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Effect of eight weeks continuous resistance trainings on levels of cortisol, dehydroepiandrosterone and dehydroepiandrosterone to cortisol serum ratio of active young women

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Abstract

The purpose of the present study was determination of acute and chronic effects of eight weeks continuous resistance trainings on levels of cortisol, dehydroepiandrosterone and dehydroepiandrosterone to cortisol serum ratio of active young women. Fourteen under study subjects of this research were divided to two training and control groups, randomly. The experimental group participated in 8 weeks progressive resistance trainings. Before, immediately then and 2 hr after the first test (48 hr before trainings beginning) and the final one (48 hr after trainings ending), blood samples were taken from the subjects. The control group gave blood samples, only at the beginning and ending of the eight weeks period. In order to investigate variations of under study variables in the continuous group, the variance analysis test with repeated measurements was used. Independent T test was utilized, to compare between the continuous training group and the control one. Also, to investigate changes of under study variants in the control group, T paired test was implemented. Cortisol decreased in a linear manner and significantly, in the training group ($P<0.005$). Dehydroepiandrosterone and dehydroepiandrosterone to cortisol ratio increased significantly and linearly, in the training group ($P<0.005$). After 8 weeks trainings, cortisol serum levels of rest time in the training group were significantly less than its levels in the control one, and levels of dehydroepiandrosterone and dehydroepiandrosterone to cortisol serum ratio of rest time in the training group were significantly more than their similar levels in the control one ($P<0.005$). It's recommend that active young women come to the continuous resistance exercises to improve their physical readiness. Rather researches about various kinds of resistance exercises are required.

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Introduction

If catabolic hormones increase following exercise, it's a sign of overly pressure of activity, and whether there's a balance between anabolic and catabolic hormones, indicates athlete is in a good readiness situation. The ratios of these hormones are useful indices to determine readiness situation of athlete and pressure of activity and exercise (Urhausen *et al.*, 1995). Cortisol is the most important human glucocorticoid and produced in adrenal cortex (Murray *et al.,* 1993). Dehydroepiandrosterone is one of specific hormones of adrenal which affects anabolic effects on many tissues via conversion to gender hormones, including testosterone and estrogen (Filaire and Lac, 2000; Obminski and Stupnicki, 1997). Recently, the resistance exercises have been paid attention by many people, especially women, with purposes of fitness. Measurement of exercise pressure indices following various trainings schedules, could aid to better understanding of acute and chronic effects of resistance exercises. Dehydroepiandrosterone to cortisol ratio is propounded as exercise pressure index (Obminski and Stupnicki, 1997). If exercise pressure is more than physiologic capacity limitation of athlete, not only the performance would improve but also leads to debilitation of the performance. In the other hand, whether exercise pressure is less than the necessary level, it wouldn't cause a remarkable progress in the performance, too. Kvorning *et al.*, (2006) reported increase in testosterone, following resistance exercises. Hakkinen *et al.*, (2005) observed increase in amounts of dehydroepiandrosterone among inactive women, after 12 and 21 strength and endurance trainings, respectively. Hakkinen *et al.,* (2000) observed nonbeing change of cortisol response to resistance activity, after a resistance trainings period. Though, Kraemer *et al.*, (1999) showed decrease in cortisol response to resistance activity, after a resistance trainings period. Alen *et al.*, (1988) reported increase in dehydroepiandrosterone to cortisol ratio, during resistance trainings. In contrast, Hakkinen *et al.*, (1987) reported decrease in dehydroepiandrosterone to cortisol ratio, during resistance trainings. Also, Hakkinen *et al.*, (1985) reported increase in testosterone and decrease in cortisol, after strength exercise. Variations of dehydroepiandrosterone concentration and also characteristic of dehydroepiandrosterone to cortisol ratio in response to sport exercises are still in ambiguity, despite few researches which have been performed in these fields.

The aim of the present study was determination of acute and chronic effects of 8 weeks continuous resistance trainings on levels of cortisol, dehydroepiandrosterone anddehydroepiandrosterone to cortisol serum ratio of active young women.

Material and methods

Subjects

Statistical society of this study consisted of entire active girl students of Tehran city. Fourteen 20-25 years old girl students of Tehran city with averages age of 22.571±1.804 years old, height of 161.19±4.094 cm, weight of 56.904±6.533 Kg, maximal oxygen consuming of 38.428±1.567 (ml/Kg weight of Body/min) and body mass index of 21.879±1.999 (Kg/squared height) declared their readiness following an announcement to participate in the research, and were chosen purposefully as a sample and were divided to two groups, including a continuous resistance training group (7 persons) and a control one (7 persons). All of the subjects had perfect physical healthiness (physician approval).

