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Effect of Vibration Produced in a Very Simple System on Physiological and Functional Parameters in Elderly

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Abstract Aging is a process characterized by morphological (structural) and functional changes that accumulate gradually in the body. These changes affect the performance of the motor skills leading to modifications in psychological and social behaviors. Vibration can be produced by different systems. It can be transmitted to the body of a person producing exercises and it has been proposed as a potential clinical intervention. Aim: To evaluate effects of vibration generated in a special system on physiological and functional parameters in healthy elderly. Methodology: It is an experimental and prospective study of healthy elderly (n=30, aging greater than 60 year old) approved by the Ethics Committee. They were divided in control group (CG) (n=10) who did not undergo intervention, kinesiotherapy group (KIG) (n=10) who performed active exercises and vibration Group (EVMG) (n=10) who underwent exercises produced by vibration generated in a simple system like a "mattress". All the subjects were evaluated (i) before and after each session through Timed Up Test (TUT) (functional capacity) and before and (ii) after each day of intervention with physiological parameters (blood pressure and heart rate). Results: It was observed that there was a significant improvement ($p<0.05$) of the TUT in the participants of the EVMG and the KIG, and in physiological parameters in the EVMG, a small, but significant alteration in the systolic (increase of 2.4%) and diastolic (decrease of 3.26%) blood pressure and in heart rate (decrease of 2.81%) ($p <0.05$). Conclusion: In conclusion, the analysis of the results, with elderly participants) indicates that the time to perform the Timed Up Test was shorter in the participants of the kinesioterapy and vibratory groups (*vibromanta* - a system like a mattress) than of the control group. Moreover, although a significant alteration was found in the participants of the vibratory group in the systolic and diastolic blood pressure and heart rate, these alterations are not too elevated.

Keywords Elderly, Physical Therapy, Vibration, Vibratory system

1. Introduction

Aging is a multifactorial, dynamic and progressive biological process characterized by morphological (structural) and functional changes in the advancing age. It affects all physiological systems with changes of motor skills, hampering the adaptation of the elderly to the environment, triggering alterations and changes in psychological and social behaviors. In consequence, there is an impaired capacity to perform daily activities [1].

The World Health Organization reports that in almost every country in the world, the proportion of people aged over 60 years is growing faster than any other age group, as a result of both longer life expectancy and declining fertility rates. It is emphasized that this population ageing can be seen as a success story for public health policies and for socioeconomic development. But, in addition, it is considered that it also challenges society to adapt, in order to maximize the health and functional capacity of older people as well as their social participation and security in all the activities. It is expected that between 2000 and 2050, the proportion of the world's population over 60 years will double from about 11% to 22%. The absolute number of people aged 60 years and over is expected to increase from 605 million to 2 billion over the same period. Brazil is a country in which the population is aging rapidly [2].

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In consequence of the aging, strategies must be taken to improve the quality of life of the elderly population [3]. The aim is to maintain the functional capacity and autonomy of the person in this period of the life avoiding undesirable situations and irreversible problems in several approaches. Among these, falls are one of the most serious consequences of the aging process. They are considered the major public health problem to the elderly due to the morbidity and high social and economic costs [4].

It is important to consider that to counteract the neuromuscular and cardiovascular declines associated with aging, as well as to prevent and treat the frailty syndrome, exercise involving the strength and endurance training seems to be an effective strategy to try to improve muscle hypertrophy, strength and power. [5].

Exercises can be also performed when the person is in a direct contact with vibratory systems [6]. Vibration training has been investigated as an alternative or complement method to traditional programs for fitness improvements [7] or in the rehabilitation programs [6]. Vibratory stimuli can be applied directly to the muscle belly [8] or the tendon muscle [9, 10], indirectly applied by gripping a vibration system [11], dumbbell [12], bar [13] or pulley system [7], or whole body vibration in which the stimuli enters via the feet while standing on a vibration platform [14-16]. Other systems that produce vibrations have been developed, as the *vibromanta* [6].

