Journal of Medicine and Medical Science Vol. 2(6) pp. 925-931, June 2011
Available online @http://www.interesjournals.org/JMMS


*Full Length Research Paper*

# The Ageing, the Decline of Hormones and the Whole-Body Vibration Exercises in Vibratory Platforms: a Review and a Case Report

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Accepted 15 May, 2011

**Aging is the accumulation of various physiological changes occurring in cells, tissues and organs with advancing age. The ageing would also be due to functional decrements in neurons and in endocrine function. Whole body vibration exercises (WBV) in oscillating platform are a clinical intervention to aid to treat several disorders. The increase of the plasma levels of some hormones has been reported. The aim of this work is to present a brief review of papers involving the utilization of WBV in vibratory platform and the effect on the hormonal levels (HL) considering the publications found in the databank PubMed. A case report involving the use a protocol with oscillating platform at 5 up to 9 Hz, in which the level of testosterone level was measured just before and after the WBV exercise, was also showed. The search was performed using the expressions "whole body vibration", "whole body vibration exercises", "whole body vibration" and hormone, and "whole body vibration exercises" and hormones. The number of publications (NP) involving WBV, exercises and hormone were also determined. An important NP was found with "whole body vibration" alone and a small number with "whole body vibration" and hormone. After the sessions has occurred an increase of the 50.1% in quality of daily conditions of the man. The plasma testosterone in the man after treatment has increased 8.43%. However, further studies are necessary to generate information about the oscillating platform and the influence of the exercises in it to alter the level of determined hormones.**

**Keywords:** Ageing, Hormones, Whole-body vibration exercises, Vibratory platforms

## 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 (Troen, 2003; Harman, 2003; Tosato et al., 2007).

Several theories try to explain the complex and multifactorial process of the ageing (Troen, 2003; Tosato et al., 2007; Weinert and Timiras, 2003). Considering the endocrine theory, the ageing would be due to

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functional decrements in neurons and a decline in endocrine function involving the responsiveness of tissues as well as reduced hormone secretion from peripheral glands. Alterations in the central mechanisms controlling the temporal organization of hormone release, with a dampening of circadian hormonal and non-hormonal rhythms are also observed. Modifications in body composition and a decline in functional status (muscular strength and power, flexibility) are associated with the ageing process (Troen, 2003; Chahal and Drake, 2007; Shephard, 2009; Rees et al., 2008). Moreover, healthy older individuals have decreased muscle mass, increased fat mass and decreased strength when a comparison with younger individuals is done (Chahal and Drake, 2007).

Bufler et al (Bufler, et al 2002) 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 (Tosato et al., 2007) have indicated various possibilities of useful procedures related with the anti-aging, as nutrition (antioxidant vitamin supplementation, caloric restriction) and hormone replacement therapy.

Shephard (Shephard, 2009) has reported that there are many good reasons to advise regular and adequate physical activity due to (i) longevity seems extended by up to 2 years, and (ii) the risk of a wide range of chronic disorders is substantially reduced. Yan et al (Yan et al., 2009) have reported that low-intensity strength exercise program had statistically significant declined in the number of falls and level of pain in a population of elderly.

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 (Rees et al., 2008) and to enhance of the stability (Cheung et al., 2007). Moreover, the increase of the plasma levels of some anabolic and catabolic hormones has been reported by some authors (Bosco et al., 2000; Goto and Takamatsu, 2005; Di Loreto et al., 2004). These effects of the WBV are probably related to direct and indirect actions (Santos-Filho et al., 2010; Prisby et al., 2008). The indirect effects might to be associated with the neuroendocrine system (Prisby et al., 2008).

The parameters used in the oscillating platforms, that have some devices, are mainly the frequency and the amplitude. Furthermore, the protocols cited are related to the number of sessions (acute or chronic effects) and in each session it is necessary to consider (i) the number of sets, (ii) the time of working in each set and (iii) the time to rest between the sets. These conditions are established to each author (Rees et al., 2008; Cheung et al., 2007; Bosco et al., 2000; Goto and Takamatsu, 2005; Di Loreto et al., 2004; Cardinale and Wakeling, 2005 ).

The qualitative measurement of the effectiveness of a treatment can be ascertained through visual analog scales (VAS). VAS has been shown to be effective for measuring perceived pain in clinical and therapeutic environments and in another clinical situation (Sayers, et al 2001).

To our knowledge no previous studies have measured the effectiveness of oscillating platform with low frequency (5 up to 9 Hz) for altering the plasma level of hormones. Therefore, the aim of this work is to present a brief review of papers involving the utilization of WBV in vibratory platform and the effect on the hormonal levels considering the publications found in the databank PubMed. A case report involving the use a simple protocol with oscillating platform at 5 up to 9 Hz, in which the level of testosterone was measured just before and after the WBV exercise is also presented.

