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ORGINAL ARTICLE

The Comparison of T3, T4, TSH, Cortisol Hormones Fluctuations between Swimming and Running Collegiate Athletes in one Bout of Competitive Exercise

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Abstract
Background: The purpose of this study was to analyze the changes of T3, T4, TSH and cortisol in swimming and running college student athletes after one bout of competitive training session. Materials and Methods: For this purpose, 15 swimmers by the average age of 22.5±2.48 yrs, height of 177.17±2.31 cm, weight of 68.75±2.24, body mass index (BMI) 21.65±2.14 kg/m^2) and 15 runner by the average age of 23.33±2.41 yrs, height of 177.5±2.52 cm, weight of 68.5±2.22, body mass index (BMI) 22.01±2.01 kg/m^2) were selected. The exercise protocols were 200-meter free style swimming for swimmers and 800-meter running for runners. Blood samples were taken before and immediately after the exercise to measure T3, T4, TSH and cortisol. The dependent and independent t- tests were used to analyze the statistical data at ($p \leq 0.05$) significant level. Results: The results showed a significant increase in T3 and TSH in runners and TSH and cortisol in swimmers. There were no significant changes in other factors.

Conclusion: Based on the results, It can be stated that different factors such as duration and intensity of physical activities, exercise history, body fitness level and the importance of the exercise activity or competition can affect the secretion of catabolic or/and the stress hormones levels, regardless of this fact that the activity takes place in water or on the earth.

Key words: Competitive athlete, Cortisol, Hormone, Running, Swimming.

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Introduction:

While performing a physical activity, a sort of harmony is required between biochemical and physiological systems of the body. Such integration is made possible if only different body systems and tissues can communicate with each other (Iellamo et al., 2003). Although the nervous system is responsible for many of these relationships, endocrine system takes the precise role of regulating the body's physiological response to any disturbance in the balance. The nervous and endocrine systems initiate and control all the physiological processes in a coordinated action. The nervous system acts quickly and bears local short-term effects, While the endocrine system is very slow to act, but has a long-term impact (Nabkasorn et al., 2006). It seems that cortisol levels and thyroid hormones may change with stress, regimen, inflammation, different diseases, and the intensity and duration of the exercise. Cortisol hormone is a widely used biochemical index to evaluate stress which is secreted in response to severe psychological or physical reactions (Simonson., 2001). Some researchers believe that prolonged activities have potential triggers for adrenocortical system to stimulate the secretion of cortisol from the adrenal glands. On the other hand, Thyrotropin-releasing hormone or thyroid-releasing hormone (TRH) is a neutral three peptide containing Proglotamic acid, histidine and proline amide. This polypeptide increases CAMP levels in the anterior pituitary cells and stimulates the secretion of thyrotropin hormones or thyroid stimulating hormone (TSH) in a minute. TSH stimulates thyroid gland to release thyroxine and triiodotyronine. Excessive secretion of T3 and T4 hormones is also negatively regulated with TRH secretion (Huang et al., 2004). In a study conducted by Daryanoosh and colleagues (1389), 40 non-athletes took bulk field tests for 12 weeks. The results showed that there was a significant increase in thyroxine. However, no significant change in triiodotyronine was observed (Daryanoosh et al., 2010). Studies have revealed that exercise plays an important role in secretion of hormone which can be affected by some factors e.g. the type, intensity, volume and rest between each step of the workout, the recovery time and, most important of all, the physical fitness level of individuals. This response contributes in the restructuring processes that occur after the exercise (Daryanoosh et al., 2010). Competition and race may cause mental stress in athletes or even their coaches. Stress increases whenever the result of a sports activity is of a great importance to the athlete. It may also alter the levels of certain hormones (Dimitris et al., 2004). Some studies indicate that salivary cortisol secretion in athletes increases after their exposure to adverse sports conditions before and during the competition. For example, it was noted in a study that elite Golfers had higher cortisol secretion during competition than exercise (Katarina ., 2003). Experience and sports skills are effective in the secretion of these hormones. Mark and colleagues (2001) reported that athletes' experience is an important factor in cortisol secretion (Marc et al., 2000). The increase in cortisol is proportional to the intensity of the exercise. The results of some studies suggest that cortisol may not change during moderate-intensity exercise. However, when the intensity of the exercise reaches more than seventy percent of the maximum oxygen consumption, there is a constant increase in cortisol (Marc et al., 2000; Michalaki et al., 2001; Daryanoosh et al., 2010). It is reported that in low work intensity activities, e.g. stretching, yoga, tai chi and qi-kong which are usually along with rehearsal and focus, stress and stress hormone level are reduced. Conversely, in maximum activities, including endurance and high-resistance exercises, increased stress hormone level is observed (Iellamo et al., 2003). The levels of epinephrine, norepinephrine, cortisol and blood lactate increases depending on exercise intensity. Even at rest, mental stresses lead to an increase in the levels of epinephrine, norepinephrine and cortisol, while the blood lactate does not change (Schernthaner et al., 2002). In a study conducted by Teixeira et al. (2007), twelve male swimmers participated in two types of aerobic swimming (for 20 minutes without interruption, and five stages of 400 meter swimming with 45-minute rest periods between each stage). Salivary cortisol levels increased 15 minutes after swimming with the rest, but the level of this hormone decreased at 1.5 to 2.5 hours after swimming in both types, while cortisol levels were still higher than the initial level until 24 hours after the test (Maria et al., 2007). Chanudda Nabkasorn et al. (2005) were practicing 59 young female volunteers with light to moderate depressive symptoms for 8 weeks. The exercise program consisted of 5 moderate-intensity running sessions per week and each session lasted 50 minutes. The results demonstrated that due to the training program, the 24-hour cortisol secretion in urinary norepinephrine and epinephrine decreased (Nabkasorn et al., 2006). In another study, the researchers found that there was a significant increase in cortisol levels, ACTH and epinephrine in female athletes performing moderate-intensity aerobic exercise for 30 minutes (Rowbottom& Green., 2001). Regarding the importance of the secretion of hormones and the mutual impact of hormones and sports activities, this study seeks to compare hormonal changes in physical activity in both types of sports activities (land and water).

