Functional evaluation of physical exercise performed on vibrating platforms

Evaluación funcional del ejercicio físico realizado en plataformas vibratorias

José E. Del Rio Valdivia[2]
Ciria Margarita Salazar C.[1]
Joel Bautista González[1]
Lenin T. Barajas Pineda[1]
José Mauricio Del Río Chacón[1]
Pedro Julián Flores Moreno[1]

[1] Facultad de Ciencias de la Educación, Universidad de Colima, Colima, Mexico
[2] Facultad de Medicina, Universidad de Colima, Colima, Mexico

Correspondence:
Pedro Julián Flores Moreno
pedrojulian_flores@ucol.mx

Short title:
Physical exercise on vibrating platforms

How to cite this article:
Del Río, J.E., Salazar, C.M. Bautista, J., Barajas-Pineda, L.T, Del Río M. & Flores-Moreno, P.J. (2023). Functional evaluation of physical exercise performed on vibrating platforms. *Cultura Ciencia y Deporte, 18*(56), 51-62. https://doi.org/10.12800/ccd.v18i56.1951

Received: 15 July 2022 / ***Accepted:*** 3 February 2023

Abstract

The use of machines that employ mechanical vibrations that transmit stimuli to the whole body through a gravitational load to the neuromuscular system increases muscular grip strength and body balance. Oxygen consumption (VO_2) was evaluated using mechanical vibration platforms in healthy individuals to check their caloric expenditure compared to other forms of physical exercise and to determine its impact on the control of body overweight. 42 men aged 20.28 ± 2.9 years, height 171.35 ± 7.01 cm, weight 67.47 ± 8.75 kg were measured. The Modified Bruce test was applied to assess VO_2 max and a Bioshaker® Compact® model vibrating platform. Each subject remained for15 min in a static position at a vibration of 2,500 cycles per minute, recording VO_2 at 5, 10 and 15 min of the test. VO_2 max. it was 3.01 ± 0.4 L/min, while on the vibrating platform it was 1.03 ± 0.33. The use of vibration platforms generates limited energy expenditure to create significant changes in body weight and consumption of fatty acids to produce energy.

Key words: vibrating platform, energy expenditure, oxygen consumption.

Resumen

El uso de máquinas que emplean vibraciones mecánicas transmiten a todo el cuerpo estímulos a través de una carga gravitatoria al sistema neuromuscular, el cual aumenta la fuerza muscular agarre y balance corporal. El método consistió en evaluar el consumo de oxígeno (VO_2), utilizando las plataformas de vibración mecánica en individuos sanos para comprobar su gasto calórico en comparación con otras formas de ejercicio físico y determinar su impacto en el control de sobrepeso corporal. Se midió a 42 varones sanos con una edad 20.28 ± 2.9 años, talla 171.35 ± 7.01 cm, peso 67.47 ± 8.75 kg. Se aplicó la prueba de Bruce Modificado para la valoración del VO_2 máx. y una plataforma vibratoria marca Bioshaker® modelo Compact®. Cada sujeto permaneció durante 15 min en posición estática a una vibración de 2,500 ciclos por minuto, registrándose el VO_2 a los 5, 10 y 15 min de la prueba. El VO_2 máx. fue de 3.01 ± 0.4 L/min, mientras que en la plataforma vibratoria fue de 1.03 ± 0.33. El uso de plataformas vibratorias genera un gasto energético limitado para crear cambios significativos en el peso corporal y consumo de ácidos grasos para producir energía.

Palabras clave: plataforma vibratoria, gasto energético, consumo de oxígeno.

Introduction

Physical activity (PA) is understood as any voluntary motor action involving energy expenditure caused by skeletal muscles. PA is a necessary component for a healthy lifestyle, however, it is necessary to understand that it is possible to differentiate physical exercise (PE) considered as a type of PA, a process determined by factors of programming, systematization and organization and that influence directly on one or more elements of physical fitness, as well as an indicator of cardiovascular and metabolic risk.

The PE involves organic adaptations that allow the subject to carry out his activities in a more efficient way, in addition to enjoying a state of adequate health by increasing the energy expenditure, both in activity and at rest, causing a change in homeostasis that can be achieved to reflect on the body weight. The balance between energy consumption/expense is achieved in part because skeletal muscles require energy substrates, coming from the catabolism of ingested carbohydrates and lipids, which convert chemical energy into mechanical energy that is then translated into muscle contraction and therefore on the move. On the other hand, aerobic PE performed at intensities ranging from 55 to 70% of the maximum oxygen consumption (VO_2max), promotes the oxidation of fat acids that are mobilized from the adipose tissue (Achten, Gleeson & Jeukendrup, 2002), therefore, causes a decrease in the grease mass.

