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The effects of the enduring exercises on salivary dehydroepiandrosterone to cortisol ratio among non-athletes women

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Abstract

The purpose of the present study was determination of the effects of eight weeks enduring exercises on levels of cortisol, dehydroepiandrosterone (DHEA) and salivary DHEA to cortisol ratio, among non-athletes women. Fourteen under investigation subjects of this research were randomly divided to two groups exercise and control groups (7 persons for each group). The exercise group participated in 8 weeks progressive enduring trainings. Salivary samples were taken from the subjects of the two groups, both 48 hr before and 48 after the eight weeks trainings. Factor analysis of variance test with repeated measurements was used, to compare changes of variables in the two groups. An enduring trainings period would cause increment of relaxation levels of salivary cortisol (P=0.000) and decrease in those of salivary DHEA (P=0.005). Salivary DHEA to cortisol ratio decreased, though in an insignificant way (P=0.078). Although the eight weeks enduring trainings showed catabolic consistency in non-athletes females, but this catabolic consistency wasn't significant. Perhaps, this insignificant catabolic consistency might turn to a significant manner, by elongating the trainings period. Therefore, longer period trainings should be designated, in future researches.

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Introduction

Attention to Sport and physical activities has been become an unavoidable issue. This interest exists in the whole groups of the society and with various goals. Physical activity and sport accompany with physiologic consistencies. Recognition and investigation of these consistencies, especially in hormonal system, which has a substantial hand in vital reactions of body, is very important and remarkable. Because, the hormones would involve various changes by the influence of performing various sport exercises and activities, that recognition of these variations is effective about interpretation of physiologic mechanisms of body. In the other hand, the enduring exercises have well-known influences on fitness that could be considered by many people, especially women.

These exercises would create structural variations and physiologic consistencies that could appear in hormonal system, as the most prominent demonstration of this issue. Measurement of exercise pressure indices following enduring trainings schedules, could aid better understanding of acute and chronic effects of these exercises. The endocrine system helps the consolidation and control of body activities and provides vital equilibrium or stability, and in other words; homeostase (Guyton & Hall., 1996).

One of the most important methods for evaluation of pressure and intensity of exercise and the amount of its influence on the athletes is measurements of anabolic and catabolic hormones. That means; if catabolic hormones increase following the exercise it indicates exceeding pressure of the activity, and whether there's a balance between catabolic and anabolic hormones it shows the athlete has a favorite readiness situation (Obminski & Stupnicki., 1997).

In this relation, testosterone and cortisol hormones (as anabolic and catabolic ones, respectively) have been paid attention rather than other hormones, and their proportion to each other is a very handful index to determine readiness situation of the person, and pressure exercise and activity (Obminski & Stupnicki., 1997). However, because of slight secretion of testosterone in girls, other sexual hormone, named dehydroepiandrosterone (DHEA) is measured. So, DHEA to cortisol ratio is usually used (Agha Alinejad *et al.,* 2013).

In the other hand, the application of saliva in physiologic studies of sport, as a diagnostic tool, is increasing. Simplicity of samples collecting, ability of repeated samples collecting, inoffensive and without stress attributes and lower costs of this method, are some reasons of using this approach. It has been cleared; salivary concentrations of the mentioned hormones relate to their serum levels, significantly (Litwack & Schmidt., 1992; Kraemer *et al.,* 1998; Cumming *et al.,* 1983). Non-athletes women comprise a vast and substantial group of the society, and their fitness progress and consequently improvement of their life quality is a very important point. Also, the enduring trainings could aid to achieve the goal of healthiness and life improvement. So, measurement of the indices of physical readiness and exercise pressure, following these trainings, among this group of women, could contribute valuable information to the humankind science, and would present applicable recommendations to non-athletes women.

Hence, the purpose of the present study was determination of the effects 8 weeks enduring trainings on salivary DHEA, cortisol and DHEA to cortisol ratio, among young non-athletes females.

Material and methods

Subjects

The statistical society of this research consisted of the whole 20 to 28 years old inactive but healthy women of Tehran city. Fourteen 20-28 sedentary student girls with average age of 24.50±2.653 years old, height of 164.64±5.624 cm, weight of 57.928±4.921 kg and body mass index (BMI) of 21.376±1.031 kg/m^3, declared their readiness to participate in the research, following an invitation. They purposefully chosen in access as the subjects, and randomly divided to two groups of exercise and control (7 persons for each group). All of the subjects had perfect physical healthiness (physician approval). The probability of impressionability of the dependent variables from the disruptive ones has been reduced as can possible, by homogenization of the subjects (except the hereditary matters). The demographic properties of the subjects have been given in table 1. The subjects of two groups are homogeneous, in aspects of age (P=0.924), height (P=0.621), weight (P=0.644) and BMI (P=0.901).

