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Effects of Endurance Workouts on Thyroid Hormone Metabolism and Biochemical Markers In Athletes

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Abstract: *Objective: Exercises can create differences in the organism by affecting the hormonal system and hemostasis. Evaluation of hormonal changes along with physical activity, many factors such as physical and physiological state of athletes, environmental factors and nutritional status are effective and affect the performance. In this study, as a result of endurance workouts, chronic changes in athletes' thyroid hormone metabolism and biochemical markers were evaluated. Method: 16 male athletes formed the research group. The athletes participating in the study received endurance training for 60 minutes a day, three days a week for 12 weeks. Blood samples were taken from the athletes before the session and after the session. The levels of Thyroid hormones, iron, iron binding capacity, UIBC, erythrocyte, leukocyte and platelet were determined in blood samples. Data were considered by using SPSS statistical package software. Findings: A significant difference was observed in athletes' thyroid hormone values as a result of the training sessions: Thyroid Stimulating Hormone (TSH), Thyroxine (T4) and Triiodothyronine (T3) levels were detected to be statistically different in pre-post test (p <0,05). As a result of the applied workouts changes were observed in the erythrocyte, leukocyte and platelet values of the athletes, and a significant difference was seen in general (p <0,05). Results: Applied regular and long-term endurance training created differences in athletes' thyroid hormone metabolism and biochemical markers. It is thought that these findings will positively affect the fight against the stress experienced by athletes during their competitions and increase their performance.*

Keywords: *Exercise; Thyroid hormones; Biochemistry; Sportsman.*

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1. Introduction

Regular exercise is known to positively affect general health, cardiovascular functions and metabolic systems. Overall studies show that regular and aerobic training positively affects the organism. However, anaerobic and intense exercises that cause physiological changes in the organism can cause oxidative stress (Friedenreich et al., 2015; Zhang et al., 2016). Oxidative stress caused by exercise causes many cardiovascular and metabolic problems (Cheserek et al., 2016). Oxidative stress resulting from exercises affects the hormonal system in addition to metabolic functions in the organism. Hormones are important markers for monitoring the changes in the organism. Thyroid hormones (TH), by controlling the expression of TR target genes, play a significant role in basal metabolism and hemostasis as well as being effective in metabolic processes necessary for growth and development through thyroid hormone receptors (TRs) (Mullur et al., 2014). It is known that thyroid hormones have an active role in many metabolic events besides lipid and glucose metabolism. With the effect of thyroid hormones on lipid metabolism, it can lower cholesterol levels in the organism and helps in the regulation of endocrine disorders, preventing cardiovascular disorders by providing improvement in lipid profile (Chi et al., 2013; Dillmann, 2010; Mask and Barnwal, 2016; Mwafy et al., 2018; Pascual and Aranda, 2013; Song et al., 2011; Teixeira et al., 2017; Yehuda-Shnaidman et al., 2013). It is known that thyroid hormone metabolism is affected with the exercises, and when the structural and functional properties of the thyroid are taken into consideration, it has been revealed that it is associated with rare elements (Calcium, Magnesium, Sodium, Chromium, Cobalt, Iodine, Iron, Selenium, Manganese, Zinc). Not only especially the effect of zinc, one of the rare elements, on the thyroid metabolism is known but also iron element creates differences in thyroid metabolism, too (Soria et al., 2016).

Iron is essential for the continuity of all living organisms. This micronutrient element plays an active role in the structure and functions of enzymes, which are vital in the energy metabolism of cells, in the proliferation of cells, in transporting oxygen to tissues and in protein synthesis. However, insufficient or high iron levels are harmful for metabolism and cause many diseases. Metabolic or cardio metabolic changes occur in the organism due to iron deficiency or excessive accumulation. In addition, iron deficiency creates differences in thyroid hormone metabolism and hematological parameters (Chifman et al., 2014; Corrales-Agudelo et al., 2016; Gallego-Narbón et al., 2019; Pantopoulos et al., 2012; Refaat et al., 2018; Vincent et al., 2019). Iron is one of the important determinants of athletic performance efficiency and endurance parameters in athletes due to its effect on oxidative metabolism (Denis & Conway, 2019; Hinton, 2014; Nandadeva et al., 2019).

Thyroid hormones and biochemical markers, which are so important for athletic performance and organism in athletes, continue to attract researchers. In this research, chronic changes in athletes caused by endurance training thyroid hormone metabolism and biochemical markers were evaluated.

2. Materials and Methods

2.1 Research Group

The research group was consisted of 16 volunteer male athletes who are licensed athletes in the field of athletics and have no metabolic disorders. The research was conducted to detect the effect of long-term athletics exercise on athlete's thyroid hormone metabolism, erythrocyte, lococyte, platelet, iron and iron binding capacity.

