Original Article

Effects of Resistance Training on Serum Cortisol and Dehydroepiandrosterone Levels in Trained Young Women

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ABSTRACT

Background & Objectives: **Endocrine hormones, through their anabolic or catabolic function, contribute in body homeostasis. They can be used to assess the physical performance in athletes. This study was performed to determine the resistance training (RT) influences on serum cortisol and dehydroepiandrosterone in trained young females.**

Materials & Methods: **The study population consisted of 36 women (20-25 years) divided into 2 experimental groups (A, B) and control group (C). Experimental groups were scheduled to do 8-week incremental RT program, intermittently (A) or continuously (B), through alterations in the prescribed training velocity. Two days before starting and after ending of program, in a testing session of RT with the intensity of 20% one repetition maximum strength, blood samples for measuring cortisol and dehydroepiandrosterone were obtained (a pre-post test design). The SPSS version 16 was used for statistical analyses.**

Results: **Serum cortisol of experimental groups showed significant decline (*P*=0.002 in each group) without significant difference between two groups, while, DHEA and DHEA/Cortisol ratio had significant increase (all *P* =0.001) with no significant difference between two groups at both stages.**

Conclusion: **With considering the role of RT in establishing an anabolic status following exercise, it seems that young women can use different types of RT to improve their physical performance. This conclusion needs more researches regarding RT.**

Keywords: **Physical Exercise, Cortisol, Dehydroisoandrosterone**

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Introduction

Endocrine system plays an important role in maintaining the body integration and homeostasis. Hormones in conjunction with central nervous system affect on almost all physiological functions. Hormonal assays, particularly anabolic (testosterone or dehydroepiandrosterone) and catabolic (cortisol) hormones, have been suggested as valuable indicators of the exercise intensity and work-load, so that the ratio between anabolic and catabolic hormones has been used to determine the readiness status of the individuals (1).

Cortisol is the major adrenocortical steroid and dehydroepiandrosterone (DHEA), as another adrenocortical steroid, affects on some tissues after transformation to testosterone or estrogen (1-3). Physical activity, as an inevitable necessity, results in physiological adaptations that influence on hormonal system. On the other hand, resistance training has been recently considered by many people, particularly women, to achieve physical fitness. Thus, exercise stress indicators can help to better designing of the exercise protocols. If the exercise workload exceeds the physiological capacity of athletes (over-training), their functional performance not only will not improve but also will be undermined.

There are few studies regarding the hormonal responses after resistance training, particularly in women. Therefore, this study was conducted to evaluate the effects of resistance training on serum cortisol and DHEA levels in trained young women.

Materials and Methods

The subjects

The study population was composed of 36 trained female students, aged 20 to 25 years, who had informed consent for participation. They were non smoker and healthy, based on medical history, physical examination and laboratory records in a questionnaire, and had regular practice around 6.0 ± 0.55 hours per week during the past two years. The participants randomly assigned into 2 experimental groups including: intermittent (A), and continuous (B) resistance training groups and control (C) group (n=12, each) that their physical characteristics have been summarized in Table 1.

Table 1- Physical characteristics of the participants

No.	Age (yr)	Weight (kg)	Height (cm)	VO_2max(ml/kg/min)	BMI (kg/m^2)
36	22.19 ± 1.81	56.53 ± 6.41	161 ± 4.49	38.4 ±1.54	21.8 ± 1.51

Values are mean ± SD

Training protocol

One week before implementing the study, the participants got familiarized with the training protocol in a meeting. In this meeting, some strength movements were introduced to the participants and their height, weight, body mass index, maximal oxygen consumption and one repetition maximum strength (1RM) were measured (Table 1). The 1RM (maximum weight that an individual can lift once) was calculated separately using the Brzycki formula: 1RM = the amount of weight / (1.0278 – (0.0278 × number of repetitions)) related to each movement (4). Two days before the study, the experimental groups met in a testing session with the intensity of 20% of 1RM, while blood samples were obtained at pre-training$_1$ and post-training$_1$ (0 and 2 hours) stages. The participants performed the training protocol (3 days/week) during 8 weeks with an increasing intensity rate of 5% of 1RM per week from 20% to 55%.