Data Collecting Method

The subjects were become familiar with the trainings protocol in the justification meeting, one week before the research execution. In addition of this introduction to the enduring trainings, personal and demographic characteristics of the subjects were measured. Thereafter, the subjects attended the test session, 48 hr before trainings beginning, and salivary samples were taken, in fasting state. Then, the subjects of exercise group performed their enduring trainings schedule progressively, in duration of 8 weeks. The control group avoided performing any sport and physical activity, in the mentioned duration, and only did their regular daily activities. After finishing of the 8 weeks trainings and after the proportional rest to the interval between the first day of samples collecting and trainings beginning (48 hr), the second test session was held just like the first one and salivary samples were taken, in fasting state, again.

Training Schedule

Enduring training consisted of 3 weekly sessions in duration of 8 weeks. A percentage of maximal heartbeat and sport span are considered as exercise intensity and duration. Each running session was in span of 35 min, and contained 5 min warm up, 25 min main exercise and 5 min cold down. The main exercise consisted of running on treadmill, which executed with 60, 65, 70, 75, 80 and 85 percent of maximal heartbeat for the first to the eighth week, respectively. Also, belt was gotten help to demonstrate heartbeat of the subjects on treadmill. Each person started and finished her entire activity sessions at particular moments, which are the same for her whole exercise sessions.

Salivary Samples Collecting and Hormonal Analysis

The gathered samples were being preserved in frozen forms and at -20°C, until arriving to lab and there the laboratory examination started, at once. It should be mentioned, the subjects were requested to avoid consumption of caffeine, alcohol and cigarette at the nights before samples collecting and generally during the research steps. All steps of sample collecting carried out in the same conditions, for the whole subjects. Salivary cortisol of each sample was measured by Elisa method and using of demeditec kit (made in Germany) with sensitivity level of 0.014 (ng/ml) and utilizing Elisa reader device (made in China). For each sample, salivary DHEA was gauged by Elisa method and using IBL kit (made in Germany) with sensitivity level of ≤0.1 (ng/ml) and utilizing phome device (made in China). In the present study, salivary DHEA to cortisol ratios were calculated by dividing the amounts of salivary DHEA (unit of (ng/ml)) to the amounts of salivary cortisol (unit of (ng/ml)).

Statistical Approach

At first, values of under study variables of each sample collecting time were described by using mean and standard deviation. Thereafter, Smirnov-Kolmogorov test was used to determine naturalness of the distribution and application permission of parametric or non-parametric tests. Since the data had natural distribution, factor analysis of variance test with repeated measurements was used to compare changes of under study variables in both exercise and control groups. Significance level was considered as 0.05, for entire statistical tests. Also, the statistical software SPSS v.16 was utilized to carry out statistical calculations. It should be mentioned, independent T test was used to compare demographic characteristics of both groups.

Results

Statistical descriptions of weight and BMI have been presented in table 2. Also, statistical descriptions of salivary cortisol, DHEA and DHEA to cortisol ratio have been represented in table 3. The values have been reported as mean and standard deviation. In order to compare changes of the variables between the two groups, results of factor variance analysis test with repeated measurements are given in tables 4, 5, 6, 7 and 8. Time operation, and time and group cooperation were significant (P=0.000) but group operation was insignificant (P=0.822), about weight. Generally, subjects' weights of the exercise group reduced significantly, in comparison to the control one (P=0.000). Time operation, and time and group cooperation were significant (P=0.000) but group operation was insignificant (P=0.261), about BMI. Overall, BMI of the exercise group significantly decreased, in comparison to that of the control one (P=0.000). Time operation, and time and group cooperation were significant (P=0.000) but group operation was insignificant (P=0.317), about salivary cortisol. Generally, salivary cortisol of the exercise group increased significantly, compared to the control one (P=0.000). Time operation, and time and group cooperation were significant (P was 0.009 and 0.005, respectively) but group operation was insignificant (P=0.261), about salivary DHEA. Overall, salivary DHEA of the exercise group significantly reduced, compared to that of the control one (P=0.000). About salivary DHEA to cortisol, time and group operation, and time and also group cooperation were insignificant (P was 0.114, and 0.593 and 0.078, respectively). Generally, variations of salivary DHEA to cortisol ratio among the exercise group decreased insignificantly, in comparison to those of the control one (P=0.078).