Data collecting method

One week before research execution, the subjects were become familiar with exercises protocol and the study method, in justification meeting. In addition of making the subject familiar with resistance movements, characteristics of heights, weights and body mass indices and values of maximal oxygen consuming and also maximum strength (1RM) for each movement were measured, in this meeting. Then 48 hr before trainings beginning, the subjects attended in test session and blood samples were taken, before, immediately then and 2 hr after a continuous resistance exercise session. This session held with 20% intensity of a maximal repetition.

Thereafter, the subjects executed their trainings schedule in a progressive manner, in span of 8 weeks. The control group didn't perform any exercise and only carried out their usual daily activities. After completion of 8 weeks trainings and following 48 hr rest, proportional to the rest interval between the first samples collecting day and trainings beginning (48 hr), last resistance activity session was done with the same 20% intensity of a maximal repetition. Also, blood samples were taken, before, immediately then and 2 hr after this session.

Trainings schedule

The resistance exercises were in progressive ways and consisted of 8 weeks (3 days in week (1 day on/ 1 day off)). A percentage of a maximal repetition and execution speed was considered as intensity and mass of exercise. The implemented progressive overload was in a manner that the subjects performed their exercises with 20%, 25%, 30%, 35%, 40%, 45%, 50% and 55% of a maximal repetition from the first week to the eighth one, respectively. The resistance exercises were continuously designed in circular figures. Each circle contains chest press, feet press, fore-arms, fore-feet, rare-arms, rare-feet and sidelong tension (or length), which order of movements execution was in the same mentioned way. Span of each station was considered as 2 min and 30 sec. The subjects were carrying out each station with speed of V. Movement speed was controlled by metronome. Rest intervals between each two successive stations and each two successive circles were considered as 1 min and 2 min, respectively. Two circles were considered in each exercise session. The resistance activities before and after the trainings period, which were counted as test and samples collecting sessions, performed with the same manners and with a 20% of a maximal repetition. Each person started and finished her whole activity sessions in particular times, which were the same for her entire exercise session. The subjects of the control group didn't carry out any sport and physical exercise, during the research, and only did their usual and daily activities.

Blood samples collecting and hormonal analysis

Before, immediately then, and 2 hr after the first test (48 hr before trainings beginning) and the final one (48 hr after trainings ending), blood samples were taken from the subjects' middle veins, in amount of 5 cc for each person. The control group gave blood samples, only at the beginning and ending of the trainings period (in company with the experimental group). Serum of gathered blood samples separated from plasma by centrifuge in span of 10 min and with revolution of 3500 RPM. All of the blood samples preserved in frigid form and at -20°C until arriving to laboratory and there, lab examination started. Cortisol serum was measured with using Elisa method and by utilizing IBL kit with sensitivity of 2.5 (ng/ml), for each sample. Dehydroepiandrosterone serum was measured with using Elisa method and by utilizing IBL and with sensitivity of 0.108 (ng/ml), for each sample. Dehydroepiandrosterone to cortisol ratio was calculated after conversion of amounts of both hormones to (nmol/l). For unit conversion of cortisol and dehydroepiandrosterone, formulas (ng/ml)×275.9=(nmol/l) and (ng/ml)×3.47=(nmol/l) were implemented, respectively (Boostani *et al.,* 2013).

Statistical method

At first, values of each under study variant were described by using mean and standard deviation. Then, in order to determine naturalness of distribution, Smirnov-Kolmogorov test was applied. Next, to investigate changes of under study variables in the training group, variance analysis test with repeated measurements and LSD post hoc test were implemented. Also, data sphericity was investigated simultaneously with execution of variance analysis test, to implement Greenhouse-Giggs modification on degree of freedom, in necessary cases. T paired test was applied, to confide nonbeing change of under study variables in the control group, too. Levels of significance were considered as 0.005 for the whole statistical tests and the statistical software SPSS v.16 was used for performing statistical calculations.

Results

Values of cortisol, dehydroepiandrosterone and dehydroepiandrosterone to cortisol ratio reported in table 1. The values represented as mean and standard deviation. Concerned results to variance analysis test with repeated measurements for investigating values of cortisol, dehydroepiandrosterone and dehydroepiandrosterone to cortisol ratio in the training group have been presented in table 2 and table 3 shows results of LSD post hoc test following variance analysis test with repeated measurements. Table 4 has reported results of T paired test concerned to variations of the control group, and table 5 has reported results of independent T test concerned to comparison of relaxation levels of the training group and the control one.

