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EFFECT OF SIX-WEEK ENDURANCE TRAINING ON THYROID, GROWTH AND CORTISOL HORMONES IN FEMALE COLLEGE STUDENTS

Gürbüz BÜYÜKYAZI*, Fatma TANELİ**, Muzaffer ÇOLAKOĞLU*, Serdar SEVEN**, Şule ÇOLAKOĞLU*, Cevval ULMAN**

SUMMARY

Studies on hormonal response to endurance training reveal conflicting results. The purpose of this study was to investigate the physiological effects of endurance training on serum growth (GH), cortisol and thyroid hormones in female college students. An exercise group (EG, n=11; 21.0 ± 2.4 yrs) performed endurance training for six weeks, 3d/wk, 30min/d by running on the treadmill at a speed requiring 65-80% of their maximal heart rate reserve (HRRmax). The control group (CG, n=11; 21.8 ± 1.7 yrs) did not perform endurance training. Basal and post-training GH, cortisol, TSH, T3, T4, fT3 and fT4 levels were assessed in serum samples. At the end of the training period, serum GH levels did not change in either group; T4 decreased ($p<0.01$) in EG, and cortisol increased ($p<0.01$) in CG. The change observed in TSH levels in the EG was lower than that in the CG ($p<0.05$). The decreases in TSH, fT3 and T4 could be attributed to a lower hypothalamic-pituitary signaling action that could be the result of energy conservation in the exercising subjects, or could result from the better regulation of oxidative processes. Post-training cortisol levels increased in both groups, but the smaller increase observed in the EG when compared to the CG might be the result of better stress management.

Keywords: Exercise, endurance training, serum growth hormone, cortisol, thyroid hormones

* Celal Bayar Üniversitesi, Beden Eğitimi ve Spor Yüksekokulu, Manisa
** Celal Bayar Üniversitesi, Tıp Fakültesi, Manisa

ÖZET

ALTI HAFTALIK DAYANIKLILIK ANTRENMANININ BAYAN ÜNİVERSİTE ÖĞRENCİLERİNİN TİROİD, BÜYÜME VE KORTİZOL HORMONLARI ÜZERİNE ETKİSİ

Dayanıklılık antrenmanlarına hormonal tepki üzerine çalışmalar çelişkili sonuçlar vermektedir. Bu çalışmanın amacı, dayanıklılık antrenmanlarının serum büyüme (GH), kortizol ve tiroid hormonları üzerine etkisini bayan üniversite öğrencilerinde incelemekti. Egzersiz grubu (EG, n=11; 21.0 ± 2.4 yaş) altı hafta boyunca, haftada üç gün, günde 30 dk maksimal kalp atım hızı rezervinin % 65-80'ine denk gelen bir hızda koşu bandında koştu. Kontrol grubu (CG, n=11; 21.8 ± 1.7 yaş) bu sürede dayanıklılık antrenmanı yapmadı. Antrenman öncesi ve sonrası bazal GH, kortizol ve TSH, T3, T4, fT3, fT4 seviyeleri ölçüldü. Antrenman periyodu sonunda, serum GH seviyeleri değişmezken; T4, EG'de azaldı, kortizol CG'de arttı (p<0.01). TSH'de EG'de gözlenen değişim CG'dekinden fazlaydı (p<0.05). TSH, fT3, T4'teki düşüş, egzersiz yapan kişilerde bir çeşit enerji koruması sağlayabilen düşük hipotalamo-hipofizer sinyal hareketinden ve oksidatif proseslerin daha iyi denetlenmesinden kaynaklanmış olabilir. Antrenman periyodu sonrası serum kortizol değerleri her iki grupta da artmıştı, ancak EG'de CG'den daha az olan artış düzeyi, stresin daha iyi kontrol edilmesinden kaynaklanmış olabilir.

Anahtar sözcükler: *Egzersiz, dayanıklılık antrenmanı, büyüme hormonu, kortizol, tiroid hormonları*

INTRODUCTION

Exercise training is associated with increased energy expenditure. Thyroid hormones affect energy metabolism in humans. The hypothalamic-pituitary-thyroid axis includes the thyroid-releasing hormone (TRH), which regulates the thyroid-stimulating hormone (TSH) released from the anterior pituitary gland. TSH causes the release of T3 and T4 from the thyroid gland. Insufficient or excessive amounts of T3 and T4 deteriorate the physiological functions and result in the medical complications related to the disorders of hypo- or hyperthyroidism (2). Despite the importance of the thyroid hormones, there is limited data on their response to prolonged exercise training and existing studies have revealed conflicting results (12,15,20).