Materials and Methods

In this study, 15 male swimmers and 15 male runners were recruited on a voluntary basis. Athletes selected based on medical information, history, sports and nutrition questionnaires. Subjects were asked to answer questions. Then, based on data collected from questionnaires, those subjects who had at least 3 exercise sessions a week with the sports experience of more than 2 years were selected. The Physiological parameters are presented in Table 1 (swimming) and Table 2 (runners). The Match protocol included a free swim 200 meter race and an 800 meter sprint race. 5mm blood samples were taken from ulna vein to assess the amount of TSH, T3, T4 and cortisol release before and after completion of activities. Monobind Laboratory kit for T3 and T4 hormones made in the USA, Monobind Laboratory kit for TSH hormone made in Germany and IBT kit for cortisol made in the USA were used in order to determine the level of these hormones. Independent T-test was also used. All data were analyzed using SPSS version 15 and the level of significance is regarded as (05/0 ≥ p).

Table1. Physiological indices of swimmers

Index	**Minimum**	**Maximum**	**Amplitude**	**Mean**	**SD**
Age (years)	20	28	8	22.50	2.35
Weight (Kg)	53	86	33	68.75	2.24
Height (cm)	165	190	25	177.17	6.96
BMI	19.48	23.82	4.34	21.65	2.14
Time (min)	2.52	4.01	1.49	3.31	0.35
Diastolic	70	90	20	77.50	6.21
Systolic	110	130	20	122.50	6.21

Table 2. Physiological indices of runners

Index	Minimum	Maximum	Amplitude	Mean	SD
Age (years)	20	29	9	23.33	2.41
Weight (Kg)	58	81	23	78.50	2.22
Height (cm)	168	186	18	177.50	2.52
BMI	20.56	23.47	2.91	22.01	2.01
Time (min)	2.09	2.39	0.30	2.25	0.09
Diastolic	60	80	20	75.00	6.74
Systolic	110	120	10	116.67	4.92