Table 1. Values of cortisol, dehydroepiandrosterone and dehydroepiandrosterone to cortisol serum.

Variables	Sampling Times	Training Groups	Control Groups
Cortisol (ng/ml)	Pre	113.56±30.253	94.2±14.803
	Post 1	98.885±13.196	
	Post 2	83.557±10.675	
	Post 3	77.328±6.515	92.342±12.022
	Post 4	70.5±5.741	
	Post 5	62.714±7.028	
DHEA (ng/ml)	Pre	3.135±0.332	3.107±0.561
	Post 1	3.261±0.278	
	Post 2	4.138±0.499	
	Post 3	4.402±0.242	3.41±0.39
	Post 4	4.665±0.327	
	Post 5	4.995±0.449	
DHEA to Cortisol Ratio (nmol/l)	Pre	3.645±0.907	4.229±0.955
	Post 1	4.198±0.532	
	Post 2	6.303±0.973	
	Post 3	7.2±0.675	4.729±0.916
	Post 4	8.336±0.318	
	Post 5	10.095±1.193	

Cortisol serum levels decreased significantly in continuous resistance training group, during the study period (P=0.002). Also, dehydroepiandrosterone serum levels increased significantly in continuous resistance training group, during the study period (P=0.000). In addition, dehydroepiandrosterone to cortisol ratio increased significantly in continuous resistance training group, during the study period (P=0.000). There wasn't observed any significant change in under study variants of the present research in the control group, too (P>0.005).

Table. 2. Statistical results of variance analysis test with repeated measurements to investigate changes of under study variables in the training group.

Variables	F	P
Cortisol	17.265	0.002 *
DHEA	30.99	0.000 *
DHEA to Cortisol Ratio	89.124	0.000 *

** The mean difference is significant at the 0.05 level.*

After 8 weeks trainings, cortisol serum levels of rest time in the training group were significantly less than their values in the control one (P=0.001). And, after the trainings period, dehydroepiandrosterone serum levels of rest time in the training group were significantly more than their values in the control one (P=0.000). Also, after 8 weeks, dehydroepiandrosterone to cortisol ratio of rest time was rather than its value in the control one, significantly (P=0.000).

Discussion

According to understandings of the present study, cortisol serum levels decreased significantly, in continuous resistance training group and during the research period. Willoughby *et al.*, (2003), related probable reduction of cortisol response to a resistance activity following a trainings period, partly to low regulation of glucocorticoids receptor. Chatard *et al.*,

(2002), reported cortisol concentrations of non-athletes were rather than athletes' ones, during rest. These results indicate exercise causes reduction of cortisol relaxation levels and also decreases cortisol response to activity. So, resistance exercises probably lead to decrease in stress and pressure, which are consequences of activity, on body and also during rest. Nindl *et al*., (2001), stated increase in cortisol levels accompanies with increment of protein lipolysis and catabolism, in raise of fuel for recovery and rehabilitation after activity. Whether, consequent pressure from activity is low or a trained ready person, in aspect of physical readiness, exposes less pressure during physical activity, minor increment and even reduction of cortisol following activity could be expected. In contrary to the present founds, Hakkinen *et al*., (2000) observed nonbeing change of cortisol response to resistance activity, after a trainings period. However, Kraemer *et al*., (1999) showed cortisol response to resistance activity, after a resistance trainings period. Incongruity of these founds maybe hidden in various trainings protocols or spans of exercises. Also, differences in under study societies shouldn't be neglected. Although, Kraemer *et al*., (1999) studied eight young men with ages of 30 years old and nine old men with ages of 62 years old, and observed that cortisol hadn't any significant difference in the beginning, third, sixth and tenth week of resistance trainings. Based on understandings of the present research, dehydroepiandrosterone serum levels of continuous resistance training group increased significantly, during the study period. Kvorning *et al*., (2006), presented increment of testosterone following resistance exercises and generation of strength development. Kraemer and Ratamess (2005), reported heavy strength exercises for several weeks or months provoke some periodic changes, but not chronic, in testosterone concentration. Also, Tremblay *et al*., (2004) revealed increase in acute response of testosterone to sport in men, after a resistance trainings period, upon variations of relaxation concentration. Willoughby and Taylor (2004), reported increase in expression of androgen receptor of trained muscle cells, resulting from intense resistance exercise, too. In contrast and in antithetical founds, Chatard *et al*., (2002) reported non-athletes' dehydroepiandrosterone concentrations were more than athletes' ones, during rest, and trainings wouldn't cause any significant difference in dehydroepiandrosterone. And, Hakkinen *et al*., (2000) didn't find any significant difference in men's dehydroepiandrosterone, after a resistance trainings period. By the way, Kraemer *et al*., (1999) reported high basic testosterone levels in subjects of resistance trainings. They indicated increment of acute response to sport in men, after a resistance trainings period, upon variations of relaxation concentration. In order to find reason of incongruous results, further investigations are required. However, expectation of observing anabolic response, following resistance exercises, couldn't be simplistic. In this way, Kadi (2000) declared resistance exercises maybe increase expression of androgen receptor in trained muscle cells. Fry *et al*., (1994), stated although testosterone acute (in consequence of activity) and chronic (rest) responses to resistance activity are different, but they're determined by mutual influences of several exercise variables (for example; intensity, mass, time span, rest interval and engaged muscular mass) and personal characteristics (like; age, fitness level and readiness). Therefore, the results wouldn't probably be the same in various researches conditions. Exercise protocols probably play important roles in observation of different results. Raemer *et al*., (1992), reported strength exercises with high intensity and adequate mass cause increment of muscular mass and testosterone concentration. In agreement with understandings of the present study, Hakkinen *et al*., (1988) reported that resistance trained subjects showed high levels of basic testosterone. According to founds of the present research, dehydroepiandrosterone to cortisol ratio increased in continuous resistance training group, during the study period. These results show a resistance trainings period in active young women leads to increment of physical readiness level and creation of desirable physiologic consistencies, and provides anabolic medium. Nindl *et al*., (2001), stated reduction of testosterone and increase in cortisol