That is why moderate intensity aerobic activities have been the most used to control body weight; however, exercise performed with resistance or strength also tends to decrease the lipid profile at the blood level (Caamaño-Navarrete, Barría & Floody, 2015), with which a loss of body fat of up to 10% is generated in people with obesity when overload programs are applied, carried out with a frequency of 2 to 3 days per week and with loads greater than 40% of 1RM (Balsalobre-Fernández & Tejero-González, 2015). So, when aerobic exercise and strength exercise are combined, a significant gain in cardiorespiratory capacity and muscle mass is observed, while visceral fat tends to decrease (Simon, Sánchez, Suarez & González, 2021).

Activities such as walking, jogging or cycling, carried out with a frequency of up to five days a week, generate changes in weight, body fat, serum concentrations of triglycerides, total cholesterol, HDL, LDL, glucose, loss of visceral and hepatic fat (Washburn, et al. 2015, Shlisky, et al., 2015, Ross, et al., 2015).

The options for exercising are wide and varied, however, several studies affirm that the most effective methods to cause changes at the body level are those that combine aerobic exercise and muscular strength with nutritional follow-up, however, it becomes necessary to explore other ways. of PE so that the population can choose the most appropriate to their needs and tastes. For example, the use of machines that use mechanical vibrations that are transmitted throughout the body cause stimuli that manage to increase the gravitational load on the neuromuscular system (Tous & Moras, 2004). Likewise, improvements have been reported in vertical jump performance derived from the increase in strength in the outer muscles of the knee (Manonelles, Giménez, Álvarez & García, 2007), increase in muscular performance of the whole body, balance, isometric strength, grip strength and body balance (Torvinen, et al., 2003).

There are still many doubts about the effects of vibrating platforms for body weight control and if we add to this, the interest in staying active in the confinement conditions that have been imposed since the beginning of 2020, the Covid-19 pandemic, We decided to carry out this intervention, whose general objective was to evaluate oxygen consumption (VO_2 m), using mechanical vibration platforms in healthy individuals, to verify their caloric expenditure compared to other forms of PE and determine its impact on overweight control.

Method

A quasi-experimental study design was carried out, in which we worked with 42 healthy men with an age of 20.28 ± 2.9 years, a height of 171.35 ± 7.01 cm, and a weight of 67.47 ± 8.75 kg.

The participants underwent a medical evaluation to determine their state of health, hereditary-family history, recent pathologies and injuries present at the time of carrying out this study, additionally weight and height were recorded according to the standards set by the Society International for the Advancement of Kinanthropometry, ISAK for its acronym in English (Esparza-Ross, Vaquero-Cristóbal & Marfell-Jones, 2019).

The Modified Bruce (MB) test was applied to assess VO_2max. For this, the study subjects were summoned at 07:00 h. fasting and without having performed physical activity the day before. The evaluation protocol was carried out with a Technogym D9.3 treadmill and a Cosmed gas analyzer, Quark CPET model, which was calibrated prior to use.

On different days and under the same fasting conditions and hours, the evaluation of oxygen consumption (VO_2) was performed on a Bioshaker® brand Compact® model vibrating platform. Each subject remained for 15 min in a static position with legs slightly bent and arms in a cross position on the chest at a vibration of 2,500 cycles per minute, recording VO_2 at 5, 10 and 15 min of the test.

Statistical analysis

Central tendency measures were applied to describe the study population. The Kolmogorov Smirnov test was performed to identify the normality of the data (p> 0.05), derived from this, the T test for related samples was applied to identify the differences between the two evaluation protocols. The SPSS v 21.0 program was used for data analysis.

Results

The average maximum oxygen consumption of the participants was 3.01 ± 0.4 L/min while the oxygen consumption obtained while performing the protocol on the vibrating platform was 1.03 ± 0.33. Table 1

Table 1. VO_2 max values. and VO_2 of the participants

Indicator	Results
$VO_{2máx}$.	3.01 ± 0.4
VO_2	1.03 ± 0.33
p valor	0.000

As already mentioned above, the VO_2 max. represents the physiological threshold reached by each participant and therefore it was considered as 100% of the capacity to capture, transport and use oxygen in each individual (Del Río, Velasco & Pérez, 2014), in such a way that when they were compared the results of oxygen consumption (VO_2), obtained on the vibrating platform with VO_2max, it was found that the use of the platform reaches 34.2% of the maximum possible, and that it represents an effort that does not require the mobilization of acids fat stored in adipose tissue.