Vibration is a mechanical stimulus characterized by an oscillatory motion [17]. The effect of the vibration will depend on biomechanical variables that determine the intensity of vibration, such as frequency (Hz), peak to peak displacement (mm), amplitude (mm), acceleration (m/s^2) and duration (second or minute). The frequency is the repetition rate of the oscillatory cycles per second. The peak to peak displacement is the displacement from the lowest to the highest point of the vibration. The maximum displacement from equilibrium is the amplitude [18]. These characteristics of the oscillatory motion determine the magnitude of acceleration wave; duration is the time of exposure to vibration [19].

Investigations have demonstrated that the exercises in oscillating/vibratory platforms generating whole body vibration promote various important effects to the health of the elderly, as improving the muscle strength, cardiovascular parameters [20], body balancing ability [21] and bone mineral density in postmenopausal women [22]. Moreover, Calder et al, 2013 [23] have reported that the fall risk has decreased in elderly. In addition, vibrations produced in different devices can also produce effects in the body, as reducing maximal knee extension in muscles [8] or improving the muscle performance enhancement by direct muscle tendon stimulation [9].

Elderly people may be potential beneficiaries of the use of vibrations. Furthermore, various equipments capable to produce vibration are available [8, 10, 24] as reliable tool for rehabilitation and to promote health and quality of life, including the elderly.

The aim of this current investigation is to evaluate effects of vibration generated in a special system like a mattress (*vibromanta*) on physiological and functional parameters in healthy elderly in comparison with a group submitted to kinesiotherapy.

2. Material and Methods

2.1. Participants

This investigation is an experimental, prospective study with convenience sampling. The participants (n = 30 (24 females and 6 males), aging over 60 years old) are outpatients of the *Clínica Escola da Faculdade Aliança / Maurício de Nassau*, Teresina, Piauí State, Brazil.

2.2. Inclusion and Exclusion Criteria

The participants to be included in this investigation must be aged over 60 years; to have preserved cognition; absence of cardiac, neurological and orthopedic disorders limiting. Moreover, they must have at least six months without physical activity.

The exclusion criteria included bleeding ulcer, pregnant, acute inflammation, fracture, recent stroke, and other surgical scarring, newborn children, labyrinthitis, malignant tumors, diabetes mellitus and deep vein thrombosis. The participants with presence of some discomfort with aphasia of understanding were excluded.

2.3. Ethics Approach

This investigation was approved by the *Comissão Científica e Comitê de Ética da Faculdade Integral Diferencial - FACID (C.E.P. nº 454.417/2013)*. All the participants signed the Consent Informed Consent Form.

2.4. Vibration System

The system is like a mattress (*vibromanta*). It is coated with insulating material (blecauty/sealing light) that prevents heat dissipation. The material is *a special plastic (bagunzito)* that permits to clean it easily. The measurements are 175 cm (length) and 80cm (width). It has heat, but was not used. The system generates a massage in the body when a person is lying in it. There four massage points (head, trunk, thigh and legs, allowing 15 types of vibrations or sequentially at each point, nine individual intensities. The possible frequencies are from 31.45 up to 82.70 Hz and amplitudes ranging from 1.5 up to 1.8 mm. The manufacturer is Nissan-Industry and Trade LTD physiotherapy apparatus, São Paulo.

2.5. Interventions

The participants (n= 30) were randomly divided into three groups. Control group (CG) (n= 10), Kinesiotherapy Group (KIG) (n= 10) and Vibration Group (GVI) (n= 10). The participants of the CG were not subjected to intervention during three weeks. They only performed their normal physical activities. The individuals of the KIG were instructed to perform active exercises based on the OTAGO protocol [24] (total of ten sessions, three times per week). The participants of the GVI were subjected to a protocol ten calls (total of ten sessions, three times weekly) in the *vibromanta* for 16 minutes in each session in the supine position (Figure 1).