Growth hormone (GH) which is the most abundant hormone released from the anterior pituitary gland, has been reported to play a critical role in the growth and development of bone, connective, visceral, adipose and muscle tissues. Studies concerning GH have shown that its release increases (6,21), decreases or remains unchanged (3,14,17) depending on the training status.

Cortisol, known as a stress hormone, is a glucocorticoid produced by the adrenal cortex (5). The catabolic effects of cortisol include the breakdown of cellular proteins, allowing for the amino acids to be used for gluconeogenesis (8). Its serum levels were found to increase (7), decrease (11) or stay stable (3,4,17) upon physical exercise.

Even though endurance training is known to modulate fat metabolism and is an important part of fitness programs, hormonal response to endurance training has revealed conflicting results. The underlying physiological mechanisms of these responses are not clear. Thus, the purpose of this study was to assess the physiological effects of endurance training on serum hormone concentrations, and to gain insights into some of the underlying physiological mechanisms of these changes.

MATERIAL AND METHODS

Subjects: Totally 22 female college students from the School of Physical Education and Sports participated in the study as exercise (EG, n=11; 21.0 ± 2.4 yrs) and control (CG, n=11; 21.8 ± 1.7 yrs) groups. Criteria for the participation were: 1) no history of heart, endocrine, or metabolic disorders, 2) not taking any medication that could affect glucose or insulin metabolism, and 3) not having any thyroid hormone system disturbances. Subjects who met the criteria were assessed by a comprehensive medical evaluation and were instructed to consume their usual weight-maintaining diets. The CG attended the same pre- and post-training measurements as the EG but did not perform any endurance training within this period, except occasional leisure activities.

Study design: The height of the subjects was measured using an anthropometric set; their body weight, and body mass index (BMI) were analyzed using Tanita 300 MA (Tanita Co., Tokyo-Japan) bioelectrical impedance. Running speeds, causing 65-80% maximal heart rate reserve (HRRmax), were calculated with the Karvonen formula following a treadmill test. The treadmill protocol started at 8.0 $km.h^{-1}$, 1% grade, and every three minutes speed was increased by 1.0 $km.h^{-1}$, and consisted of five stages. All tests were repeated at the end of the six weeks training period, at the same hour of the day and under similar circumstances.

Training program: The EG ran on a Star Track 3005 treadmill (Unisen Inc., USA) for six weeks, 3 d/wk, 30 min/d at a speed nearly equal to 65-80% of their HRRmax. During the training period, treadmill speed was automatically increased to yield target heart rates.

Blood analyses: All blood samples were taken at 08.30-09.30 h following a 12-hour fast, and a 10-min supine rest, from the antecubital vein, using Vacutainer tubes. Serum samples were separated by centrifugation at 4000 g for 10min and were stored at -70°C until being analyzed. Serum T3, T4, fT3, fT4, TSH and cortisol levels were analyzed by means of an electrochemiluminescent immunoassay based hormone analyzer using commercial reagents (E170 Modular System, Roche Diagnostics Corporation, Indianapolis, USA). GH was analyzed by enzyme-amplified chemiluminescence assay method in autoanalyzer (Immulite® 1000, Diagnostic Products Corp., Los Angeles, CA, USA).

Statistical analyses: Statistical analyses were performed using an SPSS 9.0 package program, via non-parametric Mann Whitney-U and Wilcoxon-rank tests. Significance was accepted at the $p<0.05$ level.

RESULTS

Subject characteristics are given in Table 1 and serum hormone levels are shown in Table 2. All initial basal hormone concentrations were within normal clinical ranges for both groups, except for GH in the CG due to a subject's GH value (30.4 ng/ml) well beyond normal ranges. Basal levels of TSH and cortisol in the EG were significantly ($p<0.05$ and $p<0.01$, respectively) higher than those in the CG. At the end of the training period, serum T4 decreased ($p<0.01$) in the EG and serum cortisol increased ($p<0.01$) in the CG. The change observed in TSH in the EG was lower than that in the CG ($p<0.05$).

Table 1. Physical characteristics of subjects (Mean ± SD).