Table 1. Demographic properties of the subjects.

Group	Age	Height	Weight	BMI
Exercise	24.571±2.636	165.43±4.790	58.571±5.503	21.412±1.488
Control	24.428±2.878	163.86±6.644	57.285±4.608	21.34±0.295
Overall	24.50±2.653	164.64±5.624	57.929±4.921	21.376±1.031

Table 2. Statistical descriptions of weights and BMI of the subjects.

Variables	Groups	Pre	Post
Weight (kg)	Training	58.571±5.503	54.428±5.912
	Control	57.285±4.608	57±4.932
BMI (kg/m2)	Training	21.412±1.488	19.870±1.363
	Control	21.34±0.295	21.230±0.557

Discussion

According to the results of the present study, an enduring trainings period has caused increases in relaxation levels of salivary cortisol among non-athletes women. In contrary to the present founds, Chatard *et al.*, (2002) reported that cortisol concentrations of the non-athletes were more than those of the athletes, during rest.

Table 3. Statistical description of salivary cortisol, DHEA and DHEA to cortisol ratio.

Variables	Groups	Pre	Post
Cortisol (ng/ml)	Training	29.072±26.153	31.837±26.837
	Control	19.407±8.884	19.45±8.988
DHEA (ng/ml)	Training	92.228±18.286	85.157±16.411
	Control	100.23±19.144	100.57±20.562
DHEA to Cortisol Ratio	Training	5.950±6.005	4.474±3.928
	Control	6.434±3.414	6.524±3.702

Though, used exercises by research of Chatard *et al.,* (2002) were resistance trainings, and it could be mentioned that the reason of this antithesis is the difference between the types of exercises. Therefore, although resistance exercises might reduce the stress and pressure on the resting body, but it appears enduring exercises would progress toward catabolic reactions and consequently react toward weight reduction, by increment of cortisol hormone. However, the enduring exercises with various intensities and spans could create different influences, and should be noticed in future studies. Also, the distinctions between under study societies shouldn't be neglected.

Table 4. Statistical results of factor variance analysis test with repeated measurements to compare changes of weights among the two groups.

Factor	Sum of Square	df	Mean Square	F	P	Effect Size	Observed Power
Time	34.321	1	34.321	36.962	0.000 *	0.755	1
Group	2.893	1	2.893	0.053	0.822	0.004	0.055
Time*Group	26.036	1	26.036	28.038	0.000 *	0.700	0.998

* The mean difference is significant at the 0.05 level.

Fry *et al.,* (1994) and Kraemer (1988) declared separately; although the acute (because of activity) and the chronic (because of rest) responses of cortisol to sport activities are different, they have been determined by a collection of mutual influences of many parameters such as exercise variables (like; intensity, duration, rest period and engaged muscular mass) and personal characteristics (for example; age, and fitness and readiness levels).

Table 5. Statistical results of factor variance analysis test with repeated measurements to compare changes of BMI in the two groups.

Factor	Sum of Square	df	Mean Square	F	P	Effect Size	Observed Power
Time	4.781	1	4.781	31.352	0.000*	0.723	0.999
Group	2.899	1	2.899	1.391	0.261	0.104	0.192
Time*Group	3.593	1	3.593	23.562	0.000*	0.663	0.993

* The mean difference is significant at the 0.05 level.

Volume of sample might be one of the influencing factors, too. Perhaps, it seems necessary to execute the same research (as the present study) with more subjects, in future researches. And eventually, it shouldn't be forgotten that most previous founds have been investigated serum levels of cortisol, not salivary ones. Though, significant relations between serum and salivary levels of this hormone have been reported, in the previous founds (Litwack & Schmidt., 1992; Kraemer *et al.,* 1998*;* Cumming *et al.,* 1983). Anyway, interpretation of the results must be done with discretion. Base on the results of the present study, a period of enduring trainings would cause decrease in relaxation levels of salivary DHEA among non-athletes females.

Hakkinen *et al.,* (2005) observed increases in amounts of salivary DHEA among inactive women, after 12 and 21 strength and enduring trainings, respectively. Mark *et al.,* (2003) used sedentary, resistance trained and enduring trained subjects in their research and it was cleared their subjects were different in the amounts of DHEA-sulfate, luteinizing hormone (LH) and testosterone. These hormones were evaluated both in rest and the recovery after 40 min running and one resistance activity session. The resistance trained subjects had higher sexual hormones. DHEA-sulfate levels of the trained subjects increased following resistance activity session and remained at high levels during recovery.