Through the T-Student statistic, the VO_2max yielded by the Bruce test was compared with the VO2 obtained with the vibrating platform (Bioshaker®), taking into account a 95% confidence level (α = 0.05). Resulting in a highly significant p-value of 0.000. Therefore, there are sufficient statistical tests to consider the relationship between the variables, which implies that oxygen consumption (VO_2) is related to the tests performed (Bruce or Bioshaker®). Figure 1.

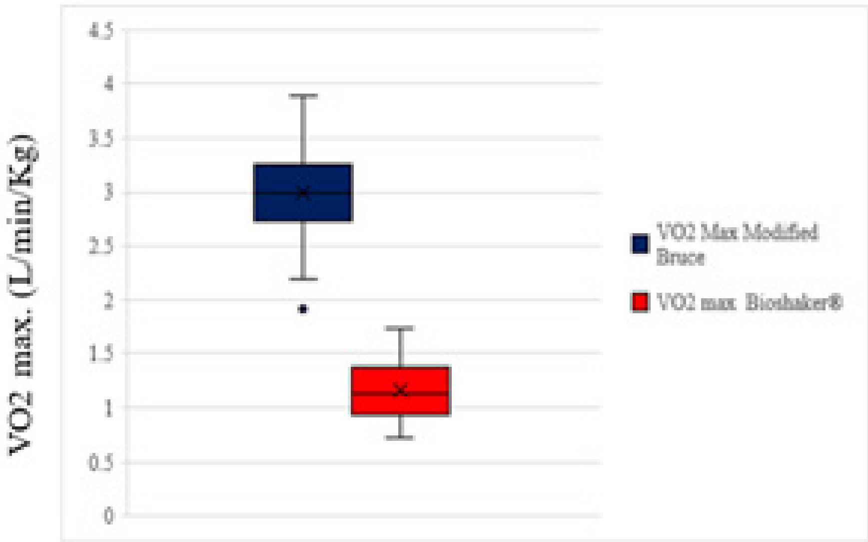

Figure 1. VO_2max. vs study group VO_2

Discussion

The aim of this intervention was to assess oxygen consumption using a mechanical vibration platform in healthy individuals.

The VO_2max. represents the physiological threshold reached by each participant and therefore it is considered as 100% of their capacity to capture, transport and use oxygen and therefore it is a global estimate of physical fitness (Del Rio, Velasco & Pérez, 2014), in such a way that when the results of oxygen consumption (VO_2) obtained on the vibrating platform are compared with VO_2max. It was identified that the study subjects reached 38.2% of the maximum possible on the mechanical vibration platform.

To determine the intensity with which a physical exercise is performed, different methods are used, Londeree & Ames (1976) as well as Pollock, Wilmore & Fox (1990), who calculated the intensity of the exercise based on the theoretical maximum heart rate and what related the percentage of VO_2max.

The use of a vibrating platform in the manner suggested by the manufacturer (15-min sessions) is equivalent to performing a mild intensity physical exercise (such as walking on a horizontal surface), which does not generate a significant impact on the mobilization of adipose tissue in order to catabolize fatty acids to produce energy and therefore influence the loss of body mass. Table 2.

Table 2. Relationship between the percentage of VO_2max, the percentage of HRmax and the intensity of exercise

% HR máx.	% del VO_2 max.	Intensity
< 35 %	< 30 %	Very low
36 - 59 %	30 - 49 %	Light
60 - 79 %	50 - 74 %	Moderate
80 - 89 %	75 - 84 %	Heavy
≥ 90 %	≥ 85 %	Very heavy

Regarding caloric expenditure, the measurement of maximum oxygen consumption with stress tests, as was the case with the modified Bruce test, is considered one of the indirect calorimetry assessment protocols mostly used by experts. With these indirect calorimetry tests, it has been determined that one liter of oxygen consumed per minute allows the body to metabolize the necessary substrates to produce 5 kcal per minute. The study subjects consumed 5.15 kcal per min. Therefore, if the platform is used in periods of 15 minutes a day (according to the manufacturer's instructions), the caloric expenditure it produces is 77.25 kcal. equivalent to performing low-intensity physical activities (Mataix, 2015). Table 3.