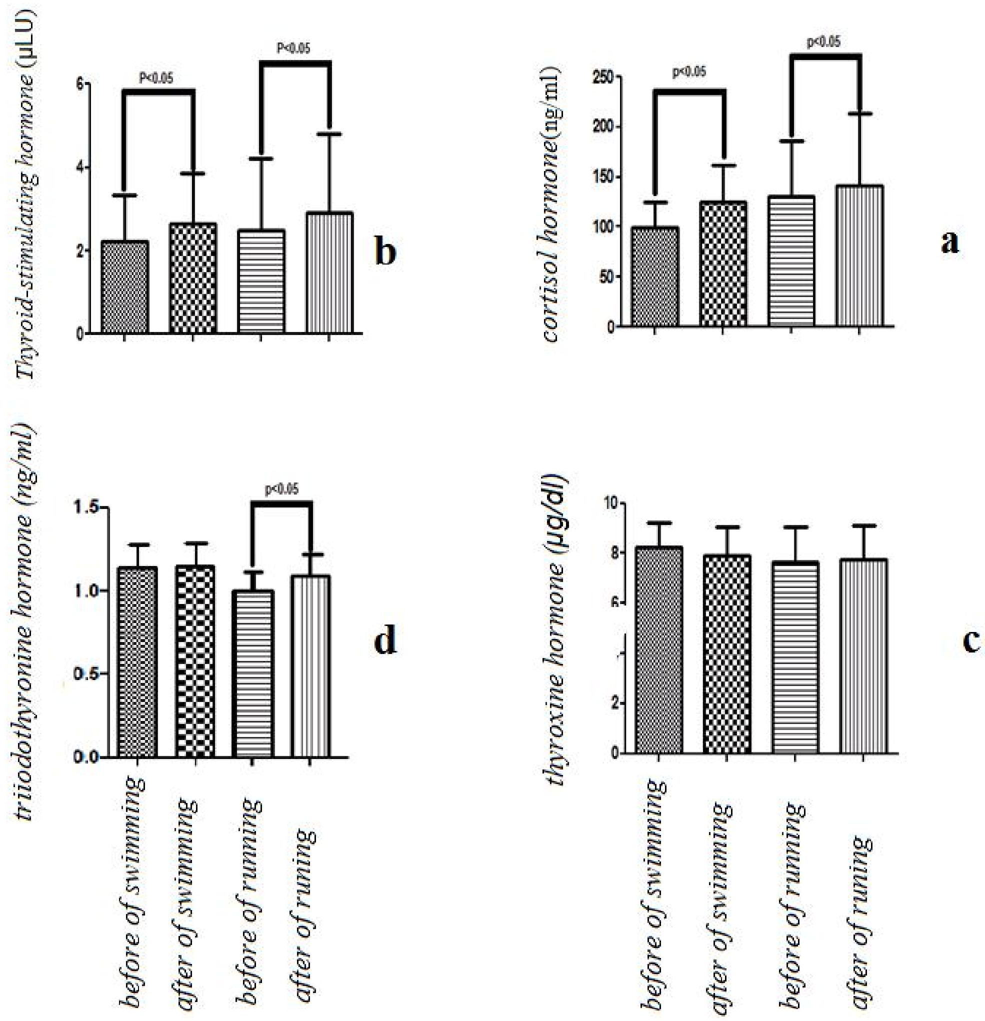

Figure1. A comparison of the changes in hormones A) cortisol (ng/ mill Liter), b) stimulating the thyroid (TSH, micro-liter/ unit), c), thyroxine (T4, micrograms per deciliter), and d) (T3, ng per mill Liter) before and after running and swimming athletes.

Result

The results showed that the concentration of T3 (P =02/0) and TSH (P = 03/0) significantly increased before and after running 800 meters, and, while there was no significant difference in the concentration of T4 (P = 12/0) and cortisol (P = 22/0). On the other hand, it was revealed that by performing competitive 200 meter swimming, the concentration of TSH (P = 02/0) and cortisol (P= 04/0) hormones significantly increased, but there was no significant difference in the concentration of T4 (P = 09/0) and T3 (P =0.16) hormones (Fig. 1, a - D). Moreover, this study demonstrated that both groups showed significant differences in T3 levels, but T4, TSH and cortisol differences were not significant.

