Changes in aspartate aminotransferase, aldolase, and creatine kinase after training in nonathletic young males

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Key words: Pyramid Resistance training, whole body vibration, aspartate aminotransferase, aldolase, creatine kinase.

Abstract

The purpose of the present study was to investigate the effect of pyramid resistance training (PRT) and whole body vibration training (WBVT) on the cell injury indices of non-athlete men. 40 healthy men in Karaj City were randomly selected and then they were put in four groups of PRT, WBVT, combined training (CT), and control (n=10). Blood sampling were collected before training. Then, the PRT group underwent a six-week pyramid resistance program (three sessions a week). The WBVT group also endured a course of standardized vibration workout which involved ten-minute training program daily. The CT underwent a combination of the trainings done by the previous groups. After the last training session, a posttest blood sampling was taken from all groups. The cell injury indices, Aspartate Aminotransferase (AST), Aldolase (ALD), and Creatine Kinase (CK), were extracted from the blood samples. The results showed that all the measured cell injury indices have significantly increased after the training in three groups (P≤0.05). Considering the results it can be concluded that the PRT, WBVT and CT protocols have similar effects on the emergence of cell injury indices. Thus, assuming documented relationship between increasing in cell injury indices after exercises with hypertrophy and strength, it is better to use DRT or CT with high intensity in order to benefit more from exercises.

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Introduction

The resistance training, are widely used for recovery programs and they are regarded important training model or protocol for preserving health. Therefore, the mechanisms which explain the effect of various types of resistance training in the skeletomuscular growth, have been always important. One of the methods of resistance training, is the pyramid power training. This method causes the hypertrophy and the increase in the size and power of the muscles, and is widely used in the body-building gyms (Kenney et al., 1999). Nevertheless, the athletes and the coaches are always looking for new methods and techniques which lead to better results, by spending less energy and time.

The recent studies in the field of sports sciences, have led to the creation of whole-body vibration device. (Rittweger, 2010). (Cardinale & Wakeling, 2005; Delecluse et al., 2003; Ronnestad, 2004). In WBVT, the individual, makes general sinusoidal vibrations on the vibration platform, takes various bodily postures, and keeps that status until the end of the training period, while the vibration device is adjustable to different frequencies and intensity levels (Bosco et al., 1998; Punakallio, 2005). Of the many different effects of this training method, one can point to issues such as short training course, increasing muscular strength, improving the flexibility, improving the nervous system, relieving the pain, increasing the bone density, increasing the key hormones (testosterone, growth hormone, serotonin), body relaxation and massage, decreasing the cortisol hormone (stress hormones), increasing the harmony and balance of the body, and reducing the delay fatigue (Cardinale & Bosco, 2003; Delecluse et al., 2003; Ronnestad, 2004).

Physical activity and sport bring about physiological adaptations. (Karamizrak et al., 1994). Intense activities cause the emergence of muscular enzymes (AST, ALD and CK) in the blood, which can be the result of muscular cell injury or the increase of cellular tissue penetrability during or after the activity (Karamizrak et al., 1994). Various studies have shown the increase of activity in the mentioned enzymes, especially after the resistance training (Nosaka et al., 1992; Skenderi et al., 2006; Smith et al., 2004).

However, in case of investigating the physiological responses to these enzymes after resistance training, few studies have been done, in case of investigating the physiological responses to these enzymes after whole-body vibration training, and also the compound resistance-vibration protocol, there has been no studies so far. Assuming that the physiological responses of these enzymes to the pyramid resistance training, whole-body vibration, and the compound protocol can be different, in this study, the researcher wants to investigate the effect of pyramid resistance training and whole-body training on the cell injury indices (AST, ALD, CK) in non-athlete men.

Materials and methods

Subject selection

This research was an applied one, which was conducted in a semi-experimental mood, with a pretest-posttest design in three experimental and one control groups. 40 people from healthy men (aged from 20 to 30 years), were voluntarily selected as the sample. The subjects were all physically healthy (confirmed by the physicians) without any record of resistance, body-building, and sport trainings. Before manipulating the independent variables of the subjects, the pretest (blood sampling) was conducted. In order to measure the secretion and density of the enzymes AST, CK, and ALD, the blood sample was taken from the arm vein of the subjects. Afterwards, the subjects were randomly divided in four groups of pyramid resistance training (PRT), whole body vibration training (WBVT), combined training (CT), and control (n=10 per groups).