Table 3. Energy expenditure of some daily activities and their description

Average energy expenditure (kcal/min)	Activity	Activity description
1.12	Inactivity	Sleep
1.26	Inactivity	Sitting
1.33	Inactivity	Sand still
1.26	Slight inactivity	Writing, sitting, speaking
6.72	Physical conditioning	Exercise bike, 100 W, light effort
8.61	Physical conditioning	Exercise bike, 170 W, moderate effort
3.08	Physical conditioning	Stretching, yoga.
4.27	Physical conditioning	Pilates.
6.16	Physical conditioning	Low impact aerobics.
4.27	Physical conditioning	Climb weightless stairs
6.16	Physical conditioning	Climb stairs with 5 kg of weight
7.35	Physical conditioning	Climb stairs with 10 kg of weight
3.71	Activities at home	intense cleaning
4.9	Activities at home	play with the kids
3.71	Activities at home	Walking pushing the baby carriage
4.9	Aquatic activities	Aqua-aerobic
8.61	Aquatic activities	Freestyle swimming (croll)
8.61	Aquatic activities	Backstroke swimming
9.8	Aquatic activities	Butterfly style swimming
7.98	Aquatic activities	Breaststroke style swimming
3.43	Walk	Walk at 4 km/h, cost below
4.06	Walk	Walking at 4.8 km/h, low terrain
4.69	Walk	Walking at 5.6 km/h, low terrain
7.35	Walk	Walking at 5.6 km/h, uphill
6.16	Walk	Walking at 6.2 km/h, brisk pace
9.17	Walk	Walking at 7.5 km/h, very energetic pace
9.17	Run	Jog at 7.5km/h.
10.15	Run	Run at 8.3 km/h
11.9	Run	Run at 9.7 km/h

Source: Adapted from Londeree & Ames (1976) and Pollock, Wilmore & Fox (1990).

To carry out the physical activities of daily life, the contribution that cardiorespiratory capacity can give to the execution of these tasks adequately is important. In addition to the benefits that it can generate in health, derived from weight control, which consequently reduces the risk of suffering from diseases such as diabetes, hypertension, osteoporosis, among others. About, Méndez, et al., (2021) report that after carrying out a relationship between indicators of muscle strength and oxygen consumption, it was possible to verify that the VO_2 max. is positively associated with muscular endurance, while Becerra, Reigal, Hernández-Mendo & Martín-Tamayo (2013) explain the relationship between physical condition, body composition and self-perception of health in adolescents, demonstrating that VO_2 max negatively predicts the factors, somatic symptoms, anxiety and insomnia.

Regarding the energy expenditure generated by the use of vibrating platforms, it was possible to verify that these machines generate a limited energy expenditure to create significant changes in body weight and consumption of fatty acids to produce energy. The World Health Organization (2012) recommends that physical activity for the age group from 18 to 64 years should be moderate for at least 150 to 300 minutes or vigorous activities for 75 to 150 minutes.

However, the use of vibrating platforms generates a stimulus that supposes for the muscles an increase in the gravitational load that they must support to generate adaptations of different kinds, since results are reported where gymnasts have increased their strength from five to six times more than traditional training (de Hoyo, Páez, Corrales & Da Silva-Grigoletto, 2011), improves static and dynamic balance (Usano, Abián & Abián-Vicen, 2014), modifies the mechanical characteristics of the jump

and muscular behavior improving the speed of shortening of the muscle fiber (Rubio, Martínez, Mendizábal, Ramos & Jiménez, 2012). The use of vibrating platforms is promoted as an alternative for carrying out physical activity, even as an effective method for weight control, therefore, and derived from the results obtained and the discussion carried out, it was concluded that the use of vibration platforms Vibration exercises are not an adequate option to develop cardiorespiratory capacity and therefore an increase in VO_2 max. Consequently, it is limited to generate changes at the level of body mass, so it is not a viable option for weight control.

Bibliography

Achten, J., Gleeson, M., & Jeukendrup, A. E. (2002). Determination of the exercise intensity that elicits maximal fat oxidation. *Medicine and science in sports and exercise*, 34(1), 92-97. https://doi:10.1097/00005768-200201000-00015

Balsalobre-Fernández, C., Tejero-González, C.M. (2015). Efecto del entrenamiento con cargas sobre la grasa corporal en personas obesas. Revisión sistemática / Effects of Resistance Training On the Body Fat In Obese People. Systematic Review. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*. 15 (58) pp. 371-386. https://cdeporte.rediris.es/revista/revista58/artefecto558.htm

Becerra, C. A., Reigal, R. E., Hernández-Mendo, A., & Martín-Tamayo, I. (2013). Relaciones de la condición física y la composición corporal con la autopercepción de salud. RICYDE. *Revista Internacional de Ciencias del Deporte*, 9(34), 305-318. https://doi:10.5232/ricyde2013.03401

Caamaño-Navarrete, F., Barría, M. C., & Floody, P. D. (2015). Efectos terapéuticos del ejercicio con sobrecarga en el perfil lipídico de adultos sedentarios. *Revista de la Facultad de Medicina*, 63(4), 617-623. https://doi:10.15446/revfacmed

Del Río, J., Velasco, J., & Pérez, P. (2014). Ejercicio y mantenimiento del peso corporal. En *México Obeso: Actualidades y perspectivas* (pp. 298-311). Editorial Universitaria: Guadalajara.

