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### Investigation of the Effect of High-Intensity Training on Mineral and Thyroid Hormone Metabolism of Athletes

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## Investigation of the Effect of High-Intensity Training on Mineral and Thyroid Hormone Metabolism of Athletes

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### ABSTRACT

It is observed that there are physiological changes in the organism as a result of long-term training, but the mineral and hormonal effects of regular and submaximal exercises have not been fully revealed. This study was conducted to determine the effect of eight-week high-intensity training on mineral and thyroid hormone metabolism of badminton athletes. The research group consisted of 24 volunteer male athletes licensed in the badminton branch. Considering the badminton competition period, an eight-week, ninety-minute training program was applied to the research group, three days a week. Within the scope of the training, 10-15 minutes of warm-up time, 50-60 minutes of badminton training and studies to improve basic motoric features, and 5-10 minutes of cool-down exercises were made at the end of the training. Blood samples were taken from the athletes in the research group twice, before the start of the training program and at the end of the training. In the blood samples taken as a result of the training, the athletes; thyroid hormones (TSH, T3, T4), sodium, potassium, calcium, magnesium, levels were determined. The obtained data were analyzed using the SPSS 22 package program and the significance was accepted as  $p>0.05$ . As a result of the research, it was determined that there was a statistically significant difference between the thyroid hormone metabolism, TSH and T3 pre-post test values of the athletes ( $p<0.05$ ), while there was no statistically significant difference between the T4 values and the pre-post test values ( $p>0.05$ ). When the mineral levels of the athletes were evaluated as a result of the training, it was determined that there was a statistically significant difference in the Sodium, Potassium and Magnesium pre-post-test levels ( $p<0.05$ ), while there was no statistically significant difference in the calcium pre-post-test level ( $p>0.05$ ). As a result, it was observed that eight-week high-intensity training caused changes on the mineral and thyroid hormone metabolism of the athletes. In this context if the trainings to be applied are designed considering these physiological changes, it will positively affect the performance of the athlete.

**Keywords:** Badminton, Mineral Metabolism, Thyroid Hormones, Training



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## INTRODUCTION

Experts in the field of sports sciences (researchers, conditioners, trainers) are constantly in search of new training methods in order to increase or improve the performance of athletes. This quest is generally for the athletes to adapt to the training physically, physiologically and psychologically. In line with this information, High-Intensity Interval Training (HIIT) comes to the fore in bringing the performance indicators of the athletes to the next level (Akgül et al., 2017).

High-intensity interval training is the repetition of exercises with specified methods at regular intervals. One of the most important features of this training method is that the parameters of loading and resting or high and low intensity loading change systematically. Thanks to this training method, it not only meets the need for fast and effective adaptation, but also shortens the time spent on training (Karayigit et al., 2020; Revan et al., 2008). Modern fitness programming has adopted the term "high-intensity interval training" or HIIT as a way to describe this approach to fitness and performance, and two general classifications have emerged. One classification is called "aerobic HIIT" and the other is called "bodyweight HIIT" or "resistance HIIT". Both involve periods of intense exertion followed by rest periods, the primary difference being the method of exercise. Aerobic HIIT training mostly uses running and cycling to provide desired intensities through activities such as spin classes and track-based running workouts. In contrast, resistance/body weight training programs such as HIIT, Tabata, CrossFit, basic boot camp training, or other similar classes benefit from gymnastics, plyometrics, and/or weightlifting (Bartlett et al., 2011). The reason why the high-intensity interval training method is preferred especially in recent times is that it is effective on body composition, energy mechanism, skeletal-muscular system and hormone metabolism in a short time.

Hormones are a vital indicator for tracking the changes in the body generated by exercise. Thyroid hormones (TH) regulate basal metabolism and hemostasis, as well as metabolic activities required for growth and development via thyroid hormone receptors (TRs) via influencing the expression of TR target genes (Mullur et al., 2014). Thyroid hormones are recognized to have an active part in numerous metabolic activities, including lipid and glucose metabolism (Erdogan, 2020). Thyroid hormone metabolism affects various systems that can alter its function, physical activity, and physical capacity (Hall and Guyton, 2015). Thyroid hormone Na/K-ATPase in skeletal muscle promotes transmembrane resting potentials and contraction and reduction in the number and load of mitochondria of myosin heavy chain, a protein feature of fast-twitch fibers (Flavia et al., 2018). It affects the physical capacity very well through the body muscles. Physical movement activity is associated with skeletal muscle and the resulting energy expenditure. Thyroid hormones have a well-known effect on energy production. This may explain a possible nest between thyroid function and physical activity. On the other hand, thyroid function can also negatively affect physical activity through diseases that can hinder a person's overall physical performance. For example, thyroid function variations, even within the reference range, have been associated with cardiovascular disease (CVD), stroke, and frailty in middle-aged and elderly populations (Chaker et al., 2016). Conversely, physical activity can also affect thyroid function. For example, physically active individuals often have a beneficial cardiometabolic profile, including an appropriate fat distribution. Higher body mass index (BMI) and obesity are known factors that affect thyroid function through leptin production, which affects the hypothalamic-pituitary-thyroid axis (Zimmermann et al., 2003). In line with this information, it is important to what extent high-intensity training affects homonym and mineral metabolism. This study was conducted to determine the effect of eight-week high-intensity training on mineral and thyroid hormone metabolism of badminton athletes.