Parameter	EG	CG
Age, yr	21.0 ± 2.4	21.8 ± 1.7
Height, cm	167.6 ± 3.8[a]	163.6 ± 5.2
Body weight, kg	59.2 ± 2.8[b]	54.3 ± 6.6
BMI, kg/m^2	21.0 ± 0.9	20.2 ± 1.4

[a]$p<0.05$, [b]$p<0.01$ between groups

Table 2. Serum hormone levels before and following the training program (Mean ± SD).

	EG		CG	
Parameter	Pre	Post	Pre	Post
T3, $ng.ml^{-1}$	1.29 ± 0.14	1.36 ± 0.18	1.25 ± 0.29	1.39 ± 0.31
T4, $\mu g.dl^{-1}$	9.42 ± 1.53	7.98 ± 1.06^a	8.47 ± 2.55	8.10 ± 2.03
fT3, $pg.ml^{-1}$	3.08 ± 0.28	3.05 ± 0.38	3.18 ± 0.40	3.19 ± 0.60
fT4, $ng.dl^{-1}$	1.31 ± 0.18	1.33 ± 0.18	1.30 ± 0.15	1.34 ± 0.24
TSH, $IU.ml^{-1}$	4.73 ± 8.77^b	3.64 ± 6.17	1.25 ± 0.37	1.63 ± 0.74
GH, ng/ml	3.95 ± 3.85	4.25 ± 5.07	7.35 ± 9.59	5.97 ± 11.5
Cortisol, µg/dl	17.7 ± 4.9^c	21.7 ± 7.8	10.4 ± 4.1	19.3 ± 7.6^a

^{a}p<0.01 change from baseline, ^{b}p<0.05 and ^{c}p<0.01 between groups

DISCUSSION

Repeated bouts of exercise or long-term training may influence the hormonal status and long-term programs may affect basal levels of anabolic and catabolic hormones. Various views are discussed in the literature on the effect of prolonged training programs on basal hormone levels. Whereas Tamer et al (17) observed no changes in serum GH levels following 12-week endurance training in male college students, similarly to Büyükyazı et al (3), following an eight-week endurance training, Zakas et al (21) determined increases in a younger, 13-16 year-old children group following a three month continuous running program. On the other hand, long-term endurance training was shown to significantly increase serum GH levels following a year's running program in women (19). Sidney and Shephard (16) found that short-term GH response to exercise in elderly women was significantly greater after 10 weeks of training. They hypothesized that conditioning restored hypothalamic sensitivity in the elderly and subsequently increased GH release. The six-week endurance-training program in our study revealed no changes in basal GH levels in either group. Thus, we may conclude that the differences in type, duration and intensity of the exercise, as well as the age groups of the subjects in question might account for the different endocrine responses, yielding in variations in GH release.

Elevated serum levels of the stress hormone cortisol have been associated with over-training (1). Tsai et al (18) determined increases in cortisol levels in female endurance athletes during the competitive season. However, other studies report no changes in serum cortisol levels upon intensive endurance training (3,10,17). In the present study, the lower increase observed in the EG when compared to the CG might have resulted from better stress management (3).

In our study, serum T4 levels of the EG significantly decreased with endurance training, in accord with the study of Limanova et al (13) who suggested that the mobilization of fuel from energy stores and the oxidative processes are better regulated in trained sportsmen than in untrained subjects.

The circulating peripheral thyroid hormone concentrations may have been influenced by factors such as deiodination (2). Deiodinaton is a conversion process in which circulating fT4 is converted to fT3. This conversion could have been inhibited during exercise training, and the non-significant decrease in the EG may support this view. An "energy conservation mechanism hypothesis" in relation to exercise needs to be further explored (9). The decrease of TSH (followed by fT3 decrease) in the EG observed in our study may be influenced by a reduced hypo-thalamic central drive to induce thyroid gland activity (2). Thus, we speculate that the decrease in TSH concentration could be attributed to lower hypothalamic pituitary signaling action and that this may be related to a possible means of energy conservation in exercising individuals.

In summary, the difference observed in serum TSH levels in young-adult females who have undergone six week endurance training was lower than that observed in the CG. Significant reductions in serum T4, and nearly significant ones for serum TSH levels were revealed in the EG. The decrease in T4 might have been caused by a better regulation of the oxidative processes. The smaller increases in the serum cortisol levels observed in the EG compared with the CG may have resulted from a better stress management in daily life. However, to explain the cause-and-effect relationship based on the present data is not possible. Therefore, further longitudinal research is necessary to draw a more concrete conclusion.

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