Londeree, B. R., & Ames, S. A. (1976). Trend analysis of the% VO_2 max-HR regression. *Medicine and science in sports*, 8(2), 123-125. PMID: 957932.

Esparza-Ros, F., Vaquero-Cristobal, R. & Mafell-Jones, M. (2019). Protocolo internacional para la valoración antropométrica. UCAM Universidad Católica de Murcia. España

Manonelles, P., Giménez, L., Álvarez, J., & García, B. (2007). Efecto de las vibraciones mecánicas en el entrenamiento de fuerza. *Apunts*. Educació física i esports. https://revista-apunts.com/wp-content/uploads/2020/10/087_073-080ES.pdf

Mataix Verdú, J. (2015). Nutrición y alimentación Humana. 2ª Edición. Ed. Ergon. España *Med. Sci. Sports*. Vol. 8. No 2. USA

Méndez, J., Gomez, C., Hecht, C., Urra, A., Alvear, V., Sulla, T., Gatica, M., Cossio, B. (2021). Relación entre indicadores de fuerza muscular con el consumo máximo de oxígeno en jóvenes universitarios. *Salus*, 25(1), 9-14. https://doi:10.54139/salus. v25i1.39

Organización Mundial de la Salud (2012). Obesidad y sobrepeso. Nota Descriptiva No 311. Recuperado de: http://www.who.int/mediacentre/factsheets/fs311/es/

Pollock, M. L., Wilmore, J. H., & Fox, S. M. (1990). Prescribing exercise for rehabilitation of the cardiac patient. *Exercise in health and disease* (pp. 298-373). WB Saunders Company, Philadelphia. https://doi:10.1097/00005768-199901000-00008

Ross, R., Hudson, R., Stotz, P. J., & Lam, M. (2015). Effects of exercise amount and intensity on abdominal obesity and glucose tolerance in obese adults: a randomized trial. *Annals of internal medicine*, 162(5), 325-334. https://doi.org/10.7326/m14-1189

Rubio, A.J., Martínez, F., Mendizábal, S., Ramos, D. & Jiménez, F., (2012). Efectividad de un programa de entrenamiento vibratorio en la mejora de la capacidad de salto. *Archivos de medicina del deporte. XIX,* 152, 967-976. http://femede.es/documentos/OR_03_Efectividad_152.pdf

Shlisky, J. D., Durward, C. M., Zack, M. K., Gugger, C. K., Campbell, J. K., & Nickols-Richardson, S. M. (2015). An energy-reduced dietary pattern, including moderate protein and increased nonfat dairy intake combined with walking promotes beneficial body composition and metabolic changes in women with excess adiposity: a randomized comparative trial. *Food Science & Nutrition*, 3(5), 376-393. https://doi.org/10.1002/fsn3.231

Simón, R. M., Sánchez, A.J. Suarez, W. González, J.A. (2021). Efecto de un programa de ejercicio físico sobre la condición física y la grasa visceral en personas con obesidad. *Retos*, 39, 723-730. https://doi.org/10.47197/RETOS.V0I39.78997

Torvinen, S. (2003). *Effect of whole body vibration on muscular performance, balance, and bone*. Tampere University Press.

Tous, J. & Moras, G. (2004). Entrenamiento por medio de vibraciones mecánicas: revisión de la literatura. *EF Deportes Revista Digital*, 10, 1-25. https://efdeportes.com/efd79/vibrac.htm

Usano, R., Abián, P., & Abián-Vicén, J. (2014). Efectos del entrenamiento con plataforma vibratoria en el equilibrio de mujeres mayores. *Archivos de medicina del deporte: revista de la Federación Española de Medicina del Deporte y de la Confederación Iberoamericana de Medicina del Deporte*, 31(164), 391-396. https://archivosdemedicinadeldeporte.com/articulos/upload/or03_164.pdf

Washburn, R. A., et al., (2015). Energy and macronutrient intake in the Midwest Exercise Trial-2 (MET-2). *Medicine and science in sports and exercise*, 47(9), 1941. https://doi.org/10.1249/MSS.0000000000000611