**METHOD**

**Research Design**

The investigation presented in this article utilized a pretest-posttest strategy, which is one of the quantitative research techniques, to investigate whether eight weeks of high-intensity training is helpful on mineral and thyroid hormone metabolism in badminton athletes.

**Research Group**

24 male athletes who are licensed in the badminton branch and regularly participate in badminton training participated in the research group voluntarily.

**Training Program**

Considering the badminton competition period, an eight-week, ninety-minute training program was applied to the research group, three days a week. Within the scope of the training, 10-15 minutes of warm-up time, 50-60 minutes of badminton training and studies to develop basic motoric features, and 5-10 minutes of cool-down exercises were made at the end of the training. The trainings were adjusted to the Max 70-80% intensity according to the condition level of the research group and were applied during the training program.

| <b>Training Sections/<br/>Days</b> | <b>Monday</b>  | <b>Wednesday</b>   | <b>Saturday</b>                              |
|------------------------------------|--|--|--|
| <b>Warm up</b>                     | 30-40% jog at the pace<br>running stretching                   | 30-40% jog at the pace<br>running stretching                   | 30-40% jog at the pace<br>running stretching |
| <b>Main Section</b>                | Basic technical studies/tactical exercises for the competition | Basic technical studies/tactical exercises for the competition | Competition                                  |
| <b>Cooling Down</b>                | 15-20 minutes of cooling exercises                             | 15-20 minutes of cooling exercises                             | 15-20 minutes of cooling exercises           |

**Collection and Analysis of Samples**

Blood samples were taken from the athletes in the research group twice, before the start of the training program and at the end of the training. The athletes participating in the study were observed during the training, and the athletes who had metabolic disorders or were taking drugs were excluded from the study. In the blood samples taken as a result of the training, the athletes; thyroid hormones (TSH, T3, T4), sodium, potassium, calcium, magnesium levels were determined. The blood samples taken from the athletes were taken by experts in the private hospital laboratory by means of a fully automatic hemogram named “Coulter Stks”, while the athletes were sitting and resting, and analyzed.

**Statistical Analysis**

The data were analyzed using the SPSS 22.0 package program. To determine if the data conformed to the normal distribution assumption, the Kolmogorov-Smirnov and Shapiro Wilk normality tests were performed. Parametric tests were used for the data determined to be normally distributed. Paired Samples t-test was used to compare the pre-post test data of the research group. Significance level was taken as  $p < 0.05$ .

## FINDINGS

The data collected on the questions to be addressed in accordance with the overall goal of the research, the findings gained, and the conclusions drawn based on these findings are reported in this section.

**Table 1.** Thyroid Hormone Changes of Athletes Before and After Training

| Parameters | Pre-test  | Post-test | t      | p     |
|------------|-----------|-----------|--------|-------|
| <b>TSH</b> | 1,88±0,14 | 1,91±0,08 | -7,112 | 0,00* |
| <b>T3</b>  | 3,50±0,13 | 3,52±0,16 | -6,970 | 0,00* |
| <b>T4</b>  | 1,23±0,09 | 1,23±0,16 | -,517  | 0,61  |

\*p < 0.05

When Table 1 was examined, it was observed that there was a statistically significant difference between the thyroid hormone metabolism of the research group, TSH and T3 pretest-posttest values ( $p < 0.05$ ), while there was no statistically significant difference between T4 values pretest-posttest values ( $p > 0.05$ ).

**Table 2.** Mineral Changes of Athletes Before and After Training

| Parameters       | Pre-test    | Post-test   | t      | p     |
|------------------|-------------|-------------|--------|-------|
| <b>Sodium</b>    | 143,17±2,98 | 145,29±2,91 | -3,989 | 0,00* |
| <b>Potassium</b> | 4,70±0,34   | 4,82±0,35   | -3,457 | 0,00* |
| <b>Calcium</b>   | 9,57±0,34   | 9,68±0,29   | -1,661 | 0,11  |
| <b>Magnesium</b> | 2,05±0,18   | 2,23±0,24   | -3,578 | 0,00* |

\*p < 0.05

In Table 2, when the mineral levels of the athletes as a result of the training were evaluated, it was determined that there was a statistically significant difference in the Sodium, Potassium and Magnesium pretest-posttest levels ( $p < 0.05$ ), there was no statistically significant difference in the calcium pretest-posttest level.