Each training session included 2 circuits. Each circuit contained 7 movements of chest press; leg press; and forearm, foreleg, hind arm, hamstrings and lateral stretching. The time period was 2.5 min for each movement. There were 2-minte and 1-minute resting intervals between 2 circuits and 2 movements, respectively.

Indeed, the total time for each session was 65 minutes which included a 10-min light warming up, RT protocol for 47 minutes and a cool down exercise for 5-10 minutes. Group B performed each movement with a constant speed (V=one attempt per 2.5 seconds), continuously. Group A were asked to do each movement with different speed (2V for 10 and ½V for 20 seconds), intermittently. The speed of movements was controlled by a metronome.

Two days after termination of training workouts, following an effort of 20% of 1RM, similar blood samples were collected as pre-training$_2$ and post-training$_2$ stages. Training workouts and samplings were performed in a similar time for each person to neutralize the effect of circadian rhythm. During this period the control group did no exercise and had normal daily activities.

Blood sampling and hormone analysis

Two days before starting the RT program and two days after termination of program, at pre-training and post-training (0 hour and 2 hour) stages, venous blood samples (5 mL) from antecubital vein of experimental groups were drawn for hormone analysis while the control group only in the beginning and the end of 8-week RT (so called pre-training stages) gave blood samples. All steps of sampling for each subject were taken in a same condition. Blood samples in tubes containing EDTA became centrifuge for 10 minutes with 3500 RPM. It should be noted after each session, subjects were considered to drink plenty of fluids up to be compensated for the lost fluids. Serum cortisol and DHEA levels were measured by ELISA method using "IBL" kits with a sensitivity of 2.5 ng/ml and 0.108 ng/ml, respectively. Then, the ratio between serum DHEA and cortisol was calculated.

Statistical methods

At first, the value of each variable was described as the mean ± standard deviation. Thereafter, to determine the normal distribution of variables for using the parametric or non-parametric tests, the Kolmogorov–Smirnov (KS) test was applied. Whereas, data were normally distributed, to evaluate alterations of the variables in both experimental groups, repeated-measures Analysis of Variance along with the LSD (Least Significance Difference) post-hoc test was used.

At the same time with the ANOVA test, the sphericity of data was examined in order to conduct Greenhouse-Geisser correction on the degree of freedom. Moreover, to make an intergroup comparison between intermittent and continuous training, independent one-way ANOVA along with Tukey's post-hoc test, on the one hand, and independent *t*-test, on the other, were applied before the activities (considering the presence of control group) and immediately and two hours after the training program, respectively. The SPSS software version 16 was used for statistical analyses and for all statistical tests, significance level was considered as P value ≤ 0.05.

Results

Serum cortisol, DHEA and DHEA/Cortisol ratio (DCR) values of three groups at different stages have been presented in Table 2.

Table 2- Serum cortisol, DHEA and DHEA/cortisol ratio values of the participants at different stages

Variables	Sampling stages	Group A	Group B	Group C
Cortisol (ng/ml)	Pre training$_1$	102.37±18.99	113.56±30.253	94.2±14.803
	Post training$_1$0	90.16±11.727	98.885±13.196	
	Post training$_1$ 1	81.157±13.318	83.557±10.675	
	Pre training$_2$	73.857±12.605	77.328±6.515	92.342±12.022
	Post training$_2$0	68.214±12.721	70.5±5.741	
	Post training$_2$1	55.311±11.063	62.714±7.028	
DHEA (ng/ml)	Pre training$_1$	3.172±0.181	3.135±0.332	3.107±0.561
	Post training$_1$0	3.288±0.526	3.261±0.278	
	Post training$_1$ 1	3.765±0.337	4.138±0.499	
	Pre training$_2$	4.091±0.437	4.402±0.242	3.41±0.39
	Post training$_2$0	4.572±0.517	4.665±0.327	
	Post training$_2$1	5.16±0.253	4.995±0.449	
DHEA to Cortisol ratio	Pre training$_1$	4.031±0.887	3.645±0.907	4.229±0.955
	Post training$_1$0	4.696±1.113	4.198±0.532	
	Post training$_1$ 1	6.061±1.706	6.303±0.973	
	Pre training$_2$	7.25±2.13	7.2±0.675	4.729±0.916
	Post training$_2$0	8.759±2.389	8.336±0.318	
	Post training$_2$1	12.199±2.842	10.095±1.193	

Values are mean ± SD

Comparing to control group (C) serum cortisol levels of two experimental groups (group A and B) showed significant decline (*P*=0.002 in each group) without significant difference between group A and B at both stages (Fig. 1).