Discussion

The present study showed that 800 meter running competition increases the levels of T3 hormone significantly. Sheng Wang Hong (2004) conducted a study on 26 male soldiers with the average age of 25 years who were under a controlled diet and a similar physical activity for a week. Bruce treadmill workout was done by the subjects and implemented blood samples were taken before the exercise, and immediately 1, 4, 24 and 48 hours after the exercise. The results illustrated that T3 significantly increased only immediately after the exercise (Huang et al., 2004). In another study of 12 male students, an aerobic test was taken. T3 levels were measured before and immediately after the exercise and also 24 hours after the test run. The results revealed that this hormone's level showed a significant decrease immediately after the test and after 24 hours. This reduction can be interpreted in terms of the conditions of the subjects during the exercise and their daily activities (Mateev et al., 1981). Figen Ciloglu et al (2005) studied the effect of different levels of intense aerobic activities on thyroid hormone in 60 male athletes. The exercise protocol included exercising on a bicycle ergo meter with a work intensity of 45% (Low), 70% (moderate) and 90% of maximum heart rate (high), respectively. At the end of the study, the researcher stated T3 hormone levels to 70% intensity does not change, but by increasing exercise intensity (90%) T3 hormone level is increased (Ciloglu et al., *2005*). In another study, researchers selected and analyzed four groups of female athletes and non-athletes in two sports, basketball and table tennis. Practice time on both strands was an hour. Blood tests were taken before and immediately after the exercise. The results showed that T3 levels were significantly increased in all subjects after the exercise (Filaire et al., 2004). In a study examining the effect of running exercise on women, it was found that T3 concentration level decreased after 48 km of running, though, T3 levels increased after 80 kilometers (Katarina., 2003). These findings suggest that when exercise intensity does not reach the threshold of secreting Tri iodothyronine, the incremental change does not happen for this hormone, while the secretion rate of Tri iodothyronine increases as the exercise intensity rises. In the present study, it apparently seems that doing sports swimming endurance (200 m), compared to running (800-meter), does not create the suitable intensity to stimulate Tri iodothyronine secretion or the subjects of this study (despite being asked to use their maximum power) did not complete the exercise with their maximum power. In addition, detailed study of these researches indicates that by increasing the fitness level of individuals, the intensity threshold for triggering the secretion of this hormone increases. The results of this study showed that both types of exercise did not significantly affect T4 hormone in the blood. In a study, the effect of different levels of activity (with the intensity of 45% maximum heart rate (Low), 70% of maximum heart rate (moderate) and 90%