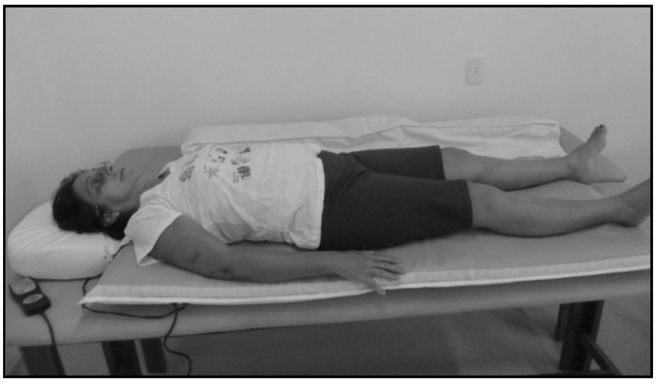


Figure 1. Patient on the *vibromanta*

2.6. Evaluations

The participants of the all groups were evaluated before and after all the procedures of the each group. The *Timed Up Test* [26] was used to verify the functional capacity. The blood pressure (BP), heart rate (HR) and respiratory rate (RR) were used to evaluate the physiological parameters of each participant.

2.7. Blood Pressure (BP) and Heart Rate (HR)

An automated device (OMRON, model HEM-7113, China) was utilized to the measurements of the systolic and diastolic blood pressure (mmHg), and the heart rate (beats per min – bpm), which were measured on the right arm of seated subjects after a 10-minute rest. Means of three readings of systolic and diastolic blood pressure and heart rate were used in the analyses.

2.8. Respiratory Rate

The respiratory rate was determined by observing the number of breaths (inhalation and exhalation) that the patient could perform within one (1) minute.

2.9. Timed Up and Test

*Timed Up and Tes*t assesses the functional capacity through the balance from sitting in a chair to standing, stability in the gait and alterations in the gait without using compensatory strategies [26]. The participant who can perform the test without alteration in the gait in a time less than 10 seconds has minimal risk of falling. Participant with time between 10 and 20 seconds is independent, and, if there is no history of falls or alteration in the gait pattern, they do not need to have further sessions. Participants who perform the test with duration equal or more than 20 seconds, possibly they have postural instability and high risk of falling [27].

The time of the participants of the three groups after the intervention was divided by the time before the intervention and a ratio of effect of the intervention (REI) was calculated.

2.10. Statistical Analysis

Analysis of the data was performed using SSPS® program, version 18.0. Firstly, it was used the Shapiro-Wilk test to assess if the values was following a normal distribution. The statistical difference among the groups was evaluated by the Student t test for paired and to averages to more than two groups, ANOVA was used with with post-hoc Tukey test. It was considered statistically significant value of $p \leq 0.05$.

3. Results

Figure 2 shows physiological parameters (BP, HR and RR) of the participants of the control group, before and after three weeks with normal physical activities. The parameters were determined with a 16 min interval of time. No alterations in these parameters were found in the control group.

Figure 3 shows physiological parameters (BP, HR and RR) of the participants of the kinesiotherapy group that have performed kinesiotherapy in ten sessions. The parameters were determined before the first and after the last session. No significant alterations in these parameters were found in the participants of the group that have performed kinesiotherapy.

Figure 4 shows physiological parameters (BP, HR and RR) of the participants of the Vibratory group that have received vibration generated in the *vibromanta* in ten sessions. The parameters were determined before the first and after the last session. A small, but significant alteration was found in the participants of the vibratory group in the systolic (increase of 2.4%) and diastolic (decrease of 3.26%) blood pressure and heart rate (decrease of 2.81%).

Table 1 shows the results of the Timed Up Test (functional capacity) of the three studied groups. It is observed that a statistical difference after the procedure was found in the participants of the groups that performed kinesiotherapy or were submitted to vibration generated in the *vibromanta*. The effect of the intervention is higher in the kinesiotherapy and vibratory groups in comparison with the control group, as it is shown by the REI.

