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The impact of fallow-up thyroid hormone alterations and its stimulant after moderate and intense exercise in male athletes

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ABSTRACT

This research is carried out as a follow-up study of the alterations in Thyroid Stimulating Hormone (TSH), Triiodothyronine (T3) and Thyroxine (T4) hormones. In this study, aerobic activities as well as Bruce protocol have been used. To this end, 14 male students participated in a semi-experimental study. The students attended a stadium for 3 months, 2 sessions a week to do physical activity. In the first session, 5 ml blood sample was taken from the subjects in a fasting state. The subjects did warm up, stretch and different aerobic exercises for 3 months under the supervision of the researchers. Then they took the Bruce aerobic test in the sports test hall. After the end of the 3-month period and after the Bruce test, 24 and 48 hours after that, blood samples were taken from the subjects. Paired sample test was used in order to track changes in TSH, T3, and T4 concentration from one stage to another. Statistical analysis of data showed that 3 months of sub maximal aerobic sport activities made a significant change in TSH serum concentration of the subjects' blood ($P = 0.011$). Also, exhausting sport activity of the Bruce test caused a significant change in TSH serum of the subjects' blood ($P = 0.003$). When the subjects rested for 24 hours, TSH serum still remained significant ($P = 0.005$). However, 48 hours of rest caused TSH serum of the subjects return to its primary mode ($P = 0.356$). After 3 months of training and performing exhausting activities of the Bruce test, T3 serum concentration was significant ($P = 0.013$), ($P = 0.028$). The results showed that 24 hours after the test T3 serum concentration is significant ($P = 0.013$). 48 hours of rest caused T3 serum of the subjects' blood to become non-significant ($P = 0.621$). Three months of aerobic exercise does not bring about a significant change in T4 serum concentration of the blood ($P = 0.58$). However, the exhausting Bruce test brought about extensive and significant changes in T4 serum of the blood even after 24 hours ($P = 0.0001$). In short, it can be said that aerobic and sub maximal physical exercise and also exhausting aerobic activities bring about significant changes in the concentrations of TSH, T3, and T4. These changes are more visible in exhausting aerobic activities and can even continue for two more days. Therefore, the changes occurred affect the metabolism of threefold foodstuff and also the performance of athletes.

Key words: Thyroid Stimulating Hormone, Triiodothyronine, Thyroxine, Bruce test

INTRODUCTION

Thyroid hormone production is regulated via pituitary thyrotropin (TSH) modulation of thyroxine (T4) prohormone secretion by the thyroid gland and regulation of active triiodothyronine (T3) production in peripheral tissues via metabolic events influencing activities of the iodothyronine modeiodinase enzyme systems[1-2]. TSH secretion in turn is largely regulated by hypothalamic thyroliberin (TRH) secreted into the pituitary portal vascular system to stimulate pituitary gland TSH release[1].

Thyroid hormones are important for maintaining normal physiological function of many body tissues. They affect a range of organs and systems, most importantly energy metabolism, growth-development, and other components in the

neuroendocrine system. Insufficient or excessive amounts of T4 and T3 can disrupt proper physiological functioning and lead to medical complications associated with the disorders of hypo- or hyperthyroidism[3].

Peripheral metabolism of thyroid hormones can be changed significantly by a number of physiological and pathological conditions, which can alter the deiodination pathway and lead to a change in the circulating level of thyroid hormones. The biological effects of short-term changes in the thyroid hormone levels are not currently completely understood but are potentially important in the body's adjustment to stressful or catabolic states[4].

In healthy subjects there is no significant impact of body weight, physical training, body habitus, posture, immobilization, exercise, or ambulatory status on thyroid function, and no significant geographic environmental variation. Nutrition also has a minimal impact except for variation in iodine intake. Sub threshold concentrations of iodine intake are associated with increased TSH secretion, goiter, increased thyroid iodine uptake, decreased T4 production, an increased T3/T4 secretion ratio, and an increased ratio of circulating T3/T4 concentrations[1].

Training disturbs the athletes' energy homeostasis in an attempt to invoke beneficial adaptations. At the same time, body weight and food intake controlling systems send the signal to save energy. Ignoring this process can result in overtraining and a reduced sensitivity to anabolic hormones and other endocrine signaling (5, 6, 7).