2.2. Training program

Considering the athletics competition schedule, the training program for endurance and athletics branches for the athletes was implemented for sixty minutes a day and three times a week during 12 weeks. Together with workout sessions, athletes participated in athletics competitions. Within the scope of the training, the athletes were given a fifteen or twenty minutes warm-up period, sixty minutes of endurance and athleticism before starting the main phase of the training, and five minutes cooling exercises (stretching) at the end of the training. Workouts were adjusted to Max 55-60% according to the fitness level of the study group, and were increased to Max 65-75% in the coming weeks. The intensity of the exercise was arranged according to the Karvonen method.

2.3 Determination of Biochemical Parameters

7 cc blood samples were taken from the athletes who form the research group while resting for twice, before and after the training. The athletes were constantly observed during the training and were asked not to take any supplements and medications that would adversely affect the metabolism.Within the blood samples iron, iron binding capacity, UIBC, thyroid hormone (T3, T4 and TSH), lococyte (WBC), erythrocyte (RBC, MCV, HGB, HCT) and platelet (PLT, PCT, RDW-SD, MPV, PDW, RDW-

CV) levels were determined. Blood samples were taken with sterile syringes by applying tourniquet from arm vein to arm by specialists. Blood samples were taken by using pre-prepared anticoagulation tubes and blood samples were analyzed in a private hospital laboratory.

2.4 Statistical Analysis

The data were analyzed using SPSS 22 package program. The normality test (Shapiro Wilt-W) was used to determine whether the data showed normal distribution. After determining that the data showed normal distribution, to compare the pre-test and post-test data of the research group Paired Samples t test was used. P <0,05 values were considered meaningful.

3. Results

Table 1. Athletes' Thyroid Hormones Analysis Results According to

Parameters	Pre-test Avrg±SD	Post-test Avrg±SD	t	P
TSH	2,39±0,41	2,47±0,45	-2,462	**0,029***
T3	3,82±0,16	3,76±0,14	4,856	**0,000***
T4	1,29±0,11	1,23±0,09	3,030	**0,010***

In Table 1, athletes' total thyroid hormone pre-post test values are given. In consequence of the training, it was determined that there was a statistically notably difference in the pre-post test values of TSH, T3 and T4 levels (p <0,05).

Table 2. Athletes' Analysis Results of Hematological Parameters According to Paired Samples t Test

Parameters	Before training	After training	t	p
Electrolyte				
Iron	118,71 ±4,73	120,14 ±4,48	-4,616	**0,000***
Iron Binding Capacity	368,14 ±10,97	368,57±9,72	-0,574	0,576
UIBC	241,29 ±18,34	243,93 ±21,22	-2,365	**0,034***
Lococyte				
WBC	7,47 ±1,42	8,62 ±1,25	-2,172	**0,049***
Erythrocyte				
RBC	4,83±0,25	5,13 ±0,20	-3,488	**0,004***
HGB	14,05 ±0,98	14,24 ±0,76	-0,624	0,544

HCT	41,47 ±2,22	41,79 ±2,13	-0,379	0,711
MCV	80,74 ±3,81	86,40 ±1,82	-4,898	**0,000***
MCH	27,72 ±1,43	29,05 ±1,32	-3,738	**0,002***
MCHC	33,63 ±1,19	34,35 ±0,29	-2,431	**0,030***
Platelet				
PLT	275,36 ±62,38	287,43 ±33,01	-0,618	0,547
MPV	7,80 ±0,37	8,11 ±0,35	-2,762	**0,016***
PDW	17,12±0,59	17,99 ±0,48	-4,212	**0,001***
PCT	0,21 ±0,04	0,23±0,03	-1,271	0,226
RDW-SD	39,29±1,05	40,57±2,47	-1,583	0,137
RDW-CV	11,74±0,66	12,18±0,55	-2,404	**0,032***

Table 2 presents the pre-post test values of athletes' iron, iron binding capacity, UIBC, erythrocyte, lococyte and platelet values. In consequence of training, a statistically important difference was seen in iron and UIBC levels ($p < 0{,}05$) but there was no major difference in iron binding capacity ($p > 0{,}05$). A crucial difference was seen in the lococyte (WBC) level of the athletes ($p < 0{,}05$). When erythrocyte values were compared, it was concluded that there was a significant difference in RBC, MCV, MCH and MCHC levels ($p < 0{,}05$), and no important difference in HGB and HCT levels ($p > 0{,}05$). When the platelet values of the athletes were compared, no significant differentiation was determined in PLT, PCT and RDW-SD levels ($p > 0{,}05$), whereas MPV, PDW and RDW-CV levels were statistically significant ($p < 0{,}05$).