of maximum heart rate (high)) on T4 and TSH were investigated and the results showed that with increasing the intensity levels of exercise, these hormones can also increase significantly (Ciloglu et al., *2005*). Based on the significant changes in T3, observed in the present study, it can be concluded that the secretion rate of thyrotropin-releasing hormone (TRH) and thyrotropin hormone (TSH) was enough. Furthermore, transferring iodine into the thyroid gland (trapping iodine) and peroxidase and iodinase enzyme activity are performed well (and it is due to the increased Tri iodothyronine production, as the entire process of the production of both hormones is the same. Considering these points, it may be possible to attribute the noticeable invariability in the Tri iodothyronine hormone to several issues, including the secretion of T4 that happens at higher intensities, or almost all T4 is converted to T3. There are also evidences that physical activity and exercise increase the change and the conversion of thyroxine to Tri iodothyronine (3 Regarding that the half-life of T4 is longer than T3 and it takes longer for it to reach its maximum activity, blood samples, in this study, were not taken in the appropriate time. Therefore, for the future studies, it is suggested to take blood samples immediately 30 minutes and 60 minutes after the exercise. This study also demonstrated that there was a significant increase in TSH hormone concentration immediately after the 800 meter running and 200 meter swimming. Schernthaner et al (2002) stated, exercising with moderate-intensity on an ergometer bicycle for 30 minutes does not produce a significant change in TSH levels (Schernthaner et al., 2002). In another study, Pourvaghar et al (2009) showed that serum TSH levels increased significantly immediately after the exercise and showed a significant reduction after 24 hours of training (Pourvaghar& Shahsavar., 2009). Considering the release of thyrotropin in both sports in the present study, it can be stated that hypothalamus is sufficiently stimulated for the secretion of TRH, and following the complex of Tirotroponin releasing hormone with its receptor in the anterior pituitary, there is an increase in secondary peaks of phosphodiesterase activity such as cyclic lipase, triacylglycerol and di calcium ions and finally results in increased TSH (Simonson ., 2001). The hypothalamic – pituitary system should also be considered here because circulation plays an important role in the effect of hypothalamus and pituitary secretion of TSH. This system also makes TRH movement for stimulation and the final production of TSH possible (Marc et al., 2000).Moreover, this study showed a significant increase in cortisol levels in both training protocols. Edmund O Acevedo et al. (2007) stated, when exercise intensity is greater or equal to 80% of maximum oxygen consumption during exercise or when it takes more than 60 min, cortisol levels usually appear in blood (Acevedo et al., 2007). K. Abraham (1384) concluded in his study that female athletes who performed a moderate-intensity aerobic exercise on a treadmill for 30 minutes demonstrated a significant increase in cortisol levels, Adorno corticotropin (ACTH) and epinephrine (18۲). Ghiasi et al (1385) conducted a study in which 25 young male runners with 5 year experience and 25 male non-athletes exercised both in the morning (between 7-8 AM) and afternoon (between 7-8 PM). The results showed that plasma cortisol level of athletes in the morning was about 2 times and in the evening was about 4 times more than non-athletes and this cortisol increase results in a significant reduction in the concentration of acyl glycerol (Ghias et al., 2006). Edmund O Acevedo et al (2007), engaged seven male runners in a training program (with the duration and severity of 10 minutes and 60%, 10 min and 70%, 5 minutes and 90%, 2 min and 100% maximal oxygen consumption) and measured cortisol levels before, during and after exercise.

According to these researchers, the level of this hormone rises as the duration and intensity of the exercise increase (Acevedo et al., 2007). In a study, twelve male swimmers performed two types of anaerobic swimming (for 20 minutes without a break and five 400 meter swimming with 45 minute rests between each step) and two onshore activities carried out on a treadmill. This program was performed alternately (on land and in water) with 48 hour elapses. To determine cortisol level, saliva samples were taken. After swimming for 15 minutes with rest, salivary cortisol level increased, but 1.5 to 2.5 hours after swimming in both types, it decreased and cortisol level was higher than the initial level 24 hours after the test (Maria et al., 2007). Katarina T et al (2003) stated ACTH and cortisol secretion is directly related to the intensity of the exercise and that is somehow related to the performance of sympathetic - adrenal system (Katarina., 2003). According to the last study (Katarina., 2003) and the present one, it might be inferred that the significant increase in cortisol hormone in both activities must be due to the stimulation of ACTH which is also associated with the activity of homeostasis center of the body (hypo thalamus). Increased cortisol level is observed with the production of GRH (ACTH stimulating hormone) from the hypothalamus, resulting in increased production of ACTH. While performing a maximum or a long-term activity, body needs more metabolisms, resulting in increased secretion of catabolic hormones. Stimulating the hypothalamus in order to increase metabolism depends on the intensity and duration of the exercise and it also depends heavily on a person's fitness level and, whether or not, this exercise is intense enough to increase metabolism (Ciloglu ewt al., *2005;* Simonson., 2001; Rowbottom& Green., 2001). Here, it should be noted that the stimulation level is different in terms of intensity and duration of the exercise for each individual. This may stimulate an individual while it may not affect the other who needs higher intensity or longer duration (Ciloglu et al., *2005;* Dimitris et al., 2004).

Conclusions

to sum up, it can be declared that the exercise intensity and duration, sports background, fitness level and the significance of that physical activity or competition are quite effective in the secretion of catabolic and stress hormones, regardless of whether the activities occur in water or land. To conduct such studies, it is proposed to take blood samples at different times and in the investigation of such studies, some hormones e.g. TRH, GRH, ACTH as well as the enzymes involved in the production of these hormones should come into account.

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