While the role of a hypo caloric diet in producing alterations in thyroid hormones has been demonstrated in several studies, the role of exercise in thyroid hormone metabolism is not very clear. A connection is established between increasing training to 80 km/week and elevated hormone levels (5, 8). In another study looking at men with six months of endurance training, while T4 and free T4 concentrations reduced a little, no change in thyrotropin was observed (8). Koistinen et al.'s study on unacclimatized top class skiers showed that training at moderate altitude for 12 days resulted in a significant decrease in serum total T3 levels and an increase in fT3 levels with no significant change in TSH, T4, fT4 and reverse T3 (rT3) (9). Another study done by Deligiannis et. al. looking at the thyroid hormone response to swimming for 30 minutes at varying water temperatures showed that TSH and fT4 levels were significantly increased at 20°C as compared to 32°C but no significant effect was seen on T3 (10). Pakerinen et. al. study on the effects of one week of very intense strength training on the thyroid hormones of male weight lifters showed a significant decrease in TSH, T3 and T4 with unchanged fT4, rT3 and thyroid binding globulin (TBG) (11, 12).

José L. et al., examined the thyroid hormone levels of professional cyclists during a 3-week stage competition, they concluded that serum T4, FT4 and FT3 levels showed a significant increase by the last week of competition while concentrations of TSH and T3 remained unchanged[13].

In female athletes, four days of low energy availability reduced T3, fT3, increased rT3, and slightly increased T4. Since an adequate amount of the prohormone T4 was available throughout the study, an alteration in the peripheral metabolism of T4 was likely. The increase in rT3 and decrease in T3 are consistent with a decreased activity of hepatic 5'-deiodinase activity, since this enzyme is responsible for the production of T3 and the clearance of rT3. These alterations in thyroid hormones could be prevented solely by increasing dietary caloric consumption without any alteration in the quantity or intensity of exercise (3, 15).

Much research have been carried out on the changes in the rate of Thyroid-stimulating hormone secretion (TSH) and also Triiodothyronine (T3) and Thyroxine (T4) hormones but none of them have been conducted for a long period of time and to follow probable changes in athletes. This research has been carried out as a follow-up study.

MATERIALS AND METHODS

In this semi-experimental study, the impact of aerobic and also the exhausting Bruce aerobic test on the amount of concentration alteration in Thyroid-stimulating (TSH), Triiodothyronine (T3) and

Thyroxine (T4) hormones were measured. The subjects of this research were 14 male student athletes. The mean and Standard Deviation (SD) of their age weight, height, body mass index (BMI) and Maximal Oxygen Consumption ($Vo_{2\ max}$) were respectively: (21.8 ± 2.25), (76.2±2.86), (175.6 ± 3.47), (22.25 ± 2.28) and (51.0 ± 4.34), table 1.

The students attended the laboratory at 8.00 o'clock in the morning in a fasting state. Five cc blood samples were drawn from each subject and this was considered as the first stage of the research or the stage before the beginning of training. The subjects participated in different aerobic physical exercises such as warm up, stretch, slow running, and different kinds of team games two sessions per week for 3 months. The subjects' heart rates were recorded by a polar clock in the test sessions. In most of the sessions, the subjects' heart rates ranged from 150 to 160 beats per minute. After 3 months of different aerobic activities, 5 cc blood samples were drawn from the subjects for the second time in order to study the effects of 3 months of physical activities on TSH, T3 and T4 variables in a resting state. The next day, the subjects took turns to stand on a treadmill and did the Bruce test to the point of exhaustion. Maximum average heart rate of some subjects who had used the treadmill reached 195 beats. The average time recorded was 17/32 minutes. After the Bruce test, subjects' $Vo_{2\ max}$ was measured 60.25 ml. kg^{-1} min^{-1} (16).

The third stage of blood samples was drawn immediately after the Bruce test to study the effects of the exhausting Bruce test on the variables of the research. The fourth and fifth stages of drawing blood were after 24 and 48 hours of rest respectively, to follow up probable changes of research variables.

RESULTS

Mean and standard deviation of the subjects' five stages of blood test and also a comparison of all stages by paired sample test can be observed in tables 2, 3 and 4.

In table 2, all stages of blood test are compared with each other. Average concentration of serum TSH of subjects' blood in resting state was measured 1.925 mic Iu/ml and after three months of aerobic exercise 3.145 mic Iu/ml. (P = 0.011), (df = 13).

In addition, after the completion of the exhausting aerobic Bruce test it was measured 3.635 mic Iu/ml. which shows serum TSH concentration is significant. (P = 0.006), (df = 13). Also, the subjects' 24 and 48 hours of rest after the exhausting aerobic Bruce test could not return serum TSH concentration of subjects to the initial mode and showed that this concentration remains significant (P = 0.006), (P = 0.012).