## MATERIAL AND METHODS

### Search of the publications in the PubMed databank

The papers were found in the PubMed on March 20$^{th}$ 2010. The search was performed using the keywords: “whole body vibration”, “whole body vibration exercises”, “whole body vibration” and hormone, and “whole body vibration exercises” and hormones. The number of publications was determined. Only the publications in English were considered. Moreover, the publications involving animals and effects in workers were excluded. The selected papers were read and considered to be discussed in this work.

### Subject

An adult man (age, 77 years, weight 76 kg, height 1.64 m) was volunteered and provided informed consent to participate in this study. He is a health man; however, he was feeling to be weak and tired. It was suggested to him to do a treatment on an oscillating platform. He provided informed consent to participate in this study and in the publication of finding related to the treatment.

### Methodology

To examine the influence of WBV exercise on the quality to do some daily activities of this healthy man, he has answered several questions about his clinical condition before and after ten sessions of WBV exercise on an oscillating platform (Novaplate fitness evolution, DAF *Produtos Hospitalares Ltda, São Paulo*).

The questions were about (i) a specific pain (head of the femur), (ii) the fortitude, (iii) the interest to start a physical activity, (iv) the interest to start a sexual activity, (v) the steadiness of the body, (vi) the posture of the

**Table 1 -** Number of publications found in the Pubmed whole body vibration and hormone

| Search | Number of publications |
|---|---|
| “whole body vibration” | 626 |
| “whole body vibration exercises” | 144 |
| “whole body vibration” and hormone | 28 |
| “whole body vibration exercises” and hormone | 12 |

body, (vii) the capacity to do an exercise, (ix) the capacity of concentration, (x) the capacity of relax and (xi) the sleep.

A VAS (0, no to 10, maximum) was used to the measurement. These questions were asked just before the first session and just after the last session of the exercises.

The total testosterone was determined in the day before the first session and in the day after the man has finished the ten sessions in the oscillating platform. The determination of the level of testosterone was carried out in the same private clinical laboratory at 8 o’clock am.

### Characteristics of the vibratory platform

The vibratory platform used in our office is based in the oscillating system with uniform velocity, with reciprocating vertical and uniform displacements on the left and right side of a fulcrum. It is a side-alternating vibration device working as a teeterboard (28cm x 58 cm) with amplitude (peak to peak) of 0 (zero) in the center of the platform up to the maximum in the edge. The position of the feet of the subject on the platform will define the amplitude that is used in the exercise and it is controlled during the exercise.

Frequencies are variable from 5 up to 30 Hz and the oscillating platform can be adjusted to work in specific and controlled frequency during the exercise.

### Steps of the whole-Body Vibration treatment Session

The session in the platform involved some steps. In the first session, different steps were done with the aim to put the man in contact with the equipment.

(i) The subject was sat in a chair with the feet under the platform. The frequency used was 5 Hz during 1 min and both feet were in both sides of the teeterboard.

(ii) He was stand up in front of the platform with a right foot under the platform and the left foot under the floor. The frequency used was 5 Hz during 1 min and the both feet were in both sides of the teeterboard. This step was repeated with the alterations of the positions of the feet.

(iii) The subject had both feet under the platform in the position, which amplitude was 5 mm and the frequency used was 5 Hz during 1 min. In this step the man was instructed to be in a comfortable squat position. This step was repeated five times with a rest of 1 min after each 1 min of work in the platform.

The other nine sessions, only the step iii was carried out, the frequencies ranged from 5 up to 9 Hz and the same amplitude was used.

In a general condition, the subject was wearing training shoes and was under the platform and this equipment was in front of a mirror. This condition permit that the subject might observe and control the posture of your whole body. Moreover, in the several steps of the protocol a physiotherapist was near of the subject.

## RESULTS

In Table 1 is shown the number of publications involving whole body vibration, exercises and hormone. An important of publications was found with "whole body vibration" alone and a small number with “whole body vibration” and hormone.

The publications found with "whole body vibration" and hormones were analyzed. Twenty one were written in English, one in Russian, three in Polish and three in Japanese. In this work only the publication in English were considered. The publications (eight) involving the use of animals were also eliminated. The publications involving the effect of vibration in workers were also deleted. Moreover, a work published in 1964 was not considered. Twelve publications were read and five revisions were not considered. The findings of seven selected papers are shown in the Table 2. These papers have information about the level of testosterone, insulin, epinephrine, nor-epinephrine, cortisol, growth hormone and insulin growth factor-1 (IGF1). In this Table 2 are shown information about the number of subjects, frequency used in the vibratory platform, details about the variation of the plasma level of hormones and the level other substances analyzed (glucose, free fatty acids, glycerol).