levels accompany with increment of protein catabolism and lipolysis in raise of fuel for recovery and rehabilitation after activity. In contrary to understandings of the present study, Obminski and Stupnicki (1997) found out dehydroepiandrosterone to cortisol ratio decreased significantly in karate players, by studying this ratio among karate and triathlon players. By methodology studying of the two researches, it's recognized that exercise protocols are the main reason of observing incongruous results. In the other hand and in agreement with founds of the present study, Alen *et al.*, (1988) reported increment of testosterone to cortisol ratio, during resistance exercises.

Table 3. Results of LSD post hoc test following variance analysis test with repeated measurements to investigate variations of under study variants in the training group.

	Cortisol	DHEA	DHEA to Cortisol Ratio
Pre - Post 1	P = 0.154	P = 0.42	P = 0.135
Pre - Post 2	P = 0.018 *	P = 0.005 *	P = 0.001 *
Pre - Post 3	P = 0.014 *	P = 0.000 *	P = 0.000 *
Pre - Post 4	P = 0.007 *	P = 0.000 *	P = 0.000 *
Pre - Post 5	P = 0.004 *	P = 0.000 *	P = 0.000 *
Post 1 - Post 2	P = 0.000 *	P = 0.004 *	P = 0.000 *
Post 1 - Post 3	P = 0.003 *	P = 0.000 *	P = 0.000 *
Post 1 - Post 4	P = 0.000 *	P = 0.000 *	P = 0.000 *
Post 1 - Post 5	P = 0.000 *	P = 0.000 *	P = 0.000 *
Post 2 - Post 3	P = 0.08	P = 0.059	P = 0.021 *
Post 2 - Post 4	P = 0.003 *	P = 0.018 *	P = 0.000 *
Post 2 - Post 5	P = 0.000 *	P = 0.028 *	P = 0.000 *
Post 3 - Post 4	P = 0.012 *	P = 0.017 *	P = 0.001 *
Post 3 - Post 5	P = 0.000 *	P = 0.022 *	P = 0.000 *
Post 4 - Post 5	P = 0.011 *	P = 0.068	P = 0.006 *

** The mean difference is significant at the 0.05 level.*

Table 4. Statistical results of T paired test concerned to variation of the control group during 8 weeks.

Variables	F	P
Cortisol	0.43	0.68
DHEA	1.34	0.22
DHEA to Cortisol Ratio	1	0.28

Table 5. Statistical results of independent T test concerned to comparison of relaxation levels of both groups.

Variables	Time of Training	T	P
Cortisol	Before Training	1.52	0.15
	After Training	2.90	0.01 *
DHEA	Before Training	0.11	0.91
	After Training	5.72	0.000 *
DHEA to Cortisol Ratio	Before Training	1.17	0.26
	After Training	5.74	0.000 *

** The mean difference is significant at the 0.05 level.*

Active young women who intent to gain advantages of resistance exercises by performing resistance trainings schedules, could use continuous resistance exercises. However, further researches are required.

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