In Table 3, serum T3 average concentration of the subjects' blood in the first stage was measured 131.214 ng/dl and after three months of aerobic exercise increased to 148.114. ng/dl. This indicates that three months of aerobic exercise has increased the concentration of serum T3 hormones significantly (P = 0.013), (df = 13). Comparison of the subjects' resting state (131.214 ng/dl) with the third stage (i. e. after the Bruce test) (146.264 ng/dl) also showed an increase in the concentration of T3 hormone (P = 0.028), (df = 13). Comparison of T3 hormone in the second stage with the fourth and fifth stages showed a significant decrease in the concentration of this hormone (P = 0.002, P = 0.013). Also, comparison of T3 hormone in the third stage with the fourth and fifth stages indicated a significant decrease in the concentration of this hormone (P= 0.13).

In table four, comparisons between T4 averages can be observed. Concentration of serum T4 hormone in the first stage is 9.735 mic g/dl and after three months of aerobic exercise decreases to 8.960 mic g/dl, (P = 0.58). However, this decrease is not significant. Comparison of the stage before and after the aerobic Bruce test (respectively 8.960

Table 1: Physical characteristic of the subjects

Variable	Mean	Standard Deviation
Age (Yr)	21.8	2.25
Height (Cm)	175.6	3.47
Body mass (Kg)	76.2	2.86
Body mass Index (BMI)	22.25	2.28
$Vo_{2\ max}$ (ml. kg^{-1} min^{-1})	51.0	4.34

Table 2: Significance of our Results for Thyroid Stimulating (TSH) Hormone

Variables (M±SD)	Variables (M±SD)	Standard Deviation (Pair)	T Values	P Values
TSH Stage 1 (1.925±0.890)	TSH Stage 2 (3.145±1.406)	1.544	2.955	0.011
TSH Stage 1 (1.925±0.890)	TSH Stage 3 (3.635±1.780)	1.767	3.619	0.003
TSH Stage 1 (1.925±0.890)	TSH Stage 4 (2.127±0.808)	1.327	0.572	0.577
TSH Stage 1 (1.925±0.890)	TSH Stage 5 (1.717±1.163)	1.361	0.571	0.578
TSH Stage 2 (3.145±1.406)	TSH Stage 3 (3.635±1.780)	0.561	3.264	0.006
TSH Stage 2 (3.145±1.406)	TSH Stage 4 (2.127±0.808)	1.295	2.938	0.012
TSH Stage 2 (3.145±1.406)	TSH Stage 5 (1.717±1.163)	1.814	2.944	0.011
TSH Stage 3 (3.635±1.780)	TSH Stage 4 (2.127±0.808)	1.649	3.420	0.005
TSH Stage 3 (3.635±1.780)	TSH Stage 5 (1.717±1.163)	2.096	3.422	0.005
TSH Stage 4 (2.127±0.808)	TSH Stage 5 (1.717±1.163)	1.637	0.938	0.365

Table 3: Significance of our Results for Triiodothyronine (T3) Hormone

Variables (M±SD)	Variables (M±SD)	Standard Deviation (Pair)	T Values	P Values
T3 Stage 1 (131.214±12.589)	T3 Stage 2 (148.114±19.237)	21.881	2.890	0.013
T3 Stage 1 131.214±12.589)	T3 Stage 3 (146.264±18.853)	22.689	2.482	0.028
T3 Stage 1 (131.214±12.589)	T3 Stage 4 (134.550±13.565)	15.311	0.815	0.430
T3 Stage 1 (131.214±12.589)	T3 Stage 5 (132.642±11.875)	6.710	0.797	0.440
T3 Stage 2 (148.114±19.237)	T3 Stage 3(146.264±18.853)	3.906	1.772	0.100
T3 Stage 2 (148.114±19.237)	T3 Stage 4(134.550±13.565)	13.134	3.864	0.002
T3 Stage 2 (148.114±19.237)	T3 Stage 5 (132.642±11.875)	20.103	2.880	0.013
T3 Stage 3 (146.264±18.853)	T3 Stage 4 (134.550±13.565)	15.243	2.875	0.113
T3 Stage 3 (146.264±18.853)	T3 Stage 5 (132.642±11.875)	21.005	2.426	0.013
T3 Stage 4 (134.550±13.565)	T3 Stage 5 (132.642±11.875)	1 4.078	0.507	0.621