Table 3 shows some information about the quality of the some daily conditions of a patient that has done exercises in an oscillating platform. A VAS was considered to evaluate the man just before and just after the exercise. The total score after the sessions have revealed an increase of the 50.1% in quality of daily conditions, as compared to the earlier assessment, prior to the oscillating platform exercises.

The plasma level of testosterone was measured

**Tabel 2** - Information about the plasma level of some hormones and other substances in subjects submitted to the whole body vibration on vibratory platforms

| Reference | Method of Vibration | Frequency/Amplitude (peak to peak) | Treatment | Number of subjects/Age | Variation of the plasma level of hormones | Variation of the plasma level of substances |
|---|---|---|---|---|---|---|
| Bosco et al, 2000 | Vertical Platform | 26 Hz/ 4 mm | Single session: 5 x 60 s/60s rest + 6 min rest + 5 x 60s/60s rest | 14 male (25±4.6 years) | Testosterone and GH↑ Cortisol↓ | |
| Di Loreto et al, 2004 | Vertical Platform | 30 Hz/ 4 mm | Single session: 10 x 60 s/60s rest | 10 healthy men (39±3 years) | Epinephrine ↑ Norepinephrine↑ Insulin, glucagon, cortisol, GH, IGF-1, free and total testosterone= | glucose↓ |
| Goto and Takamatsu, 2005 | Oscillating Platform | 26 Hz/ 2.5 mm | Single session: 10 x 60 s/60s rest | 8 men (23.4±0.9 years) | Epinephrine ↑ Norepinephrine↑ GH = | Free fatty acids↑ glycerol= |
| Cardinale et al, 2006 | Vertical Platform | 30 Hz/ 1.5 mm & 3 mm | Single session: 10 x 60 s/60s rest + 5 min rest + 10 x 60s / 60s | 9 healthy men (22±2 years | Testosterone and IGF-1= | |
| Kvorning et al, 2006 | Oscillating Platform | 20 and 25 Hz/ 4 mm | Single session (First training): 6x30 s /120 s rest | 28 young men | Testosterone = GH↑ Cortisol↓ | |
| Erskine et al, 2007 | Vertical Platform | 30 Hz/ 4 mm | Single session: 10 x 60 s/60s rest | 7 healthy men (22.3±2.7 years) | testosterone and cortisol = (salivary concentration) | |
| Cardinale et al, 2008 | Vertical Platform | 30 Hz | Single session: 5 min | 9 men and 11 women (median age 70 years) | GH and Testosterone= Cortisol and IGF-1↑ | |

Insulin growth factor-1 (IGF-1
Growth hormone (GH)
= not alteration
↑ increase

**Table 3**: Information about the quality of the some daily conditions of a man after exercise in an oscillating platform.

| Question about to the improvement of | Score (just before) | Score (just after) |
|---|---|---|
| a specific pain (head of the femur) | 5 | 7 |
| the fortitude | 3 | 7 |
| the interest to start a physical activity | 3 | 7 |
| the interest to start a sexual activity | 3 | 6 |
| the steadiness of the body | 8 | 8 |
| the posture of the body | 4 | 6 |
| the capacity to do an exercise | 3 | 5 |
| the capacity of concentration | 5 | 5 |
| the capacity of relax | 5 | 5 |
| the sleep | 6 | 6 |
| Total | 49 | 66 |

**Table 4** :Some considerations about the parameters of the oscillating platform and the plasma level of testosterone in the man

| Considerations | Value |
|---|---|
| Frequency | 5 to 9 Hz |
| Amplitude | 5 mm |
| Number of sessions | Ten |
| Plasma level of testosterone before | 771 ng/dl |
| Plasma level of testosterone after | 836 ng/dl |

before and after the sessions in the oscillating platform. In the Table 4 are shown some considerations involving the measurements of the testosterone and some parameters used in the platform that were used with this man. The level of the plasma testosterone in the man that has performed a considered protocol in the oscillating platform has increased 8.43%.

## DISCUSSION

Considering the endocrine theory with the ageing there are complex changes in the endocrine systems, including estrogen (menopause), testosterone (andropause), growth hormone/insulin like growth factor-I axis (somatopause), hypothalamic–pituitary–thyroid axis, hypothalamic–pituitary–cortisol axis and dehydroepiandrosterone (DHEA) and its sulphate (DHEA-S) (adrenopause) (Troen, 2003; Chahal and Drake, 2007). Tosato et al (Tosato et al., 2007) reported that the alterations in neural and endocrine functions due to the ageing are crucial for (i) the coordination and responsiveness of different systems to the external environmental stimuli, (ii) programming physiological responses to environmental stimuli and (iii) the maintenance of an optimal functional status for reproduction and survival. Chahal and Drake (Drake, 2007) have described that endocrine deficiencies in older individuals include a decrease in the peripheral levels of estrogen and testosterone, with an increase in LH, FSH and sex hormone-binding globulin. In addition there is a decline in serum concentrations of GH, IGF-I and DHEA-S.