Supplementation and exercise prescription

The PRT underwent a sex-week pyramid resistance program (three sessions a week). In the pyramid training (Delorme), firstly in the first set, a weight which is the 50 percent of the one repetition maximum of an individual (1RM), is lifted ten times, and in the second set, 75 percent of 1RM, is lifted for
more ten times, and eventually in the last set, 100 percent of 1RM of the individual, is lifted for another ten times (Fleck & Kraemer, 2004).

A repetition maximum (the maximum strength) of the subjects is estimated using the formulas and submaximal repetitions. One of the common equations for estimating the repetition maximum is presented by Brzycki in 1993. This equation can be used for those submaximal repetitions whose number is lower than 10. For using this test, the subject repeats the lifting test of a submaximal weight, reduces to the extent of exhaustion and the maximum strength (repetition maximum) is estimated using the following equation (Bompa & Haff, 1999):

\[
1RM = \frac{\text{weight lifted (kg)}}{1.0278 - (\text{number of repetitions until exhaustion} \times 0.0278)}
\]

The selected activities were done in six stations including lateral stretch, leg press, front leg, front arm and back arm exercises. Firstly, by using the equation above, the 1RM of the subjects were determined in each activity, and then by calculating 50 percent and 75 percent of a 1RM, the resistance trainings were done. Considering the resources and the fact that in the hypertrophy approach, the subject had to continue lifting the weights despite the fatigue, a two-minute rest interval was given between the sets (Bompa & Haff, 1999; Willardson & Burkett, 2005, 2006).

The experimental group of WBVT did a standardized whole-body vibration training course which involved a ten-minute training session each day (Albasini et al., 2010). This training protocol involved standing on the vibration device with a frequency of 30 to 45 Hz, and domain of 10 mm in five different bodily postures, which are as follows: 1) upright standing 2) 90-degree squat in knees 3) 90-degree squat of the knee with the external rotation of the feet 4) 90-degree squat on the right leg 5) 90-degree squat on the left leg. The training time in each bodily posture, had 40-second rest intervals (Table 1).

The experimental group of CT, did trainings similar to PRT, with this difference that the subjects of this group, did a WBVT course according to the WBVT group. In every training session, the subjects of this group, firstly would do the WBVT and then the PRT, related to that session was conducted. The control group would do the daily activities during this period. After the last training session of the experimental group, posttest (blood samples) were taken from all the experimental and control groups. Then, the blood samples were frozen in -80 degrees Celsius, and were transferred to the biochemical analysis laboratory, for evaluating the hormonal dependent variables. The AST enzyme was measured by the use of IFCC enzymatic method; ALD was measured by means of UV enzymatic method, and the CK enzyme was measured in a serum by means of optimum kinetic IFCC/DGKC method.

**Results**

The results of repeated measurements analysis of variance, showed a significant interaction between the time and group for the AST (P = 0.000), ALD (P = 0.000), and CK (P = 0.000). Also, the main effects of time was significant for AST (P = 0.000), ALD (P = 0.000), and CK (P = 0.000). However, the main effects of groups was not significant for AST (P = 0.821), ALD (P = 0.169), and CK (P = 0.828). The cell injury indices were compared by the paired t-test in both times (pretest and posttest) for more accurate investigation. Also, in each time, the cell injury indices were considered by the one-way analysis of variance test. Table 2, 3, and 4 shows the results of repeated measurements ANOVA, besides the results of paired t-test and one-way ANOVA test for the variables of AST, ALD and CK respectively.

