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The Effect of a Single Session of Moderate and Heavy Intensity Weight-lifting Exercise on Plasma Testosterone and Cortisol in Elite Male Weight-lifters

[1]Abbass Rahimi*, [2]Seyed Morteza Tayebi

1- Faculty of Physical Education and Sport Sciences, Neka Branch, Islamic Azad University, Neka, Mazandaran, Iran.
2- Faculty of Physical Education and Sport Science, Allameh Tabataba'i University, Tehran, Iran.

Abstract

The aim of this study was effect of a single session of weight-lifting exercise on serum testosterone and cortisol and testosterone-cortisol ratio changes in elite weight-lifter of Mazandaran state. 10 elite weight-lifter of Mazandaran state was selected randomly. Moderate-intensity exercise was contained stand snatch (2 sets with 3 repeats of 60 one repeat maximum), Olympic snatch (2 sets with 2 repeats of 60 1RM and 1 sets with 2 repeats of 70 1RM), Olympic clean & jerk (2 sets with 2 repeats of 60 1RM and 1 sets with 2 repeats of 70 1RM), squat on chest (2 sets with 3 repeats of 70 1RM); and heavy-intensity exercise was contained Olympic snatch (idoneous warm up and reach to %100 of record), Olympic clean & jerk (idoneous warm up and reach to %100 of record), mean lift (2 sets with 3 repeat of %120 Olympic snatch record), squat on chest (idoneous warm up and reach to %100 of record). Blood samples were taken at 30 minutes previous and immediately post exercise while the subjects were overnight fast (at least 12h). Blood variables were measurement containing Hemoglobin, heamatocrit, Testosterone and cortisol. Data were analyzed by spss program and paired sample t-test was used to compare mean of previous and Post of information. Finally any significant changes were not observed in blood variables not only in moderate-intensity exercise but also in heavy-intensity exercise. Insignificant changes in testosterone, cortisol and testosterone-cortisol ratio may be accounted as exercise performance time and fitness level of weightlifters.

Key Words: Elite Weight-lifters, Testosterone, Cortisol, moderate-intensity, heavy-intensity.

Corresponding Author:
Abbass Rahimi
E-mail1: rahimi.abbass@yahoo.com

Introduction

Testosterone is hormone belonging to androgens which are involved in anabolic processes and respond to exercise, especially resistance exercises. Testosterone release increases other hormonal mechanisms including Growth Hormone (GH) and Insulin-like Growth Factor–1 (IGF-1) in anabolic processes (1). It also usefully affects nervous system (2). Factors that cause short-term and acute responses of testosterone to resistance exercises include mass of involved muscles (3), intensity and volume of exercise (4), diet (5), and exercise experience (6). Short-term and acute responses of testosterone are also influenced by age, gender, and proportion of basic values (7).

Guezennec *et al* (1986) reported a slight increase in testosterone during resistance exercises (3 or 4 sets with 3 to 10 repetitions, 70-90% of a maximum repetition, and 150-second rest periods) (8). Kramer *et al* (2003) observed a significant increase in testosterone after 5 sets of squat with 15 to 20 repetitions and by using 50% of a maximum repetition (9). Jurimae and *et al* (1990) observed a significant increase in testosterone and cortisol and a slight increase in the ratio of cortisol to testosterone (C/T) after a session of circuit resistance exercise of ten exercises done in three rounds with an intensity of 70% of a maximum repetition and a work to rest period of 30 seconds: 30 seconds (10).

Cortisol is hormone from the group of glucocorticoids which is secreted by the adrenal cortex in response to exercise pressure. Cortisol which has a catabolic function mostly affects muscle fibers type II (9). About 10% of the cortisol cycle is free, while 15% and 75% of it is restricted to albumin and basic globulin of corticosteroid, respectively. In peripheral tissues, cortisol triggers lipolysis in fat-maker cells, increases protein degradation, and reduces its in muscle cells as a result of increased secretion of lipids and amino acids into the cycle (8).

It has been mentioned in the literature that cortisol has a considerable variability in responding to exercise which depends on many factors such as intensity and duration of exercise, physical fitness, quality of nutrition, and even circadian rhythm. Cortisol increase after exercise has been reported in most studies (3). On the other hand, in studies conducted by Cornil *et al* (1965) and Raymond *et al* (1969), a decrease in cortisol levels was observed after short-term exercise with a moderate intensity (11). Davis and Fiu (1973) correctly showed the importance of exercise intensity in cortisol response and stated that cortisol is decreased at intensities below 60% of maximum oxygen uptake, but it increases as the intensity goes up (3). As a result, the important role of cortisol in tissue deformation and its short-term and long-term changes are often tested during resistance exercises.