In addition, significant increase in serum DHEA levels and DCR was observed in two experimental groups compared to control group (all *P* =0.001) without significant difference between group A and B at different stages (Fig. 1).

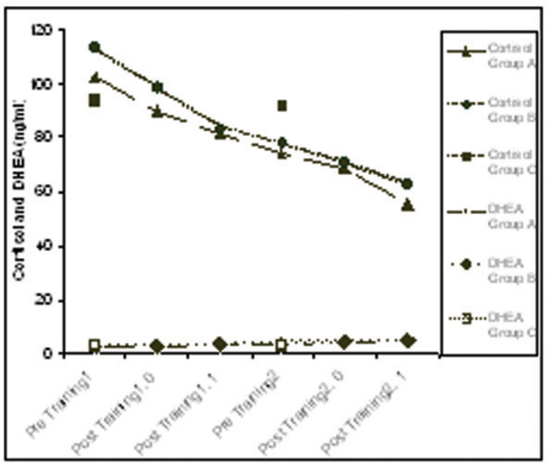

Fig. 1- Serum cortisol and DHEA alterations in study groups

Table 3 shows the statistical analyses of one way ANOVA test to compare the basal hormone levels at different stages in study groups.

Table 3- Comparison of basal hormone levels at different stages in study groups

Variables	Stages		Sum of Squares	df	Mean Square	F	*P*
Cortisol	Pre-training	Intragroup	1049.732	2	524.866	1.067	0.365
		Intergroup	8855.3	18	491.961		
		Total	9905.032	20			
	Post-training	Intragroup	1351.47	2	675.735	5.861	0.011 *
		Intergroup	2075.249	18	115.292		
		Total	3426.718	20			
DHEA	Pre-training	Intragroup	0.015	2	0.008	0.05	0.952
		Intergroup	2.753	18	0.153		
		Total	2.769	20			
	Post-training	Intragroup	3.61	2	1.805	13.456	0.000 *
		Intergroup	2.414	18	0.134		
		Total	6.024	20			
DHEA to Cortisol Ratio	Pre-training	Intragroup	1.233	2	0.617	0.733	0.494
		Intergroup	15.144	18	0.841		
		Total	16.377	20			
	Post-training	Intragroup	29.084	2	14.542	7.478	0.004 *
		Intergroup	35.004	18	1.945		
		Total	64.088	20			

* The mean difference is significant at the 0.05 level

Table 4. Presents the results of Tukey's post-hoc test related to significant differences in post-training basal hormone levels which were found following the ANOVA test

Table 4- Intragroup comparison of post-training basal hormone levels

Variables	Intragroup comparison	Mean Difference	Std. Error	*P*
Cortisol	Group B - Group A	3.471	5.739	0.819
	Group B - Group C	15.014	5.739	0.044 *
	Group A - Group C	18.485	5.739	0.013 *
DHEA	Group B - Group A	0.311	0.195	0.275
	Group B - Group C	0.992	0.195	0.000 *
	Group A - Group C	0.681	0.195	0.007 *
DHEA to Cortisol Ratio	Group B - Group A	0.05014	0.7454	0.998
	Group B - Group C	2.471	0.7454	0.01 *
	Group A - Group C	2.52114	0.7454	0.009 *

* The mean difference is significant at the 0.05 level

Table 5 demonstrates results of independent *t*-test about comparing of post-exercise hormone changes at different stages in experimental groups.