Table 1. Values of the Timed up Test in the studied groups

Timed Up Test	Before	After	*REI*	*P*
Control Group	12.3 s	12.3 s	1	1.000
Kinesiotherapy Group	13.8 s	11.3 s	0.818	0.001*
Vibratory Group	12.3 s	9.5 s	0.772	0.001*

REI- ratio of the time of the participants of the three groups after the intervention divided by the time before the intervention.
*Statistical difference ($p<0.05$)

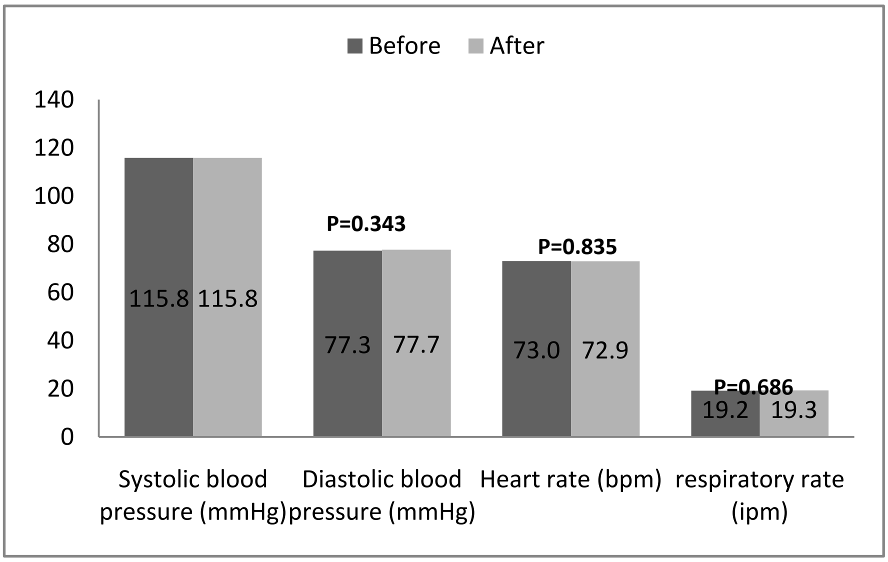


Figure 2. Physiological parameters of the Control group

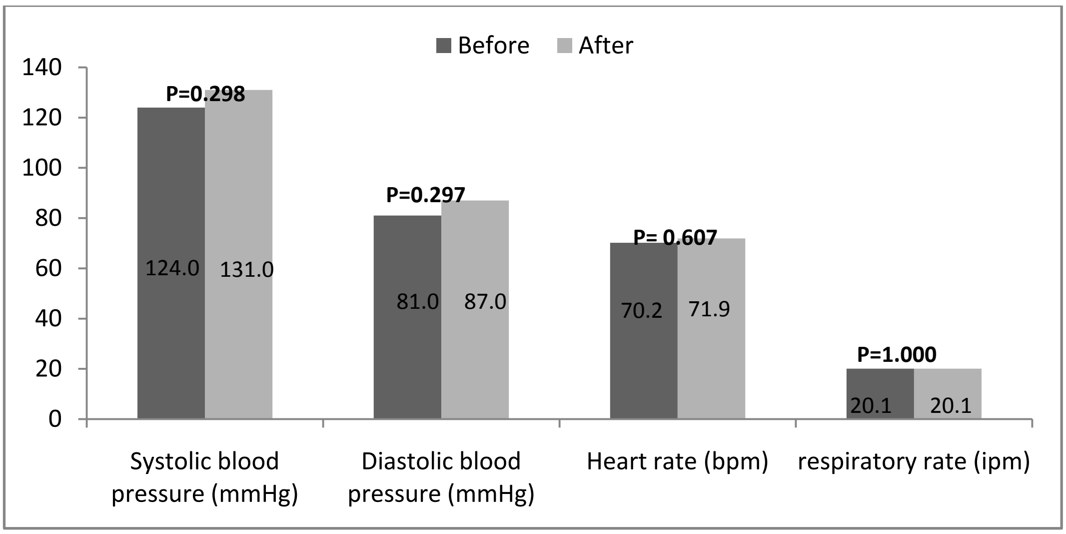
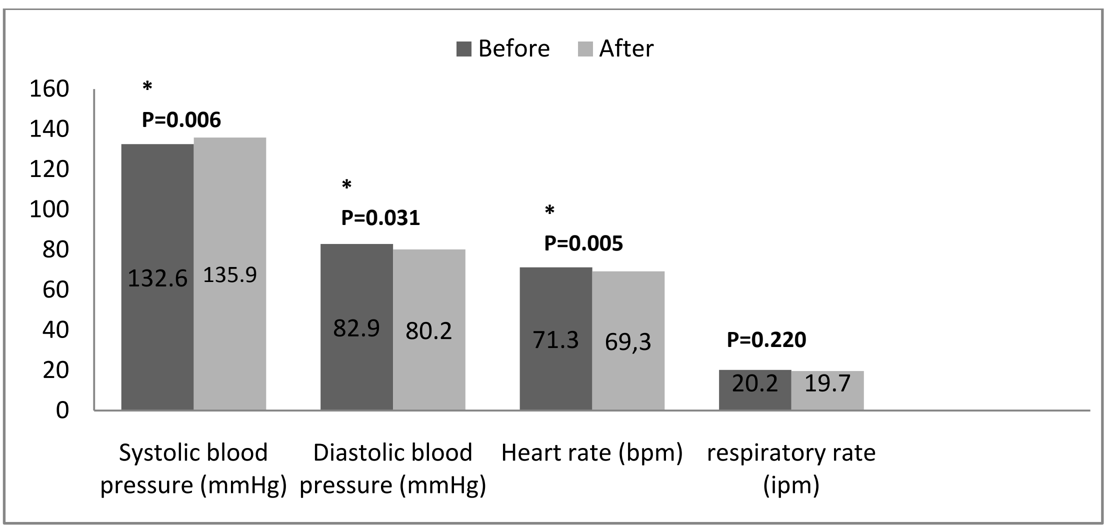