Kostka *et al* (2003) studied the effect of a low-volume resistance training session on anabolic and catabolic hormones in old people with low activity. They observed no significant change in total testosterone (TT), a significant decrease in cortisol, and a significant increase in ratio of cortisol to testosterone (C/T) (12). A similar decrease in cortisol response has been reported by Fry *et al* (1993) in academic elite weightlifter after a week of high-volume resistance training (13). This response was dependent on the changed hypothalamus or pituitary function, because individuals showed a decrease in the levels of beta-endorphin (13). Another study conducted by Kramer *et al* (1996) showed that response properties of beta-endorphin, ACTH, and cortisol are highly depended on intensity of exercise in response to a given protocol of heavy resistance training (5, 14). Kramer *et al* (1998) also observed a significant decrease in cortisol levels after the first session of a heavy resistance training protocol in three consecutive days (5).

The ratio of testosterone to cortisol (T/C) or the ratio of free testosterone to free cortisol (FT/FC) are considered as markers for anabolic to catabolic state change of skeletal muscles during resistance exercises (15). Increase in testosterone levels, decrease in cortisol, or both of them indicate a potential anabolic state. Despite of being a simple and superficial method, it is an indirect measurement of anabolic to catabolic state change for skeletal muscles (16).

Tayebi *et al* (2007), in a study observed a significant decrease in cortisol, a significant increase in T/C, and significant change in testosterone in male students, while no significant change was found in these three parameters among young weightlifters (17). It should be noted that this study was conducted on weightlifters who were preparing for the national championship competitions and they had a relatively high physical fitness. In addition, the objective this study was to evaluate the effect of a session of weightlifting training with moderate and heavy intensities on changes in serum testosterone and cortisol and also the ratio of testosterone to cortisol. Santos *et al* (2006) reported that exercise would be effective if it is intense enough for homeostasis rupture, adaptation, and thereby ultra- compensatory. On the other hand, excessive pressure resulting from the exercise may increase adverse effects (18). In fact, this study was decided to be conducted to control the optimal conditions of training for these individuals.

Materials and Methods

Sample: Population of the present study included all elite weightlifters of Mazandaran Province selected from provincial championships and invited to the preparatory camp for the national championships. Among those who were in the competitions season and were preparing themselves for competition by a three-week training program, 10 weightlifters with a mean age of 18.82 ± 1.08 years old, a mean weight of 87 ± 15.96 kg, a Snatch record of 113.86 ± 17.24 kg, and a Clean & Jerk record of 137.05 ± 22.42 kg were randomly selected. Conditions for selection of subjects included non-use of drugs and supplements and also medication, personal health, and not having the history of blood diseases or diseases affecting these factors such as hormonal and behavioral disorders. All subjects had been continuously training at least for three and, at least, had two titles in provincial championships and one title in national championships.

Training protocol: The first and the last sessions of the three-week preparatory camps were scheduled a moderate-intensity exercise and heavy-intensity exercise, respectively. Moderate-intensity exercise included snatch standing (2 sets of 3 repetitions with 60% of the record), Olympic Snatch (2 sets of 2 repetitions with 60% of the record and 1 set of 2 repetitions with 70% of the record), Olympic Clean & Jerk (2 sets of 2 repetitions with 60% of the record and 1 set of 2 repetitions with 70% of the record), and feet from the front (2 sets of 3 repetitions with 70% of the record). This training session lasted 75 minutes. Heavy-intensity exercise included Olympic snatch (specific warm-up and achieving the 100% of the record), Olympic Clean & Jerk (specific warm-up and achieving the 100% of the record), total lifting (2 sets of 3 repetitions with 120% of the Olympic snatch record), or feet from the front (specific warm-up and achieving the 100% of the record). This training session lasted 60 minutes.

Blood samples: 30 minutes before and immediately after the first and the last training sessions, blood sampling was done through brachial vein when the subject was sitting. The variables measured included HGB, HCT, testosterone level, and cortisol level. In order to equalize the dietary conditions of subjects before the training session, they were asked to fast for at least 12 hours. Blood samples were taken immediately to the laboratory and centrifuged with 1500 rmp for 10-15 minutes. Then, the supernatant fluid (blood plasma) was taken immediately and frozen and stored at -20$^{\circ C}$ for further measurements. Hemoglobin and hematocrit were measured by the automated system of hematology analyzer of Sysmex (kx-21). Concentrations of testosterone and cortisol were also measured by Radio Immunoassay (RIA) method and using the kits purchased, respectively, from DRG and IBL companies in Germany with a accuracy of 10 ng/ml.