Table 5- Comparison of post-exercise hormone levels in experimental groups

Variables	Stages	Time of Exercise	T	df	*P*
Cortisol	Pre-training	0 h post-exercise	1.308	12	0.216
		1 h post-exercise	0.372	12	0.716
	Post-training	0 h post-exercise	0.433	12	0.672
		1 h post-exercise	1.494	12	0.161
DHEA	Pre-training	0 h post-exercise	0.121	12	0.906
		1 h post-exercise	1.637	12	0.128
	Post-training	0 h post-exercise	0.401	12	0.695
		1 h post-exercise	0.842	12	0.416
DHEA to Cortisol Ratio	Pre-training	0 h post-exercise	1.068	12	0.307
		1 h post-exercise	0.327	12	0.749
	Post-training	0 h post-exercise	0.464	12	0.651
		1 h post-exercise	1.806	12	0.096

Discussion

To our knowledge, despite conducting of several studies regarding the hormonal responses of different types of exercise training including resistive and endurance trainings or both, there is no conclusive comparison between intermittent and continuous RT. Hackney *et al.* found a transient significant elevation in serum cortisol levels following endurance training which was greater for intermittent training compared to continuous training (5). Tremblay and colleagues showed increased levels of serum cortisol following resistance exercise than endurance training (6). Folland and Williams reported a significant increase in serum cortisol following a high volume of moderate to severe RT with short breaks (7). Nindl explained that high cortisol level, as an adaptive mechanism, is needed for induction of post-exercise lipolysis and proteolysis in recovery period (8). Hickson *et al.* stated that cortisol function might be inhibited by anabolic hormones (androgen). Indeed, both resistance and endurance trainings, decrease glucocorticoid-induced muscle catabolism. It has been suggested that regular activity may abate muscle gene expression of glucocorticoid-inducible proteins and exercise-induced physical stress particularly in low workloads (9).

In addition, many investigators found a similar decline in post-exercise cortisol levels indicating that exercise training may reduce resting cortisol levels and cortisol response to physical activity (10-14), however, some researchers cited no changes in cortisol response following RT (15,16). Based on the present study, serum cortisol levels declined following both types of RT without any significant difference between experimental groups. As, exercise intensity and duration are the major determinants of cortisol response and with considering of prescription of similar intensity RT protocol during 8 weeks, it may be reasonable to get such finding in our study. Furthermore, most researches have focused on endurance training than RT and none compared different types of RT (5), thus, different results should be naturally expected. However, further investigations for more precise conclusions are needed.

Moreover, several studies have evaluated DHEA response to different types of exercise training which there has been a lot of controversy surrounding these experiments. Some researchers reported elevated levels of DHEA following RT (3, 6, 12, 17-21) that was more prominent in continuous type (18) while some found no significant changes in post-exercise DHEA levels (5,11,15). On the other hand, Ponjee *et al.* cited decline of serum DHEA and cortisol in long-term endurance activities (22). This study revealed increased DHEA levels following both training exercises with no significant difference between them which may be attributed to similar intensity and duration of both types. Whereas, we found no study regarding comparison of hormonal response following intermittent and continuous RT, more investigations surrounding this issue are recommended.

The ratio between anabolic and catabolic hormones including testosterone or DHEA to cortisol which had been proposed by Adlercreutz in 1986, can be used as a useful indicator of activity load and physical fitness (23). However; the pattern of this ratio in response to physical activity changes continues to be a subject of controversy so that reduced, increased and constant values has been reported following exercise (23-25). We found an increased ratio in both experimental groups indicating that RT can improve physical performance and physiologic adaptations by providing an anabolic status in trained young women. Alen *et al.* have got similar findings (26) but, surprisingly, other researchers observed a decreased ratio following RT (1, 6, 25, 27). Undoubtedly, further researches surrounding the anabolic effects of RT are needed.

Conclusion

This study revealed establishment an anabolic status following resistance training which can improve physical performance and also maintain physical fitness in trained young females. It seems that types of RT have not an influence on the above achievements. With regard to the highly controversial opinions surrounding the hormonal responses following different types of exercise training due to the influences of training (intensity, volume, duration and resting period) and individual (age, health and fitness level) characteristics, further investigation are recommended.

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