Discussions about the importance of the quality of the nutrition, hormone replacement therapy and exercises have been considered in the approaches about anti-aging medicine (Tosato et al., 2007; Yan et al., 2009; Shephard, 2009).

Exercises can be done in oscillating platform (whole body vibration exercises) and the individuals with some limitations and elderly can safely use this kind of procedure. Papers about the application of whole body vibration exercises in vibratory platforms in Health Sciences have been published and an important number of publications are found in the PubMed as shown in Table 1. Santos-Filho et al (Santos-Filho et al., 2010) have described that the papers about the WBV have been mainly published in the last years. Nowdays, this finding demonstrates the high relevance of this subject. Moreover, several authors have indicated improvements in various clinical functions in elderly, as positive effects in strength or power development (Russo et al.,2003), in the postural steadiness (Rees et al., 2009), and in the bone mass (Rubin et al., 2003; Fjeldstad et al.,2009).

The physiological adjustments in the body due to the action of hormones have been discussed by Weinert and Timiras (Weinert and Timiras, 2003), Tosato et al (Tosato et al., 2004). These adjustments aimed the preservation and maintenance of an internal homeostasis despite the continuous changes in the environment. The decline of the plasma level of hormones with the aging has been noticed by different authors (Troen, 2003; Tosato et al., 2004; Drake, 2007). In the Table 2 is shown that the effect of the whole body vibration exercises on the plasma level of determined hormones has been published.

In the Table 3 are presented papers that were selected due to present findings involving studies related to the whole body vibration exercises and hormones. Concerning to the epinephrine and nor-epinephrine, it is observed an agreement with papers published by Di Loreto et al (Di Loreto et al., 2004), and Goto and Takamatsu (Goto and Takamatsu, 2005). In both papers the concentrations of these hormones have increased. Concerning to the GH, Bosco et al (Bosco et al, 2000) and Kvorning et al (Kvorning et al., 2006) found and increase in the plasma concentration, however, Di Loreto et al (Di Loreto et al., 2004) and Cardinale et al (Cardinale et al., 2008) did not find any alteration. Considering the Cortisol, Bosco et al (Bosco et al., 2000) have reported a decrease, Cardinale et al (Cardinale et al., 2008) an increase, and Di Loreto et al (Di Loreto et al., 2004) and Erskine et al (Erskine et al., 2007) no alteration in the plasma concentration of this hormone. Concerning to the testosterone, Bosco et al (Bosco et al., 2000) have reported an increase, however, the other authors (Di Loreto et al., 2004; Cardinale et al., 2008; Erskine et al., 2007) have not found any modification in the concentration of this hormone. Insulin and glucagon were studied by Di Loreto et al (Di Loreto et al., 2004) that did not find alteration in the plasma concentrations of them. IGF1 has been studied by Di Loreto et al (Di Loreto et al., 2004) and Cardinale et al (Cardinale et al.,2006) that did not find modification in the plasma concentration

of it. As the frequencies used by these authors are very closed (26 or 30 Hz), 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 (Marín and Rhea, 2010; Marín and Rhea, 2010, 29) showing that the magnitude of the strength and power gains elicited by vibration training are strongly dependent on: training status, gender, vibration application (vertical platform vs. Oscillating platform), as well as exercise protocol.

The analysis of the total score of the patient (before and after) that has done exercise in an oscillating platform indicates that an improvement in the quality of his daily activities was obtained (Table 4). Moreover, an increase (8.43%) in the plasma level of testosterone was observed in this individual. This finding is in agreement with Bosco et al (Bosco et al., 2000) that have reported an increase of 7% in the plasma concentration of testosterone. It is important to consider the use in our work the variation of frequency from 5 up to 9 Hz. Probably this condition could improve the stimulation of the pathways involving with the production of this hormone. Moreover, the different findings reported for the various authors could be associated with the specific protocols used, as well as the device of the oscillating platform. Nevertheless, it is necessary to consider the individual characteristics of the populations used in each work.

In conclusion, studies about ageing and the endocrine theory of ageing seem to be of high relevance. There is strong scientific interest in the studies about whole body vibration exercises and some authors are studying the effect of these exercises in the plasma concentration of hormones. The case report of a man that has done exercises in an oscillating platform indicates an improvement in the quality of some daily activities and an increase in the level of testosterone with a frequency from 5 to 9 Hz. However, further studies are necessary to generate safe information about the action of the oscillating platform and the influence of the exercises in it to alter the level of determined hormones.

## ACKNOWLEDGMENTS

This work was supported by CNPq, FAPERJ, CAPES, INCa and UERJ.

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