Figure 3. Physiological parameters of the Kinesiotherapy group



*Statistical difference ($p<0.05$)

Figure 4. Physiological parameters of the Vibratory group

4. Discussion

As it was expected, no alterations in physiological parameters (blood pressure, heart rate and respiratory rate) were found in the participants of the control group. These parameters were also not altered in the participants of the kinesiotherapy group. A significant alteration was found in the participants of the vibratory group in the systolic and diastolic blood pressure and heart rate. Considering the time to perform the *Timed Up Test* was shorter in the participants of the kinesioterapy and of the vibratory groups than of the control group. These findings are relevant due to the elevated number of participants female over 60 years old in this current investigation. There are various studies of the vibration generated in oscillating/vibratory platform with female and important effects have been reported [16, 20, 22].

The findings reported in Figure 1 related to physiological parameters of the control group is justified due to participants were not subjected to interventions that could alter homeostasis.

Although the participants of the kinesiotherapy group have performed some exercises following the otago protocols, physiological parameters (blood pressure, heart rate) were not also altered significantly (Figure 3). Nevertheless, Kura et al, 2011 [29] have reported that the sympathetic regulation to the heart and peripheral circulation may undergo adaptations after some kinds of exercise. In the current investigation, the respiratory rate was not modified due to the exercises. Moreover, Kura et al, 2011 [29] have described that immediately post-exercise, respiratory tract increases the respiratory rate lately decreases this rate.

The analysis of the findings shown in Figure 3, some physiological parameters (systolic and diastolic blood pressure and heart rate) were significantly altered due to the vibrations produced in the *vibromanta* and transmitted to the body of the participants of this group. This result could be justified due to the effect of the vibration provides that would increase the muscle blood flow secondarily causing muscle relaxation, thereby interfering in the blood pressure and heart rate [30]. Furthermore, Herrero et al, 2011 [31] have pointed out that whole body vibration exercise produced in the body due to vibration generated in oscillating/vibratory platform is an effective method to increase blood flow and to activate muscle mass in patients with Friedreich's ataxia.

As expected, the performance of the participants of the control group in the *Timed Up Test* was not altered and the value of the REI was 1 (Table 1).

Silva and Schneider, 2011 [32] have reported that the practice of exercise, according to the duration, intensity and time of the activity gradually bring benefits to the individual with improvement of the gait and balance. In the current investigation, it was observed that there was a statistically significant improvement (p<0.05) in the time to perform the *Timed Up Test* in the individuals of the group that have performed exercises (kinesiotherapy) or were submitted to vibration produced in a *vibromanta*. Zambaldi et al, 2007 [33] have evaluated elderly women with balance disorders that have performed exercises twice a week, with one hour for a period of eight weeks. These authors have demonstrated an effective improving in the balance of these women. In addition, Marin et al, 2012 [16] observed that the vibration training (3 times weekly for 4 weeks), showed significant results in body balance. It is suggested that the vibration increases neuromuscular properties and influences the control and execution of the movement, acting directly on proprioception.