The subjects, who performed enduring exercises, showed fewer variations of hormonal concentrations in response to the activity. They showed significant decreases in total and free levels of testosterone, during the recovery after resistance activity. Also, DHEA-sulfate levels increased after the activity, though its values after resistance activity were greater than those of running.

Table 6. Statistical results of factor analysis of variance test with repeated measurements to compare changes of salivary cortisol of the two groups.

Factor	Sum of Square	df	Mean Square	F	P	Effect Size	Observed Power
Time	13.790	1	13.790	34.980	0.000*	0.745	1
Group	851.075	1	851.075	1.089	0.317	0.083	0.161
Time*Group	12.961	1	12.961	32.876	0.000*	0.733	0.999

* The mean difference is significant at the 0.05 level.

In contrary to these founds, Arce *et al.,* (1993) reported that the resistance and enduring trained subjects had lower testosterone levels than the subjects of control group. Jensen *et al.,* (1991) stated testosterone increased significantly following both resistance and enduring activities, and came back to the basic levels, after 2 hr. The amount and pattern of testosterone variations was almost similar between the resistance and enduring activities.

Table 7. Statistical results of factor analysis of variance test with repeated measurements to compare changes of salivary DHEA of the two groups.

Factor	Sum of Square	df	Mean Square	F	P	Effect Size	Observed Power
Time	79.229	1	79.229	9.763	0.009 *	0.449	0.818
Group	959.400	1	959.400	1.394	0.261	0.104	0.193
Time*Group	96.200	1	96.200	11.854	0.005 *	0.497	0.884

* The mean difference is significant at the 0.05 level.

In contrast, Mark *et al.,* (2003) reported that response of testosterone to resistance activity was greater than that of enduring one. Jenson *et al.,* (1991) didn't find any difference in responses of sexual hormones, between the sessions. Also, Keizer *et al* (1989) declared DHEA-sulfate would increase, in response to enduring activity (Keizer *et al.,* 1989). However, the expectation of observing catabolic response, following enduring exercises, couldn't be simplistic. Fry *et al.,* (1994) stated; although the acute (because of activity) and the chronic (rest) responses of testosterone to resistance activity are different, they have been determined by a collection of mutual influences of many parameters such as variables of activity schedule (like; intensity, duration, rest period and engaged muscular mass) and personal characteristics (for example; age, and fitness and readiness levels) (Fry *et al.,* 1994).

Also, Kraemer (1988) investigated acute (resulting from activity) and chronic (relaxation levels) responses of testosterone to resistance activity and stated that a collection of several variables affects acute and chronic responses of testosterone. This researcher counted intensity, mass, span and rest period of exercise and also engaged muscular mass, in company with subjects' characteristics (like; age, fitness level and exercise situation), as important issues. So, the result might not be the same, in different research condition. Since, most previous researches have surveyed serum levels (not salivary ones) of hormones, so interpretation of the results should be done with more discretion, and any explanation of DHEA related founds, upon related testosterone and/or other sexual hormones results, might be simplistic. Therefore, the best recommendation could be execution of further studies with simultaneous evaluation of other variabl

Table 8. Statistical results of factor analysis of variance test with repeated measurements to compare variation of salivary DHEA to cortisol ratio among the two groups.

Factor	Sum of Square	df	Mean Square	F	P	Effect Size	Observed Power
Time	3.363	1	3.363	2.903	0.114	0.195	0.348
Group	11.237	1	11.237	0.301	0.593	0.025	0.080
Time*Group	4.292	1	4.292	3.704	0.078	0.236	0.425

Base on the results of the present study, a period of enduring trainings would cause insignificant reduction of salivary DHEA to cortisol ratio, among non-athlete females. Mark *et al.,* (2003) used sedentary, resistance trained and enduring trained subjects in their research, and it was cleared that the subjects were different in ratios of testosterone and DHEA-sulfate to cortisol, in a manner that these ratios were fewer in enduring trained subjects.

Ponjee *et al.,* (1994) reported significant decreases in DHEA and cortisol, following long-term enduring activities, too. Obminski and Stupnicki (1997) studied salivary DHEA to cortisol ratio among karate and triathlon players, and reported this ratio had a significant decrease in karate players. The enduring exercises might probably cause a reduction of anabolic to catabolic hormones ratio. Though salivary DHEA to cortisol ratio of the present study has decreased, but this reduction wasn't statistically significant. In the other hand, salivary cortisol increased significantly and salivary DHEA decreased significantly. The reason of insignificant reduction of salivary DHEA to cortisol ratio might probably because of exercise span. At the present moment, it could be mentioned only as a supposition that whether the duration of trainings was longer than 8 weeks then the reduction of salivary DHEA to cortisol ratio might be significant. By the way, it's necessary to elongate duration of trainings schedule, in future studies.

