The Testosterone Responses to a Single Session of Whole Body Vibration

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Abstract: The aim was to study whether whole body vibration (WBV) induces a higher increase in neuromuscular and hormonal measures respectively. Twenty young women were in 2 groups, athlete and none athlete. They performed ten sets with eight repetitions with corresponding eight repetition maximum (RM) loads on the vibrating platform. Acute hormonal responses to training sessions were measured before and after training period. Blood samples were collected and plasma concentrations of testosterone were measured. Testosterone increased during training sessions in two groups. T test showed differences was significant in none athlete but ANOVA and following test of LSD did not show significant changes in two groups. Results suggest that WBV training leads to acute responses of hormonal profile and neuromuscular performance. It is therefore likely that the effect of WBV training elicited a biological adaptation that is connected to a neural potentiation effect. In conclusion, it is suggested that WBV influences the hormonal responses, characterized by an increase in neuromuscular effectiveness were simultaneous but independent.

Key words: Stress hormone • Vibration • Exercise

INTRODUCTION

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 [1,2]. It has been suggested that vibration exercise (VE) may be an alternative to heavy resistance training for stimulating musculoskeletal structures [3-6]. The endocrine system plays a major role in determining an individual response to exercise [7]. In particular, changes in the concentration of testosterone and cortisol have received significant attention due to their marked effects on muscle and bone remodeling [8,9]. Furthermore, due to their altered circulating levels with different forms of exercise, these hormones have been used to determine the physiological stress imposed during single and repeated exercise sessions. Sport effectively alters hormone level and neural system functions [8,10]. There is a response-rate relationship between exercise and particular hormonal responses. There is significant interaction between the exercise duration and exercise intensity and to a certain level of readiness, in determining the particular hormonal parameters in the exercise. There are evidences indicating that at the time of exercise, the stress hormones act as mediator in changing the while cell corpuscles number and redistribution of their sub cellular fragment, but such relationship seems to be complex. It has been cleared that hormones such as epinephrine and testosterone affect the redistribution of the white blood corpuscles between blood circulation and spleen, liver and bone marrow. The time and type of training, the involved tissues, the type of involved metabolic process (aerobic or anaerobic) or combination of them lead to excess function or suppression of the system during training or at the return period to the initial condition [4,7,11]. The effect of various exercises on hormones have different response. Studies in 2007 and 2008 on the effect of the WBV on different hormone levels showed insignificant changes of cortisol and testosterone levels after vibration compared to the before vibration [7]. Vibration has been used for the immediate treatment of injuries [7,11]. Bosco was the first who noticed the positive and exciting effects of vibration training. They showed that vibration is a mechanical stimulus described by oscillatory motion. Despite the recent studies on vibration training, the exact mechanism of vibration behind the muscular function leading to the improvement of exercise performance is not clearly understood yet [8]. Whole body vibration (WBV) training
in the health centers is recognized as a training method together with the other training methods. Different risk factors of vibration training have been studied extensively at particular frequencies and amplitude on man [8,11]. On the other hand, recently has been suggested that, mechanical stimulation with the low frequency and amplitude, is effective in preparing the skeletal structures [4,8,11].

Whole body vibration exercise has been shown to acutely increase testosterone and growth hormone (GH) in healthy young individuals after a single bout of 10 min [11]. Di Loreto and Cardinale did not find any acute changes in testosterone and cortisol in healthy individuals undergoing 5 and 20 min of WBV exercise albeit with relatively small amplitude and frequencies of 27 and 30 Hz respectively [12,13]. It showed a significant decline of blood glucose after vibration training, but norepinephrine increased. Insignificant difference was observed on insulin, glucagons, cortisol, epinephrine and testosterone levels [9]. In a recent study Kvorning reported an acute increase in testosterone, GH and cortisol but only when WBV was performed while squatting with a load equal to 10 RM [14]. Bosco studied the effect of WBV to hormonal response in 14 male subjects mean age 25±4. 6 years, exposed to vertical sinusoidal WBV, 10 times for 60 seconds, with 60 seconds rest between vibration sets, a rest period lasting 6 min was allowed after 5 and 6 vibration sets [8,11]. Findings indicated increase of testosterone and growth hormones level, but serum cortisol level significantly decreased [8]. Studies revealed that WBV results in enhancement of body strength, which depends on the characteristics of the vibration training amplitude, frequency and method of applied and the training protocols (intensity, volume and type of training). It has been shown that, a training protocol with certain frequency, amplitude and condition significantly increases training performances. While when the same protocol in the condition but in the low amplitude was conducted elsewhere, insignificant different result was observed. Due to existing contraindication on a particular training protocol, presenting and use of this method should be done with care, that demands further studies. Suggestion of a comprehensive and effective program is felt.