5. Conclusions

In conclusion, the analysis of the results, with elderly participants) indicates that the time to perform the *Timed Up Test* was shorter in the participants of the kinesioterapy and vibratory groups (*vibromanta*) than of the control group. Moreover, although a significant alteration was found in the participants of the vibratory group in the systolic and diastolic blood pressure and heart rate, these alterations are not too elevated.

Conflict of interest

The authors declare that there is no conflict of interest in this current investigation.

REFERENCES

[1] Candeloro, J., Caromano, F., 2007, Effect of a hydrotherapy program on flexibility and muscle strength in elderly women., Rev bras Fisioter., 11, 303-309.

[2] World Health Organization. http://www.who.int/topics/ageing/en/, accessed on September, 21st 2014.

[3] Meschial, W.C., Soares, D.F., de Oliveira, N.L., Nespollo, A.M., da Silva, W.A., Santil, F.L., 2014, Elderly victims of falls seen by prehospital care: gender differences., Rev bras epidemiol., 17, 56-62.

[4] Ambrose, A.F., Paul, G., Hausdorff, J.M., 2013, Risk factors for falls among older adults: a review of the literature. Maturitas., 75, 51-61.

[5] Cadore, E.L., Pinto, R.S., Bottaro, M., Izquierdo, M., 2014, Strength and endurance training prescription in healthy and frail elderly. Aging Dis., 5, 183-195.

[6] Batista, M.A.B., Wallerstein, L.F., Dias, R.M., Silva, R.G., Ugrinowitsch, C., Tricoli, V., 2007, Efeitos do Treinamento com Plataformas Vibratórias., R. bras. Ci e Mov., 15, 103-113.

[7] Issurin, VB., Liebermann, D.G., Tenenbaum G., 1994, Effect of vibratory stimulation training on maximal force and flexibility., J Sports Sci., 12, 561-566.

[8] Jackson, S.W., Turner, D.L., 2003, Prolonged muscle vibration reduces maximal voluntary knee extension performance in both the ipsilateral and the contralateral limb

in man., Eur J Appl Physiol., 88, 380-386.

[9] Luo, J., McNamara, B.P., Moran, K., 2005, A portable vibrator for muscle performance enhancement by means of direct muscle tendon stimulation., Med Eng Phys., 27, 513-522.

[10] Moran, K., McNamara, B., Luo, J., 2007, Effect of vibration training in maximal effort (70% 1RM) dynamic bicep curls., Med Sci Sports Exerc., 39, 526-533.

[11] Humphries, B., Warman, G., Purton, J., Doyle, T.L., Dugan, E., 2004, The influence of vibration on muscle activation and rate of force development during Maximal isometric contractions., J Sports Sci Med., 1, 16-22.

[12] Cochrane, D.J., Hawke, E.J., 2007, Effects of acute upper-body vibration on strength and power variables in climbers., J Strength Cond Res., 21, 527-531.

[13] Poston, B., Holcomb, W.R., Guadagnoli, M.A., Linn, L.L., 2007, The acute effects of mechanical vibration on power output in the bench press., J Strength Cond Res., 21, 199-203.

[14] Rittweger, J., Beller, G., Felsenberg, D., 2000, Acute physiological effects of exhaustive whole-body vibration exercise in man., Clin Physiol., 20, 134-142.

[15] García-Gutiérrez, M.T., Rhea, M.R., Marín, P.J., 2014, A comparison of different vibration exercise techniques on neuromuscular performance., J Musculoskelet Neuronal Interact., 14, 303-310.

[16] Marin, R.V., Oliveira, M.L. Rodrigues, H.K.C, Dutra, M. C., Lazaretti-Castro, M. 2012, Efeito de 1 ano de tratamento com plataforma vibratória de baixa intensidade melhora dor e mobilidade funcional em mulheres osteopênicas pós menopausadas., Coleç. Pesqui. Educ. Fís., 11, 85-92.