## DISCUSSION & CONCLUSION

In this study, pre- and post-training thyroid hormone changes and pre- and post-training mineral changes of the athletes were evaluated in the light of scientific data. Accordingly, when Table 1 was examined in our study, it was determined that there was a statistically significant difference between the thyroid hormone metabolism of the research group, TSH and T3 pretest-posttest values ( $p < 0.05$ ). There was no statistically significant difference between T4 values and pretest-posttest values ( $p > 0.05$ ). In Table 2, when the mineral levels of the athletes as a result of the training were evaluated, it was determined that the sodium, potassium and magnesium pretest-posttest levels were statistically significant ( $p < 0.05$ ). There was no statistically significant difference in the calcium pretest-posttest level ( $p > 0.05$ ).

Hormones are molecules produced by endocrine glands, including the hypothalamus, pituitary gland, adrenal glands, gonads (i.e. testes and ovaries), thyroid gland, parathyroid glands, and pancreas. The term endocrine means the release of the products of these glands into the bloodstream in response to certain stimuli. The hormones are then transported through the

blood to target cells. Some hormones have only a few specific target cells, whereas other hormones affect a large number of cell types in the body. It is known that target cells for each hormone have specific binding molecules (ie receptors) located on the cell surface or inside the cell. The interaction between the hormone and its receptor triggers a series of biochemical reactions in the target cell that eventually change the function or activity of the cell (Susanne et al., 2022). Thyroid hormones are responsible for metabolic processes in all cells. TSH is a hormone in glycoprotein structure and ensures the metabolism and development of the thyroid gland. TSH hormone secreted by the pituitary also has a stimulating effect on the thyroid hormone. In addition, thyroid hormone stimulates the structure of many genes (Berne et al., 2008). There is a study by Hess (2010) that providing athletes with iodine, iron and selenium along with exercise provides more improvement in athletes' thyroid function. Athletes with low energy intake or iron deficiency are reported to benefit from medical nutrition therapy by a board-certified expert in sports dietetics. Çelikel (2023), in his study, determined that the training program he applied affects some physiological and physical parameters of the athletes. Çelenk (2011) states that the duration, intensity and frequency of exercise affect the plasma hormone level, and that androgen secretion begins with exercise, and thus estrogen from ovarian hormones responds to exercise as in testosterone. Therefore, it can be mentioned that exercise has an effect on thyroid hormones, so it also has an effect on TSH. Atabaş and Yapıcı (2022) determined in their study that high-intensity interval training, both with and without a mask, positively affects the physiological and respiratory parameters of football players. In the study conducted by Akbulut et al., (2019), it was determined that vitamin E supplementation applied in addition to eight-week high-intensity interval training caused changes in the thyroid hormone metabolism of athletes. Considering the studies on male athletes, it has been reported that there is an increase in TSH levels predominantly (Büyükippekçi et al., 2018; Erdoğan, 2020; Pala et al., 2020), while Limanova et al.'s studies on young athletes and Fortunato et al. It is reported that they did not find any significant difference in TSH levels immediately after. Erdoğan and Sarıkaya (2020) stated in their study that regular and long-term training affects the mineral metabolism and muscle damage markers of athletes. Maynar et al., (2018) determined that regular and long-term exercises cause changes in the mineral levels of athletes.

As a result, it was observed that eight-week high-intensity training caused changes on the mineral and thyroid hormone metabolism of the athletes.

### **Suggestions**

Sports medicine professionals, coaches and athletes must be aware of the signs and symptoms and potential causes of thyroid-related disorders in order to achieve peak performance and to be successful against potential unwanted ailments.

Since thyroid disease is relatively common in the general population, especially in women, it may also be common among athletes, and this prevalence may be due to the nutritional factors of athletes.

While excessive exercise does not necessarily cause thyroid problems, strenuous exercise can be associated with temporary changes in thyroid hormones that can be important in monitoring the health of the athlete, training status and nutritional intake.

An overall assessment is important to help identify the cause and treat thyroid disorders. Future studies are needed to assess the prevalence of nutritional and non-nutritional thyroid disorders in athletes and their potential impact on athletic training, competition and recovery.

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***Author(s)' statements on ethics and conflict of interest***

**Ethics statement:** We hereby declare that research/publication ethics and citing principles have been considered in all the stages of the study. We take full responsibility for the content of the paper in case of dispute.

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