The aim of the study was to analyze the acute effects of a single session of whole body vibration exercise on testosterone indexes in athlete and non-athlete girls. Whole body vibration (WBV) has been proposed as an alternative exercise stimulus to produce adaptive responses similar to resistance exercise. Few studies have analyzed acute hormonal responses to WBV. Purpose To evaluate testosterone responses to an acute bout of superimposition of WBV.

**Methodology:** Twenty subjects (10 athlete with average of 23. 4 ± 4. 1 years, high 166 ± 43. 4 cm and weight 61 ± 3. 2 kg and 10 non-athlete with average of 22 ± 2. 3 years, high 168 ± 4. 15 cm and weight 63 ± 3. 26 kg voluntarily participated in the experiment. All testing procedures and the training protocol were explained and subjects gave written informed consent prior to participating in the study. Ethics approval was obtained from the IAU Committee. In the first, subjects performed training protocol and were educated how they can use from vibration. One week prior to the beginning of the study the subjects performed the vibration test for 1 min, as an introductory. They were told not to have any heavy exercise 24 h before the beginning of the test. They performed 10 sets of half squat isometric exercise for 1 min, with 1-min rest between sets. Blood samples were drawn from the brachial vein before and immediately after vibration. During blood drawing, the subjects sat down on the chair, the arm fasten with tourniquet by the lab. expert, 10 ml blood was drawn and collected in test tube. They warmed up before and after the first blood collection by reflecting and extending movement and only drank water since 3 hours before beginning of training till after the 3rd blood collection. The samples were kept frozen at-20 °C until assayed. Since the tests were performed in a day, hence the samples were kept in the laboratory for a short period. No subject had history of chronic pains, allergy and immunologic complication and did not use any drug regularly. The used tool were as follow: NEMES whole-body vibration machine, Jet-Vibe EST 900 N model, Germany; Hunhart chronometer, Germany, for measuring and recording of the obtained data with accuracy of 0. 01 second, 5 ml syringe for blood drawing; The laboratory cooler, with 5 hours cooling efficiency; Kit of serum testosterone. For measuring of serum testosterone the ELISA kits from IBL company, Germany, with the sensitivity of 0. 05 ng/ml were used. The laboratory examinations were done at the medical diagnostic laboratory of Noor in Tehran.

**Statistical Analysis:** All data were found to be normally distributed, therefore analysis was carried out using parametric statistical tests. Analysis of variance ANOVA and following test of LSD was used to identify any statistically. Significant differences with treatment (Control, WBV) and time(Pre-, Post) as within factors.
Where significant differences were identified by one way ANOVA. Unless otherwise stated values given in the text are mean ± standard deviation (SD). SPSS software was used for statistical analysis (α was set at 0.05).

RESULTS

Characteristics of experimental and control groups have showed in table 1.

Means showed the concentration of testosterone increased in two groups (Table 2 and Figure 1).

T test showed differences was significant in none athlete (Table 3).

ANOVA following test of LSD did not show significant changes in none athlete (Table 4).

Testosterone increased during training sessions and results suggest that WBV training leads to acute responses of hormonal profile and neuromuscular performance.