**Table 1.** Whole body vibration training program.

<table>
<thead>
<tr>
<th>Weeks of workout</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets</td>
<td>5×30Hz</td>
<td>2×30Hz</td>
<td>5×35Hz</td>
<td>2×35Hz</td>
<td>5×40Hz</td>
<td>2×40Hz</td>
</tr>
<tr>
<td></td>
<td>3×35Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Table 1](image-url)
**Discussion**

The purpose of the present study was to investigate the effect of pyramid resistance training and whole-body vibration on the cell injury indices of non-athlete men. The results showed a significant increase in the cell injury indices (AST, ALD, CK) after the PRT, WBVT and CT protocols. The results are compatible with the results of the previous studies which have reported the increase of the aforementioned indices after doing the trainings (Bruunsgaard et al., 1997; Karamizrak et al., 1994; Nosaka & Clarkson, 1996; Nosaka et al., 1992). However, the results are in contrast with the results of studies that did not report any changes in the cell injury indices after doing the trainings (Song, 1990; Tsukamoto et al., 2001). The probable reasons for the incompatibility of the present study with the results of Song’s (1990) and Tsukamoto’s (2001), can be the different gender and records of the subjects and the different type of trainings.

**Table 2.** The results of repeated measurement ANOVA, paired t-test, and one way ANOVA for AST in training groups.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Groups</th>
<th>Pre test</th>
<th>Post test</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST</td>
<td>PRT</td>
<td>17.09±2.89</td>
<td>20.15±3.83*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>WBVT</td>
<td>17.28±2.58</td>
<td>19.07±2.93*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>16.41±2.58</td>
<td>19.72±2.92*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>17.38±2.14</td>
<td>17.56±1.69</td>
<td>0.422</td>
</tr>
</tbody>
</table>

P-Value 0.831 0.235

*Significant differences with pre-test.

**Table 3.** The results of repeated measurement ANOVA, paired t-test, and one way ANOVA for ALD in training groups.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Groups</th>
<th>Pre test</th>
<th>Post test</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALD</td>
<td>PRT</td>
<td>3.84±1.30</td>
<td>5.91±1.75*†</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>WBVT</td>
<td>3.82±1.30</td>
<td>5.03±1.81*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>3.87±1.38</td>
<td>6.37±1.56*†</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.72±1.12</td>
<td>3.74±1.48</td>
<td>0.888</td>
</tr>
</tbody>
</table>

P-Value 0.995 0.006

*Significant differences with pre-test, †Significant differences with control group.
It has been maintained in the sport science texts and articles that the muscular injury can cause the release of certain enzymes from the muscular fiber into the interstitial fluid, and from there into the blood. One of these certain enzymes is the AST. This enzyme which is also called "glutamate oxaloacetate transaminase" (GOT), catalyzes the following reaction:

\[
\begin{align*}
\text{AST} & \quad \text{L-Aspartate} + \alpha\text{-ketoglutarate} \quad \xrightarrow{\text{oxaloacetate}} \quad \text{L-glutamate}
\end{align*}
\]

\[\alpha\text{-ketoglutarate}\] is one of the important participants in the Krebs cycle (Murray et al., 2007). The body cells contain a lot of aminotransferase. The AST isoenzymes are in the cytoplasm of the cells (s-AST), and the mitochondrias (m-AST). Hence, in the small cell injuries which increases the serum AST, this increase is only related to its release from the cytoplasm of the cell; whereas the intense cell injuries, leads to the release of these enzymes from the mitochondrias.

**Table 4.** The results of repeated measurement ANOVA, paird t-test, and one way ANOVA for CK in training groups.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Groups</th>
<th>Pre test</th>
<th>Post test</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>PRT</td>
<td>104.34±28.84</td>
<td>122.01±28.66*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>WBVT</td>
<td>104.53±26.70</td>
<td>113.02±26.70*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>106.05±27.43</td>
<td>126.33±28.90*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>105.80±26.44</td>
<td>105.22±26.89</td>
<td>0.702</td>
</tr>
</tbody>
</table>

| P-Value | 0.999 | 0.343 |

*Significant differences with pre-test.
It has been reported in some studies that the sport activities can increase the levels of aminotransferases especially AST (Bompa & Haff, 1999). Some researchers, have regarded the increase of transaminases as the reason for the muscular injury. In sports in which the body weight cannot be borne, like cycling, immediately after the activity, high levels of AST enzyme, can be observed. In endurance sports, short intense activities, and in eccentric trainings, the levels of AST increase immediately after the training (Bompa & Haff, 1999).

