveness of vibration training on body fat loss as well as in other populations, such as overweight and obese individuals.

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