![Fig. 1: Changes of testosterone in 2 groups](image)

Table 1: characteristics of experimental and control groups

<table>
<thead>
<tr>
<th>variable</th>
<th>athlete</th>
<th>none athlete</th>
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<tbody>
<tr>
<td>Age (year)</td>
<td>23.4±1.4</td>
<td>22±2.3</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166±4.43</td>
<td>168±4.15</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>61±3.2</td>
<td>63±3.26</td>
</tr>
<tr>
<td>number</td>
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</tr>
</tbody>
</table>

Table 2. Mean ±SD Testosterone in two groups

<table>
<thead>
<tr>
<th>phase</th>
<th>group</th>
<th>Testosterone Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre vibration</td>
<td>athlete</td>
<td>49.70±2.3</td>
</tr>
<tr>
<td></td>
<td>none athlete</td>
<td>56.31±2.17</td>
</tr>
<tr>
<td>Post vibration</td>
<td>athlete</td>
<td>49.72±2.87</td>
</tr>
<tr>
<td></td>
<td>none athlete</td>
<td>76.5±1.77</td>
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</table>

Table 3: the results of T-test

<table>
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<tr>
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<th>none athlete</th>
<th>athlete</th>
<th>none athlete</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>testosterone</td>
<td>0.00</td>
<td>2.9</td>
<td>0.1</td>
<td>0.02?</td>
<td>P&lt;0.05</td>
</tr>
</tbody>
</table>

Table 4: the results of ANOVA test

<table>
<thead>
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<th>variable</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>testosterone</td>
<td>0.91</td>
<td>0.45</td>
</tr>
</tbody>
</table>

DISCUSSION

It was hypothesized that WBV condition would induce an increase in testosterone concentration. The results seem to suggest that WBV is not markedly stressful to this type of subject while undergoing intermittent short duration bouts of WBV and when the magnitude of vibration is low. A recent study conducted in our laboratory showed that serum anabolic hormone levels were not affected by 20 min of WBV exercise with small amplitudes [13]. These findings support Di Loreto who reported that an acute session of WBV had no effect on the serum concentrations of anabolic hormones such as GH, testosterone and insulin-like growth factor-I (IGF-I) [12].

The WBV stimulus employed in this study was under a threshold intensity to trigger a hormonal response in these subjects. As supportive evidence, the results of Kvorning seem to suggest that in young healthy individuals WBV should be superimposed to high levels of muscle tension in order to elicit a marked hormonal response [14]. In fact, in their study, the combination of squatting and WBV acutely increased testosterone concentrations, whereas WBV alone did not produce such an acute hormonal response [14]. In addition, the duration of WBV exposure may have been insufficient to elicit a physiological significant hormonal response. Whether WBV would impose a greater stress in other subject populations, for example in the elderly who experience some depression in endocrine system function,
remains to be determined. The present results seem more in agreement with those of Di Loreto, WBV failed to significantly affect the pituitary adrenal-gonadal axis [12]. As acute hormonal responses reveal the level and type of physiological stress, the metabolic demands of the exercise and changes in metabolic homeostasis [2], we can conclude that for healthy fit individuals low acceleration WBV with static exercise does not represent a stressful form of exercise and is probably insufficient in stimulating a significant training effect. Different vibration parameters can produce different effects in humans. In fact, vibration frequency seems to produce specific EMG responses in muscles [15,16]. However, as vibration amplitude and frequency together determine the acceleration (vibration magnitude) that is transmitted to the body [10], it is likely that high magnitudes may be necessary in healthy individuals in order to trigger specific hormonal responses. It has been reported that acceleration stress can produce powerful glucocorticoid and androgen responses [8,17], purported to be a good indicator for acceleration stress [8,18].

Notwithstanding the lack of hormonal responses observed in our study, recent studies provide evidence that mechanical vibration-induced activation of muscle afferents is capable of producing a hormonal response by modulating the release of bio assayable growth hormone in both rats [8,19] and humans [20,21]. This novel muscle afferent-pituitary axis has been suggested to be involved in the maintenance of musculoskeletal integrity and further studies should explore whether a similar response can be observed with WBV exercise [9]. It is evident from the present results and those of other studies that the force-generating capacity of human skeletal muscle can be both acutely and chronically affected by exposure to mechanical vibrations. Despite negative acute effects of vibration exposure, applied both locally and at a whole body level, WBV protocols have in fact been merited for their potential performance enhancing qualities.

REFERENCES