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Muscular and Hormonal Responses to Whole Body Vibration Exercises in Elderly

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Abstract: Purpose this study was conducted to evaluate the muscular and hormonal responses in elderly males following a program of whole body vibration (WBV) exercise. Subjects Sixty male participants aged from 62 to 75 years were recruited from Hedaya Barakat residential care centre to participate in this study. They divided into two groups: WBV group (n=30) and the control group (n=30). ProcedureWBV exercise was performed at intensity of 12 -20 Hz for duration of 4 minutes, three times weekly, for a total treatment period of eight weeks. Hormonal measurements for testosterone (T) and growth hormone (GH), mechanical measurements for isokinetic plantar and dorsiflexion peak torque, isokinetic knee flexion and extension peak torque were performed. Student's t test for independent samples was used for the statistical analysis, considering $p< 0.05$ as the statistical significance level. Results hormonal measurements showed significant increase in the plasma concentration of T and GH. The mechanical measurements showed significantly improved isokinetic ankle and knee muscle strength. Conclusion exercise program with WBV in elderly men caused an increased plasma concentrations of T and GH, also improved isokinetic ankle and knee muscle strength. Therefore, WBV training can be a beneficial addition to traditional strength programs in elderly.

Key words: Ageing · Hormones · Whole Body Vibrations · Isokinetic Muscle Strength

INTRODUCTION

Aging is commonly defined as the accumulation of various universal, inexorable, undesirable and deleterious physiological changes occurring in cells, tissues and organs with advancing age. These changes are responsible for the increased risk of disease and death [1].

Several theories try to explain the complex and multifactorial process of the ageing [2]. Considering the endocrine theory, the ageing would be due to functional decrements in neurons and a decline in endocrine function involving the responsiveness of tissues as well as reduced hormone secretion [3].

Modifications in body composition and a decline in functional status (Muscular strength, power and flexibility) are associated with the ageing process [4]. Moreover, healthy older individuals have decreased muscle mass, increased fat mass and decreased strength when a comparison with younger individuals is done [5].

Bufler *et al*. [6] state that any intervention able to delay the development of age-related changes in human beings that are not considered as diseases are indicated with the term "Anti-aging medicine". Tosato *et al*. [7] have indicated various possibilities of useful procedures related with the anti-aging, as nutrition antioxidant vitamin supplementation and hormone replacement therapy

Over the last decade, vibration applied as an alternative exercise modality has received increasing interest. Investigations have centered on mechanical vibrations that suggest various physiological benefits from this novel exercise intervention on bone and muscle [8]. It has been suggested that vibration exercise (VE) may be an alternative to heavy resistance training for stimulating musculoskeletal structures [9].

Several studies have suggested that vibration exposure elicits small but rapid changes in muscle length producing reflex muscle activity in an attempt to dampen the vibratory waves. This reflex muscle activation is likely to be similar to the tonic vibration reflex [10].

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Whole body vibration exercises (WBV) in oscillating platform have been proposed as a clinical intervention, to aid to treat several disorders. Some authors have demonstrated that the WBV in vibratory platform are capable to improve ankle plantar flexor strength and power and to enhance of the stability [11]. Moreover, the increase of the plasma levels of some anabolic and catabolic hormones has been reported by some authors [12]. These effects of the WBV are probably related to direct and indirect action. The indirect effects might to be associated with the neuroendocrine system [13].

The aim of this study was to evaluate the muscular and hormonal responses in elderly males following a program of whole body vibration exercise.

MATERIALS AND METHODS

Subjects: Sixty male participants aged from 62 to 75 years were recruited from Hedaya Barakat residential care centre for elderly to participate in this study. They divided into two groups. WBV group (n=30) and the control group (n=30). The study had local research and ethics committee approval and all subjects, guardians gave written consent.

Exclusion Criteria: Only healthy subjects without any history of pathologic or orthopedic limitations were included in the study. No subject was currently engaged in any other exercise programs, Subjects with a body mass index (BMI) below 30 were only chosen.

Procedures

Treatment Procedures: WBV exercise was performed on Galileo machine (Novetec,Pforzheim, Germany),at intensity of 12 -20 Hz for a duration of 4 minutes three times weekly for a total treatment period of eight weeks. the subjects stands with bent hips and knees on a rocking platform with a sagittal axles which alternatively thrust the left and right legs upward and down ward thereby promoting strengthing of the extensors muscles of lower extremities,

The subjects were wearing training shoe and the equipment was in front of a mirror. This condition permits that the subject might observe and control the posture of his whole body. Moreover, a physiotherapist was near of the subject

Hormonal Measurements: The first blood samples were drawn at 8: am from the anticupital vein after the subjects had fasted for 12hours and rested for 1 day, the second samples were obtained on 2nd day after study period. Subjects were instructed not to exercise within 12 hours before blood sampling; serum samples for hormone determinations were kept frozen at-20°C until assayed. The assays for serum total testosterone (T) and growth (GH) hormones were performed by radioimmunoassay (RIA),

Mechanical Measurements: Isokinetic Muscle Strength: Isokinetic performance of the right lower limb muscles was measured with a Biodex System 3 isokinetic dynamometer (Biodex Medical Systems Inc, Shirley,NY).