[17] Cardinale, M., Bosco, C., 2003, The use of vibration as an exercise intervention. Exerc Sport Sci Rev., 31, 3-7.

[18] Rauch, F., Sievanen, H., Boonen, S., Cardinale, M., Degens, H., Felsenberg, D., Roth, J., Schoenau, E., Verschueren, S., Rittweger, J., 2010, Reporting whole-body vibration intervention studies: recommendations of the International Society of Musculoskeletal and Neuronal Interactions., J Musculoskelet Neuronal Interact., 10, 193-198.

[19] Bautmans, I., Hees, E.V., Lemper, J.C., Mets, T., 2005, The feasibility of whole body vibration in institutionalised elderly persons and its influence on muscle performance, balance and mobility: a randomised controlled trial., BMC Geriatr., 15, 5-17.

[20] Bogaerts, A.C.G., Delecluse, C., Claessens, A., Troosters, T., Boonen, S., Verschueren, S.M.P., 2009, Effects of whole body vibration training on cardiorespiratory fitness and muscle strength in older individuals (a 1-year randomised controlled trial). Age Ageing., 38, 448-454.

[21] Cheung, W., Mok, H., Qin, L., Sze, P., Lee, K., Leung, K., 2007, High frequency whole body vibration improves balancing ability in elderly women. Arch Phys Med Rehabil, 88, 852-857.

[22] Lai, C.L., Tseng, S.Y., Chen, C.N., Liao, W.C., Wang, C.H., Lee, M.C., Hsu, P.S., 2013, Effect of 6 months of whole body vibration on lumbar spine bone density in postmenopausal women: a randomized controlled trial., Clin Interv Aging., 8, 1603-1609.

[23] Calder, C.G., Mannion, J., Metcalf, P.A., 2013, Low-intensity whole-body vibration training to reduce fall risk in active, elderly residents of a retirement village., J Am Geriatr Soc., 61, 1424-1426.

[24] Rittweger, J., 2010, Vibration as an exercise modality: how it may work, and what its potential might be., Eur J Appl Physiol., 108, 877-904.

[25] Otago Medical School. Otago exercise programme to prevent fall in older adults. University of Otago, 2003. Available: http://www.acc.co.nz/PRD_EXT_CSMP/groups/external_providers/documents/publications_promotion/prd_ctrb118334.pdf. Accessed November 2nd 2014.

[26] Paula, F.L., Alves Junior, E.D., Prata, H., 2007, Timed up and go test: a comparison between values obtained outdoors and indoors., Fisioter Mov (Online)., 20, 143-148.

[27] Figueiredo, K.M.O.B., Lima, K.C., Guerra, R.O., 2007, Instruments for the assessment of physical balance in the elderly., Rev Bras Cineantropom Desempenho Hum (Impr.)., 9, 408-413.

[28] Monteiro, M.F., Sobral Filho, D,C., 2014, Physical exercise and blood pressure control. Rev Bras Med Esporte., 10, 513-516.

[29] Kura, G.G., Tourinho Filho, H., 2011, Adaptaciones agudas y crónicas de los ejercicios de resistencia en el sistema cardiovascular. Revista Digital. Buenos Aires, 153, 127-158.

[30] Hallal, C.Z., Marques, N.R., Gonçalves, M., 2010, The use of vibration as an auxiliary method to train physical capabilities: a literature review. Motriz rev educ fís. (Impr.)., 16, 527-533.

[31] Herrero, A.J., Martín, J., Martín, T., García-López, D., Garatachea, N., Jiménez, B., Marín, P.J., 2011, Whole-body vibration alters blood flow velocity and neuromuscular activity in Friedreich's ataxia. Clin Physiol Funct Imaging., 31, 139-144.

[32] Silva, P.Z., Schneider, R.H., 2011, Effects of a whole body vibrating platform on postural balance in elderly persons., Acta Fisiatr., 18, 21-26.

[33] Zambaldi, P.A., Costa, T.A.B.N., Diniz, G.C.L.M., Scalzo, P.L., 2007, The effect of balance training in a group of community-dwelling elderly women: a pilot study of a specific, non-systematic and short-term approach. Acta Fisiatr., 14, 17-24.