4. Discussion and conclusions

For the human organism, to work regularly and adapt to the current situation, some warnings are activated. As a result of exercises in the organism, changes occur in hormones and biochemical markers, which are elements of the hemostatic mechanism aimed at controlling physiological stresses caused by exercise. In our study, secreted hormones and biochemical markers associated with the adaptation of the organism as a result of chronic exercises were examined in order to reveal the changes and interactions that occur in the organism following physiological changes arising from exercise.

Thyroid Hormone Metabolism

Exercises are indicators of oxidative stress for the organism, while hemostasis is restored during recovery, serious problems occur especially in hormones secreted during exercise, cells, organs and hemostasis. Regulatory mechanisms appear specifically to provide hemostasis (Philippou et al., 2017). Especially in acute and chronic exercises, thyroid hormone (TSH, T3, T4) release increases. Thyroid hormones, along with exercise, improve the endurance of the organism by affecting protein carbohydrates, fat, metabolism, and adaptation of the organism to physiological and metabolic changes that will occur as a result of exercises (Elliott-Sale et al., 2018; Louzada & Carvalho, 2018). As a consequence of the workout sessions, an important increase was observed in the level of TSH and it was also observed that there was a statistically major difference in T3 and T4 levels. In their study, Akbulut and his friends (2019) determined that an eight-week exercise program and vitamin E supplementation caused changes in thyroid hormone metabolism. Zarei and friends (2018) observed that chronic exercises increase TSH level and decrease T3 and T4 levels. In their study, Chicharro and friends (2001) reported that the three-week race period process increased the T4 level and did not change the TSH and T3 levels. In their study, Johannsen and friends (2012) stated that acute troxin and exercise practises had significant changes in thyroid hormones. Sultan and Rashed (2009) stated in their study that one-month exercise and diet create differences in thyroid hormones. Teixeira and friends (2017) found in their study that there was no major change in thyroid hormones of the ten-week exercise program. Masaki and friends (2019) found that acute exercise had changes in TSH and T3 levels, and there was no change in T4 level. In their study, Cinar and friends (2017) determined that a six-week exercise program and zinc supplement affected the participants' thyroid hormone metabolism positively. In their study, Mwafy and friends (2018) observed that the six-month exercise program had a significant increase in TSH level and a decrease in T3 and T4 levels. The results of the study were found to be generally similar to the literature. Changes in thyroid hormone metabolism may have been resulted from physiological responses to minimize oxidative stress in the organism as a result of the exercises applied and to adapt the organism to the current state. Iron and hematological parameters are biochemical markers and are indicators of athletic performance. Changes appear together with acute or chronic exercises. Problems in oxygen use and transportation as a result of iron deficiency may adversely affect sports anemia and athletic performance. Potential mechanisms involved in exercise-induced iron deficiency are intravascular and extravascular hemolysis, hematuria, and sweat and gastrointestinal iron loss and inflammation. Hemolysis is caused by many factors such as oxidative stress and erythrocyte deformability. The adaptation of the organism is ensured against these problems that will occur as a result of the exercises (Burden and friends, 2014; Peeling and friends, 2014). As a result of the training, an increase in iron, iron binding capacity and UIBC levels of athletes was observed. In the study, when the hematological parameters of the athletes were examined, there were generally increases. Govus and friends (2015) determined that 2-4 week altitude training increases iron and hematological parameters. In their study, Badenhorst and friends (2015) found that acute exercise increases iron levels in athletes. Mielgo-Ayuso and friends (2015) observed that eleven-week training performed with iron supplementation led to increases in iron and hematological parameters. Sim and friends (2014) stated that one week of exercise does not affect iron levels in athletes. Corsetti and friends (2012) stated that there was no difference in iron and hematological parameters as a result of the trainings covering the three-week race period. Tayebi and friends (2017) found in the study in which different exercise models were applied that there were increases in iron levels with aerobic exercises, and there were decreases in iron levels in anaerobic and wrestling training exercises. Skarpańska-Stejnborn and friends (2015) observed that athletes' iron levels decrased as a result of acute intense exercise, and found significant increases in hematological parameters after exercise. In general, acute and chronic training creates differences in iron metabolism and hematological parameters. We think that these results will help to prevent the negativities in biochemical markers of acute or chronic exercises that will occur in the organism and to adapt the athletes to the current situation.

As a result; endurance training has been found to create positive differences in thyroid hormone metabolism and biochemical markers. In the research results, it was determined that there were increases in iron metabolism, erythrocyte, lococyte, platelet and TSH levels, and decreases in T3 and T4 levels. These results are generally thought that positive changes caused by chronic and aerobic exercises in the organism will improve athletic performance and endurance as well as preventing metabolic problems.

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