Relationship between Aerobic Training and Testosterone Levels in Male Athletes

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Abstract

Salivary testosterone levels of 11 athletes and 15 non-athletes were studied to test for the effects of 20 hours per week of aerobic training on the levels of testosterone. The samples were taken in the 13th week of the 21-week basketball season. Athletes had a significant (84.4%) higher level of testosterone when compared to non-athletes. The correlation between testosterone concentration and aerobic training suggest that 20 hours of aerobic training per week was sufficient for elevation of testosterone levels.

Introduction

Testosterone is an androgenic hormone that stimulates protein synthesis and cell growth (Malm et al. 2004). Resistance training has been shown to increase testosterone concentrations in men (Kraemer & Ratamess 2005). Linnamo et al. (2005) showed that serum testosterone increased significantly during heavy resistance exercise in men, with no significant changes in women. Ahtiainen et al. (2004) determined that the concentrations of testosterone increased significantly after heavy resistance training in athletes. Testosterone elevation was influenced by the volume of total work in a heavy-resistance exercise protocol. A high-intensity resistance training protocol using three sets stimulated higher magnitudes of postexercise elevations in circulating concentrations of testosterone than did a one-set protocol (Gotshalk et al. 1997). Baker et al. (2006) demonstrated testosterone concentrations were significantly higher in males age 20 to 26 than in males 38 to 53 or 59 to 72 year old test subjects. Similar relative increases in testosterone among these three groups suggested aging did not attenuate hormone responses. Increases in testosterone were found immediately following resistance exercise (Baker et al. 2006). Kraemer & Ratamess (2005) reported that basal testosterone concentrations were also elevated after an exercise bout. Ahtiainen et al. (2003) reported significant increases in basal testosterone concentrations after a fourteen-week high-volume resistance training program. Twenty-one weeks following the exercise program, testosterone
levels returned to the base line. This study suggested no chronic effects of strength training on testosterone levels. Ari et al. (2004) found significantly higher testosterone levels in elderly male athletes, who exercise regularly, than in sedentary elderly males.

There are few reports on changes in testosterone levels as a result of aerobic exercise training. Malm et al. (2004) found that after two soccer games on two consecutive days, there was a significant decrease in testosterone levels six hours after the second game, and 72 hours later it was still below the resting concentration levels. A recent study (Martinez et al. 2010) showed that 35 hours per week of basketball training increased the testosterone levels significantly after five months. The purpose of this research was to determine whether 20 hours per week aerobic training protocol increased testosterone concentrations in college age males.

Methods

The research proposal was approved by BYU–Hawaii Institutional Review Board for Human Subjects. A total of 15 athletes from the BYU–Hawaii men’s basketball team were recruited as subjects. Also, 15 sedentary males were recruited as the control group. Each subject was asked to sign an informed consent agreement to participate in the study. The athletes trained aerobically for four hours per day, five days per week, for a total of 20 hours per week, beginning six weeks prior (mid September) to the end of the basketball season (November to March).

Saliva samples were collected with oral swabs. Samples of the non-athlete control subjects (male students who had been sedentary for at least one month) were collected on 26th January, 2010. Samples of the athletes were collected during a training session in the 13th week
of the 21-week basketball season, on 5th February, 2010. Samples were all taken in the afternoon (between 1500 and 1800 hours). All salivary samples were analyzed for testosterone by Enzyme Immunoassay (Salimetrics).

Testosterone concentrations from athletes were compared to non-athletes to determine the effect of aerobic training on the concentration of testosterone. The data were analyzed by Mann-Whitney U test, and p values of less than 0.05 were considered significant.

Results

Due to insufficient quantity of saliva, only 11 athlete samples were analyzed. An Anderson-Darling normality test was performed on the raw data. Data obtained from non-athletes showed a normal distribution ($p = 0.559$) but the data from the athletes showed a non-normal distribution ($p < 0.005$). Since the data were nonparametric, they were evaluated by the Mann-Whitney U test. The mean testosterone levels for athletes was 198 pg/ml (SD = 149 pg/ml). Non-athletes had a mean of 107.4 pg/ml (SD = 36.0 pg/ml) (Table 1). The P value for Mann-Whitney U test was 0.0031. (Table 1 & Figure 1).

Table 1. The mean, SD, SE Mean and median values for the non-athletes (control) and athletes. *p < 0.05

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ± SD (pg/ml)</th>
<th>SE Mean</th>
<th>Median (pg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes (n=11)</td>
<td>198 ± 149*</td>
<td>45</td>
<td>163.7</td>
</tr>
<tr>
<td>Control (n=15)</td>
<td>107.4 ± 36.0</td>
<td>9.3</td>
<td>107.7</td>
</tr>
</tbody>
</table>
Athletes had a higher median concentration than the non-athletes. The distribution of data for testosterone concentration for the athletes was not normal (Figure 2).
Discussion

The basketball players had a significantly \( p < 0.05 \) greater mean testosterone level than the non-athletes. Their difference was 84.4% higher when compared to the non-athletes. However, there was a greater standard deviation among athletes than non-athletes.

Previous studies focused on anaerobic exercise-induced increase of testosterone concentrations (Gotshalk et al. 1997, Ahtiainen et al. 2003, Kraemer & Ratamess, 2005). Basketball training was found to exert the same influence as resistance training. The higher testosterone levels found in basketball players resulted from frequent aerobic training.

Martinez et al. (2010) demonstrated that 35 hours of basketball training per week induced an increase of testosterone levels. This study found that 20 hours of training could also increase testosterone levels.

The standard deviation of the athlete group was quite high, and the increase in hormone levels varied among the basketball players. One possible reason for the variance may be due to the diet of the individuals since it was not monitored during the study. Intensity of exercise during practice for each individual was also not monitored. Some individuals may have worked harder than others during practice. The difference in intensity may have increased the variance.

Testosterone levels decline over an individual’s lifespan (Morley et al. 2006). Male hypogonadism may result in osteoporosis, raising the percentage of body fat, high blood pressure, heightened risk of heart attack brought about by the dilation of arteries, blood clots, lessened libido, depression, increased irritability, and mental fatigue. Booth et al. (1999) suggested that testosterone supplementation reduced depression. One way to treat male
hypogonadism is to boost the natural testosterone production in the body. This study suggested that exercise could be used as a prescription for low testosterone concentration in males as they age.

In conclusion, this study demonstrated that basketball training elevated testosterone levels. Furthermore, 20 hours of training per week was sufficient to illicit the increase. The minimal amount of training time needed to cause the elevation is unknown and remains to be examined. Future studies might determine whether or not 10 hours of training per week creates the same response. This would delineate the minimal amount of training time.

Acknowledgments

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Works Cited


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