The values of the peak torque (Nm) of the right plantar flexors and dorsiflexors were used for the data analysis. The peak torque was determined as the single repetition with the highest muscular force output (Nm) of the multiple test trials. The values of the peak torque (Nm) of the right knee flexors and extensors were used for the data analysis [14].

Statistics: To analyze the variables investigated between the groups, Student t-test was used for independent samples, considering a significance level of 95% ($p < 0.05$). The statistical analyses were performed with Statistical Package for Social Sciences (SPSS).

RESULTS AND DISCUSSION

The results obtained show that training with WBV treatments induces increased blood concentrations of T and GH. These results were similar to that of Bosco *et al.* [12] who studied the hormonal response to whole body vibration in men and concluded that acute exposure to WBV causes an increased plasma concentration of T and GH and a decreased plasma concentration of cortisol (c). The increases in neuromuscular effectiveness and T concentration were simultaneous but independent responses; however the two phenomena may have a common Mechanism.

Concerning to the GH, Bosco *et al*. [12] and Kvorning *et al*. [15] found an increase in the plasma concentration, however, Di Loreto *et al*. [13] and Cardinale *et al*. [16] did not find any alteration.

Concerning to the testosterone, Bosco *et al.* [12] have reported an increase, however, the other authors [13, 16] have not found any modification in the concentration of this hormone.

Table 1: General characteristics of both groups

Variable	WBV group	Control group	P	Significance
Age	69.83±0.59	69.59±0.64	0.110	NS
Weight	60.00±1.41	59.06±1.87	0.101	NS
Height	155.83±2.19	157.72±4.11	0.212	NS
BMI	23.21±3.01	24.65±1.34	0.083	NS

Table 2: Mean, slandered deviation and significance of testosterone and growth hormones.

Variable	WBV group	Control group	#p
Testosterone(nmol.$1^{-1)}$			
Pre	22.8±4.3	21.8±11	Ns
Post	25.2±3.5 **	22.3±13	P <0.05
Growth hormone(ng.ml^{-1}			
pre	6.4±5.07	7.6.±6.2	Ns
post	11.6±3.80**	7.0±7.6	P <0.05

**p< 0.05 within group between pre- and post-training (Paired t -test); #p value between exercise and control group

Table 3: Mean, slandered deviation and significance of isokinetic measurements

Variable	WBV group	Control group	#p
Knee extension 60_•s_1)			
Pre	92.35±30.68	91.82±32	Ns
Post	114.98±40.00**	92.30±43	P <0.05
Knee flexion (60_•s_1)			
pre	66.36±20.61	70.21.±22.2	Ns
post	74.25±34.80**	69.30±23.6	P <0.05
Ankle plantar flexion (30_•s_1)			
pre	70.81± 22.82	69±23.97	Ns
post	90.09±28.29**	72±14.88	P <0.05
Ankle dorsiflexion (30_•s_1)			
Pre	11.20± 5.37	13±3.42	Ns
Post	16.99± 9.99**	11±8.99	P <0.05

**p< 0.05 within group between pre- and post-training (paired t -test); #p value between exercise and control group

Probably the differences in the findings could be associated with the protocol utilized, as well as, the characteristics of the subjects submitted to the WBV exercises. In this sense, two meta-analysis were recently published by Marín *et al*. [17] showing that the magnitude of the strength and power gains elicited by vibration training are strongly dependent on: training status, gender, vibration application, as well as exercise protocol.

Recent studies provide evidence that mechanical vibration induced activation of muscle afferent is capable of producing a hormonal response by modulating the releases of Bio-assayable growth hormone in both rats [18] and humans [19]. This novel muscle afferent pitutary axis has been suggested to be involved in the maintainance of muscloskeletal integrity [18].

It is evident from several studies that the force genertating capacity of human skeletal muscles can be affected both acutely and chronically by exposture to mechanical vibration [20].

In the present study a WBV program improved isokinetic ankle and knee muscle strength of the subjects after 8-weeks training period. These findings are in accordance with those of several authors, affirming that WBV increases the dynamic strength of the lower extremity muscles [21].

Roelants *et al*. [22] investigated the effects of 24 weeks of WBV on knee extension strength in 89 postmenopausal women in a randomized controlled study. Isokinetic and dynamic strength of the knee extensors increased in both WBV and traditional resistance training

groups, with the training effects not significantly different between the groups. Similarly, Delecluse *et al*. [21] concluded that a WBV program can induce a strength gain in the knee extensors of previously untrained females to the same extent as a traditional resistance training program

Previous authors [21, 23] have tried to find a plausible explanation for these positive effects of vibration training. Some investigators have suggested that the large strength gain is the result of the tonic vibration reflex. They stated that standing on a vibration plate provokes length changes in the muscle that stimulate the muscle spindles. (In these studies, knee flexor and extensor muscles were tested.) These receptors would elicit the tonic vibration reflex. In addition, it has been proposed that the recruitment thresholds of the motor units during WBV are expected to be lower than during voluntary contractions, probably resulting in a more rapid activation and training of high-threshold motor units. Therefore, it has been suggested that WBV training specifically trains fast-twitch fibers, which are responsible for explosive power [24].