Creatine kinase enzyme (CK), also known as creatine phosphokinase (CPK), speeds the phosphorylation process of creatine done by ATP, to form the phosphocreatine.  

\[
\text{ATP} + \text{Creatine} \rightarrow \text{Phosphocreatine} + \text{ADP}
\]

The levels of serum creatinekinase, in the healthy people depends on the age, race, bodily fatless mass, and the physical activities. The serum CK, was first used by Ebashi et al. (1959) as an instrument for diagnosing the advanced muscular dystrophy (Ebashi et al., 1959). Since then, CK has been used an important clinical indicator of muscular injury. Some common reasons for the increase of serum CK, are the intense sport activities (Evans et al., 1986), intramuscular injection (Sidell et al., 1974), heart failure (Lott & Stang, 1980), muscular dystrophy, and Polymyositis (Tzvetanova, 1978). Determining the activity of these enzymes can be effective in diagnosing the myocardial infarction and muscular diseases. In case of torn muscular cell tissues, this enzyme oozes out of the cell. This can happen after any muscular injury. After surgeries, the levels of CK can reach to 1000 to 2000 IU/L, and at hard injuries, this levels reach to 10000 IU/L.

It has been reported in different studies that the whole-body vibration trainings can increase the muscular strength (Rittweger, 2010). Also, in the present study, the results showed that the whole-body vibration trainings can increase the strength of the muscles. A probable reason for the observed increase of the muscles in the study, can be the increase of simultaneous recruitment of the motor units. In addition, it was also demonstrated that the whole-body vibration increases the rate of perceived exertions (RPE) and the levels of blood lactate (Rittweger et al., 2003). This process can improve the neuromuscular stimulations and increases the recruitment of the motor units (Torvinen et al., 2002). Furthermore, the simultaneous activities of the synergist muscles of the lower limb or the increase of inhibition of antagonist muscles which is exclusivity. In order to clinically diagnose the muscular diseases, both ALD and CK should be measured (Murray et al., 2007).If the levels of both are unnatural, then one can interpret the results of the clinical diagnosis, with more certainty. These two tests contribute to the quick diagnosis of muscular dystrophy, before the appearance of clinical symptoms, and they can lead to helpful hints about the diagnosis of diseased women. These two enzymes, are valuable resources for the differential diagnosis of some other muscular diseases and also in case of tracing the inflammatory muscle diseases. ALD and CK are useful indices for diagnosing the skeletal muscles disorders (Murray et al., 2007). CK is mainly available in the skeletal muscles, the cardiac muscle, the brain, and in small amounts in the fibers. The serum activity of this serum increases in the myocardial infarction, which does not last long; hence, it cannot be confused with the skeletal muscle defect (Murray et al., 2007). ALD is also present in high densities in the skeletal muscles, and can support the results of the CK evaluation. Although ALD exists in the other fibers, its density in skeletal muscles, is distinctly high. The important notion is the existence of high density ALD in the red blood cells, so it is necessary that the serum sample does not involve red blood cells.
caused by the stretch reflex activation, can justify the results of the present study (Torvinen et al., 2002). It is possible that the whole-body vibration training, by causing small lesions in the skeletal muscles, lead to the emergence of cell injury indices in the blood, and consequently it would significantly increase these enzymes after the trainings.

The results of this study, did not show any significant difference in the cell injury indices after doing the pyramid resistance training, whole-body vibration, and compound trainings. Despite some uncertainties, one can conclude that the pyramid resistance training, whole body vibration training and compound ones, equally increase the muscular strength, so the measured enzyme levels that are the cell injury indices, did not experience any significant difference during these trainings.

**Conclusion**

In general, considering the results of the present study, it is concluded that the pyramid resistance whole-body vibration and compound trainings, have similar effects on the emergence of cell injury indices (AST, ALD, CK). Therefore, regarding the evident relation of the cell injury indices with the muscular hypertrophy and the strength of the muscles after the trainings, it can be stated that in order to optimally use the sport trainings and for increasing the strength and size of the muscles, it is better to use resistance sport training or compound trainings with high intensity, and despite the fact that the vibration trainings have increased the muscular strength, it is suggested that these trainings be used only at times when the aim is to cure the injured athlete, to improve the recovery period, or to increase the bone density, especially preventing from osteoporosis.

**References**


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