Table 4: Significance of our Results for Thyroxine (T4) Hormone

Variables (M±SD)	Variables (M±SD)	Standard Deviation (Pair)	T Values	P Values
T4 Stage 1 (9.735±1.043)	T4 Stage 2 (8.960±1.171)	0.372	2.081	0.058
T4 Stage 1 (9.735±1.043)	T4 Stage 3 (10.055±1.574)	0.472	0.676	0.511
T4 Stage 1 (9.735±1.043)	T4 Stage 4 (8.740±0.902)	0.308	3.221	0.007
T4 Stage 1 (9.735±1.043)	T4 Stage 5 (11.408±0.979)	0.301	5.548	0.0001
T4 Stage 2 (8.960±1.171)	T4 Stage 3 (10.055±1.574)	0.135	8.106	0.0001
T4 Stage 2 (8.960±1.171)	T4 Stage 4 (8.740±0.902)	0.251	0.874	0.398
T4 Stage 2 (8.960±1.171)	T4 Stage 5 (11.408±0.979)	0.386	6.339	0.0001
T4 Stage 3 (10.055±1.574)	T4 Stage 4 (8.740±0.902)	0.303	4.334	0.001
T4 Stage 3 (10.055±1.574)	T4 Stage 5 (11.408±0.979)	0.461	2.931	0.012
T4 Stage 4 (8.740±0.902)	T4 Stage 5 (11.408±0.979)	0.306	8.695	0.0001

and 10.055 mic g/dl) is indicative of an increase in the concentration of T4. This increase is significant (P = 0.0001), (df = 13).

Comparison of T4 serum concentration between the third and fourth stages showed a significant decrease in the concentration of the hormone after 24 hours of rest (P = 0.001). Comparison of T4 hormone concentration means between the fourth and fifth stages also shows a significant increase (P = 0.0001), (df = 13).

DISCUSSION

This research has been carried out to study the alterations in Thyroid Stimulating Hormone (TSH), Triiodothyronine (T3) and Thyroxine (T4) Hormones in response to two different types of aerobic activities, since very slight alterations in these hormones cause considerable changes in body metabolism and finally in the whole body. In the current study, blood samples were drawn from 14 subjects in five different stages. Comparison of the results of the first stage from TSH and T3 hormones showed a significant increase in the concentration of these two hormones. Thus, three months of aerobic physical activities can increase the concentration rate of hormone TSH to 63.54 % and T3 hormone rate to 12.87 %.

About serum T4 hormone it can be said that three months of aerobic exercise did not change the concentration of this hormone significantly (P = 0.058). This may be due to the fact that the intensity of physical activities for the subjects of this research has been low. From this respect, the present research is consistent with the one carried out by Miller et. al. (1998), since the researchers also observed very slight changes in T4 hormone concentration of subjects after 6 months of physical exercise. However, Ciloglu et. al. (2005) observed a significant change in the concentration of TSH, T3, and T4 hormones in their study that was carried out for a week of intense physical activity. This may have been due to the intensity of the physical activities.

T3 Hormone concentration is shown in Table 3. Moderate aerobic activities that lasted for around three months, and intense aerobic activities, with an average time of 17.32 minutes, caused a significant change in serum concentrations of the subjects. This study is consistent with the Ciloglu et. al. (2005) research's, although the physical activities in the latter research took only one week. About T3 hormone, it seems that intense and exhausting activity can reduce T3 Hormone concentration from148.114 ng/dl to 146.264 ng/dl, which means to 1.24 %.

About T3 Hormone, 24 hours of rest can probably keep the concentration of the hormone at the same level, but 48 hours of rest will return the concentration level to its initial state.

About T4 Hormone, it can be said that three months of moderate aerobic exercise does not have a significant effect on the mentioned hormone. It can be said that the low intensity of the exercises can not decrease or increase T4 hormone concentration significantly. This study is consistent with the one by Miller et. al. (1998).

One can conclude that both moderate aerobic physical activity and intense and exhausting physical activity can produce different responses in the concentration of TSH, T3 and T4 hormones. However, it seems that the change in the concentration of TSH and T3 hormones after three months of moderate aerobic activity is higher than the average, whereas three months of moderate aerobic exercise could not change the subjects' T4 hormone significantly. Instead, performing exhausting Bruce aerobic test could only make a significant change in TSH and T4 hormones but statistically, it did not change T3 hormone significantly. Since TSH hormone has a mutual effect (interaction efficacy) on the T3 and T4 hormones, their responses can not be studied separately. The interaction of the three hormones has a direct effect on food metabolism, fats, proteins, and carbohydrates in both non athletes and athletes. Therefore, very slight changes at mic Iu/ml level can have significant effects on the body. The wide range of changes in these hormones can affect the athletes' performance and also can influence or destroy their ability and speed. However, more research is needed about these hormones to clarify the existing ambiguities about different exercise intensities and durations and responses to concentration of TSH, T3 and T4 hormones.

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