The limitation of our study was that we have not studied the length of the training effects. Therefore, future researchers should include a follow-up of the length of the training effects.

In conclusion, we have shown that exercise program with WBV in elderly men caused an increased plasma concentrations of T and GH, also improved isokinetic ankle and knee muscle strength. Therefore our findings support that WBV training can be a beneficial addition to traditional strength programs in elderly.

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REFERENCES

1. Tosato, M., V. Zamboni, A. Ferrini and M. Cesari, 2007. The aging process and potential interventions to extend life expectancy. Clin Interv Aging, 2:401-412.
2. Troen, B.R., 2003. The Biology of Aging. Mount Sinai J. Med., 70: 3-22.
3. Weinert, B.T. and P.S. Timiras, 2003. Theories of aging. J. Appl. Physiol, 95: 1706-1716.
4. Shephard, R.J., 2009. Independence: a new reason for recommending regular exercise to your patients. Phys. Sports Med., 37: 115-118.
5. Chahal, H.S. and W.M. Drake, 2007. The endocrine system and ageing. J. Pathol., 211: 173-180.
6. Bufler, R.N., M. Fossel and S.A. Harman, 2002. Is there an anti-aging medicine? J Gerontol A Biol Sci Med Sci., 57A: B333-338.
7. Tosato, M., V. Zamboni, A. Ferrini and M. Cesari, 2007. The aging process and potential interventions to extend life expectancy. Clin Interv Aging, 2: 401-412.
8. Rubin, C., A.S. Turner, S. Bain, C. Mallinckrodt and K. McLeod, 2001a. Anabolism. Low mechanical signals strengthen long bones. Nature, 412: 603-604.
9. Rubin, C., G. Xu and S. Judex, 2001b. The anabolic activity of bone tissue, suppressed by disuse, is normalized by brief exposure to extremely low-magnitude mechanical stimuli. FASEB J), 15: 2225-2229.
10. Cardinale, M. and C. Bosco, 2003. The use of vibration as an exercise intervention. Exerc Sport Sci Rev), 31: 3-7.
11. Rees, S.S., A.J. Murphy and M.L. Watsford, 2008. Effects of whole body vibration exercise on lower-extremity muscle strength and power in an older population: a randomized clinical trial. Phys. Ther., 88: 462-470.
12. Bosco, C., M. Iacovelli and O. Tsarpela, 2000. Hormonal responses to whole-body vibration in men. Eur. J Appl. Physiol., 81: 449-454.
13. Di Loreto, C., A. Ranchelli and P. Lucidi, 2004. Effects of whole-body vibration exercise on the endocrine system of healthy men. J. Endocrinol. Invest., 27: 323-327.
14. Tredinnick, T.J. and P.W. Duncan, 1998. Reliability of measurements of concentric and eccentric isokinetic loading. Phys Ther, 68: 656-659.
15. Kvorning, T., M. Bagger, P. Caserotti and K. Madsen, 2006. Effects o vibration and resistance training on neuromuscular and hormonal measures. Eur. J. Appl. Physiol., 96: 615-625.
16. Cardinale, M., R.L. Soiza, J.B. Leiper, A. Gibson and W.R. Primrose, 2008. Hormonal responses to a single session of whole body vibration exercise in elderly individuals. Br. J. Sports Med., [Epub ahead of print
17. Marin, P.J. and M.R. Rhea, 2010. Effects of vibration training on muscle power: a meta-analysis. J. Strength Cond. Res., 24: 871-878.
18. Gosselink, K.L., R.R. Roy, H. Zhong, R.E. Grindeland, A.J. Bigbee and V.R. Edgerton, 2004. Vibration-induced activation of muscle afferents modulates bioassayable growth hormone release. J Appl Physiol, 96: 2097-2102.

19. McCall, G.E., R.E. Grindeland, R.R. Roy and V.R. Edgerton, 2000. Muscle afferent activity modulates bioassayable growth hormone in human plasma. J Appl Physiol, 89: 1137-1141.
20. De Ruiter, C.J., R.M. Van der Linden, M.J. Van der Zijden, A.P. Hollander and A De Haan, 2003. Short-term effects of whole-body vibration on maximal voluntary isometric knee extensor force and rate of force rise. Eur J Appl Physiol), 88: 472-475.
21. Delecluse, C., M. Roelants and S. Verschueren, 2003. Strength increase after whole body vibration compared with resistance training. Med Sci Sports Exerc, 35: 1033-1041.
22. Roelants, M., C. Delecluse and S. Verschueren, 2004. Whole body vibration training increases knee-extension strength and speed of movement in older women.J Am Geriatr Soc., 52: 901-908.
23. Ronnestad, B.R., 2004. Comparing the performance-enhancing effects of squats on a vibration platform with conventional squats in recreationally resistance-trained men. J Strength Cond Res, 18: 839-845.
24. Rittweger, J., G. Beller and D. Felsenberg, 2002. Acute physiological effects of exhaustive whole-body vibration exercise in man. Clin Physiol., 20: 134-142.