Statistical Analysis: All obtained data were analyzed using descriptive statistics. Dependent t-student and independent t-student were used to compare the difference between data related to before and after the training session and to compare the two heavy-intensity and moderate-intensity training sessions, respectively. All statistical analyses were done using SPSS software. All data are presented in mean ± standard error. The mean difference was considered significant at an alpha level of 0.05 (α≤0.05).

Results

According the results of the statistical analyses, a weightlifting training session with a moderate intensity and a training session with a heavy intensity did not significantly affect serum testosterone, serum cortisol, and the ratio of testosterone/cortisol in elite weightlifters. According to Table 1, there is no significant difference in plasma testosterone levels before and immediately after a moderate-intensity (p=0.895) and a heavy intensity (p=0.926) training session. Additionally, no significant difference was observed in the ratio of testosterone/cortisol before and immediately after a moderate-intensity (p=0.723) and a heavy intensity (p=0.51) training session.

Table 1. level in elite male weightlifters

Variable	Intensity	Blood Sampling	Mean	df	p
plasma testosterone (ng/mL)	Moderate	pre	8.2 ± 4/3	9	0.865
		post	9 ± 3/7		
	Heavy	pre	8.26 ± 3/48	9	0.91
		post	8.58 ± 3/79		
plasma cortisol (ng/mL)	Moderate	pre	7.5 ± 5/3	9	0.895
		post	7.59 ± 5/9		
	Heavy	pre	11.34 ± 4/3	9	0.926
		post	9.16 ± 5/5		
Testosterone to cortisol ratio	Moderate	pre	1.09 ± 0.62	9	0.723
		post	1.18 ± 0.62		
	Heavy	pre	0.72 ± 0.63	9	0.51
		post	0.94 ± 0.74		

Discussion

In the present study, hemoglobin and hematocrit were also measured in order to determine plasma volume. As none of them showed any significant change during the study period, no plasma volume change was consequently occurred.

Although in most reports it has been mentioned that resistance trainings significantly increase testosterone concentration in men (19), attributed to some reasons such as decrease in plasma volume, adrenergic stimulations (20), release of stimulated lactate (6), potential adaptations of testosterone synthesis, and secretory capacity of Leydig cells in testes (16), training sessions with moderate and heavy intensities has no significant impact on testosterone levels in the present study. Results of the present study are inconsistent with findings of Kramer *et al* (2003), Jeremy *et al* (1990), and Kostka *et al* (2003) (9, 10, 12), but they were consistent with results of Guezennec *et al* (1986), and Tayebi *et al* (2007) (8, 17).

In training of moderate intensity and training of heavy intensity, cortisol showed insignificant increase and decrease, respectively. Some strength protocols did not cause a significant increase in cortisol concentration, while bulking and endurance protocols done by the same group of people showed more essential acute increases about 30 minutes after the training session (21, 22). Cortisol response to exercise is dependent on many factors such as intensity and duration of exercise, level of physical fitness, quality of nutrition, and even the circadian rhythm. Reports state that at a fixed level of work, trained persons showed no change in cortisol level, while it increased in untrained ones (11). As the subjects were in the training camp and all of them had the same training program, their physical fitness and quality of nutrition were similar. So, intensity and duration of exercise could not act as a stimulant. Hence, observations of the present study were inconsistent with results of Kornil *et al* (1965), Raymond *et al* (1969), Fry *et al* (1993), Kramer *et al* (1998), Kostka *et al* (2003), and Tayebi *et al* (2007) in the group of Physical Education students (5, 11-13, 17), but consistent with findings of Tayebi *et al* (2007) in the group of weightlifters (17).

Conclusion

Although it has been stated that training in compliance with the principle of overload temporarily disrupt homeostasis and balance of many physiological processes in the body (23-25), it can be concluded from the observations that some adaptations are created in elite weightlifters who are in competition and preparation season that even one intense and long training session cannot cause significant changes in balance between anabolic and catabolic processes in them. However, further studies are needed to make clear the effect of resistance training, especially weightlifting, on hormone changes.

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