Conclusion

According to the results of the present study, it's concluded that although the eight weeks enduring exercises schedule showed catabolic consistency in non-athlete women, but this consistency wasn't significant. The mention catabolic consistency might probably become significant by elongating period of trainings. Therefore, future researches should be designated with longer durations.

References

Agha Alinejad H, Kohanpour MA, Sanavi S, Sojudi S, Behrouzi GR, Mirsepasi M. 2013. Effects of resistance training on serum cortisol and dehydroepiandrosterone levels in trained young women. Iranian Journal of Pathology, **8(1),** 9 – 16.

Arce JC, De Souza MJ, Pescatello LS, Luciano AA. 1993. Subclinical alterations in hormone and semen profile in athletes. Fertil Steril **59,** 398–404.

Chatard JC, Atlaoui D, Lac G, Duclos M, Hooper S, Mackinnon L. 2002. Cortisol, DHEA, performance and training in elite swimmers. International Journal Sports Medicine, **23(7),** 510-15.
http://dx.doi.org/10.1055/s-2002-35073

Cumming DC, Quigly ME, Yens SSC. 1983. Acute suppression of circulating testosterone levels by cortisol in men. Journal of Clinical Endocrinology &amp Metabolism **39,** 611-673.
http://dx.doi.org/10.1210/jcem-57-3-671

Fry AC, Kraemer WJ, Stone MH, Warren BJ, Fleck SJ, Kearney JT, Gordon SE. 1994. Endocrine response to overreaching before and after 1 year of weightlifting. Canadian journal of applied physiology **19,** 400-410.
http://dx.doi.org/10.1139/h94-032

Guyton AC, Hall JE. 1996. Text book of medical physiology. The eds. W.B.Saunders Company.

Hakkinen A, Pakarinen A, Hannonen P, Kautiainen H, Nyman K, Kraemer WJ,

Häkkinen K. 2005. Effects of prolonged combined strength and endurance training on physical fitness, body composition and serum hormones in women with rheumatoid arthritis and in healthy controls. Clinical and Experimental Rheumatology, **23(4),** 505-12.

Jensen J, Oftebro H, Breigan B, Johnsson A, Ohlin K, Meen HD, Stromme SB, Dahl HA. 1991. Comparison of changes in testosterone concentrations after strength and endurance exercise in well trained men. European Journal of Applied Physiology and Occupational Physiology, **63,** 467-471.
http://dx.doi.org/10.1007/BF00868080

Keizer H, Janssen GM, Menheere P, Kranenburg G. 1989. Changes in basal plasma testosterone, cortisol, and dehydroepiandrosterone sulfate in previously untrained males and females preparing for a marathon. International Journal of Sports Medicine **10(3),** S139–S145.

Kraemer WJ, Staron RS, Hagerman FC, Hikida RS, Fry AC, Gordon SE, Nindl BC, Gothshalk LA, Volek JS, Marx JO, Newton RU, Hakkinen K. 1998. The effects of short-term resistance training on endocrine function in men and women. European Journal of Applied Physiology and Occupational Physiology **78, 69-76.**
http://dx.doi.org/10.1007/s004210050389

Kraemer WJ. 1988. Endocrine responses to resistance exercise. 1988. Medicine *and* Science *in* Sports and Exercise **20(5),** S152-S157.

Litwack G, Schmidt TJW. 1992. Biochemistry of Hormones: Steroid Hormones. In: Deulin,T,M; Text book of biochemistry: with Correlations .3rd Ed Network: wiley-liss.

Obminski Z, Stupnicki R. 1997. Comparison of the testosterone-to- cortisol ratio values obtained from hormonal assays in saliva and serum. Journal of Sports Physiology and Fitness **37(1),** 50-55.

Ponjee GA, Hans Rooya HA, Vader HL. 1994. Androgen turnover during marathon running. Medicine &amp Science in Sports &amp Exercise, **26(10),** 1274-1277.
http://dx.doi.org/10.1249/00005768-199410000-00015

Tremblay MS, Copeland JL, Helder WV. 2004. Effect of training status and exercise mode on endogenous steroid hormones in men. Journal of Applied Physiology **96,** 531–539.
http://dx.doi.org/10.1152/japplphysiol.00656.2003