

The Effects of Aerobic Exercise on Thyroid Hormone Levels in Obese Boys

Nuray Satılmış, Leyla Çimen, İhsan Çetin*, Yahya Polat, Behzat Çimen

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Nuray Satılmış: Doctor Faculty Member, Alanya Alaaddin Keykubat University, Health Sciences Institute, Department of Physical Education and Sports, Kayseri
Email: nuray.satilmis@alanya.edu.tr
ORCID id: <https://orcid.org/0000-0002-2086-1436>

Leyla Çimen: Dr., Erciyes University, Faculty of Medicine, Department of Medical Biochemistry, Kayseri
Email: cimenleyla@gmail.com
ORCID id: <https://orcid.org/0000-0002-4730-5595>

İhsan Çetin: Assoc. Prof. Dr. Hitit University, Faculty of Medicine, Department of Medical Biochemistry, Çorum
Email: ihsancetinilim@gmail.com
ORCID id: <https://orcid.org/0000-0002-0937-0054>

Yahya Polat: Prof. Dr., Erciyes University, High school of Physical Education and Sports, Department of Physical Education and Sports, Kayseri
Email: ypolat@erciyes.edu.tr
ORCID id: <https://orcid.org/0000-0002-5512-5869>

Behzat Çimen: Prof. Dr., Erciyes University, Faculty of Pharmacy, Department of Biochemistry, Kayseri
Email: behzaticimen@yahoo.com
ORCID id: <https://orcid.org/0000-0001-6904-1474>

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* Sorumlu Yazar/Corresponding Author

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Öz

Aerobik Egzersizin Obez Erkek Çocuklarda Tiroid Hormon Düzeylerine Etkisi

Amaç: Fiziksel egzersizlerin obezite üzerindeki yararlı etkileri iyi bilinse de, obez çocuklarda fiziksel egzersizlerin tiroid hormonuna bağlı vücut kompozisyonunu, bazal metabolik hızı ve termojenezini nasıl etkilediği açık değildir. Amacımız, obez erkek çocuklarda egzersiz programının 3-5-3'triiodotironin (T3) ve 3-5-3'-5'tetraiodotironin (T4) üzerindeki etkilerini incelemektir.

Gereç ve Yöntem: Çalışmamız 10 obez erkek (13-15 yaş arası) ve kontrol grubu olarak 10 sağlıklı erkek çocuktan oluşuyordu. Egzersiz programından önce obez ve kontrol grubu erkek çocuklardan 10 ml kan örneği alındı; 12 hafta boyunca haftada 3 gün/hafta egzersizden sonra obez çocuklardan 10 ml kan örneği alındı. Her iki grubun kan örneklerinde lipit profilleri, kreatin kinaz (CK), kreatin kinaz-MB (CK-MB), T3 ve T4 düzeyleri ölçüldü.

Bulgular: Bu çalışmada, aerobik egzersizi öncesi obez çocuklarla (sırasıyla, 1.19±0.81; 7.37±0.47 and 165.3±2.49) kıyaslandığı zaman kontrol grubu ve aerobik egzersiz sonrası obez erkek çocukların anlamlı olarak daha yüksek T3 ve T4 düzeyleri (sırasıyla, 1.63±0.17; 9.80±0.93 and 1.70±0.10; 10.1±0.54) ve anlamlı derecede daha düşük CK düzeylerine (sırasıyla, 142.7±4.11 and 151.8±3.70) sahip oldukları görülmüştür. Ayrıca, aerobik egzersizin obez erkeklerde trigliserit ve kolesterol seviyelerini anlamlı derecede azalttığı bulundu (sırasıyla, 104.0±3.77 and 193.7±2.90).

Sonuç: Bu bulgular dikkate alındığında, aerobik egzersizlerin, obez erkek çocuklarda bazal metabolik hız ve termojenezde azalma ile birlikte kilo artışına neden olabilecek azalmış tiroid hormon düzeylerinin iyileştirilmesinde yardımcı olabileceği öne sürülebilir.

Anahtar Kelimeler: Obezite, Çocuklar, Aerobik egzersiz, Triiodotironin, Kreatin Kinaz, Kolesterol

Abstract

The Effects of Aerobic Exercise on Thyroid Hormone Levels in Obese Boys

Aim: Although beneficial effects of physical exercises on adulthood obesity are well known, it is unclear how physical exercises affect thyroid hormone related body composition, basal metabolic rate and thermogenesis in obese children. Our objective is to examine the effects of physical exercise program on 3-5-3'triiodothyronine (T3) and 3-5-3'-5'tetraiodothyronine (T4) in obese boys.

Materials and Method: Our study consisted of 10 obese boys (aged from 13 to 15) and a control group of 10 healthy boys age and gender matched. Before exercise program, 10 ml blood samples were taken from the obese and control group boys; and 10 ml blood samples were taken from the obese boys after program exercise 3 days/week for 12 weeks. The lipid profiles, creatine kinase (CK), creatine kinase-MB, T3 and T4 levels in blood samples were measured for both groups.

Results: In present study, it was found that control group and obese boys after aerobic exercise had significantly higher T3 and T4 levels (1.63±0.17; 9.80±0.93 and 1.70±0.10; 10.1±0.54, respectively) and significantly lower CK levels (142.7±4.11 and 151.8±3.70, respectively) than those of obese boys before aerobic exercise (1.19±0.81; 7.37±0.47 and 165.3±2.49, respectively). Furthermore, it was found that aerobic exercise significantly decreased triglyceride and cholesterol levels in obese boys (104.0±3.77 and 193.7±2.90, respectively).

Conclusion: When these findings are taken into account, it may be suggested that aerobic exercises can help with the improvement of decreased thyroid hormone levels which may be cause a weight increase together with a decrease in basal metabolic rate and thermogenesis in obese boys.

Keywords: Obesity, Children, Aerobic Exercise, Triiodothyronine, Creatine Kinase, Cholesterol

INTRODUCTION

The prevalence of obesity worldwide has reached epidemic dimension including children and adolescents (1). Moreover, secular and cross-sectional trends indicate an increase in childhood and adolescent obesity, particularly in developing countries (2). Childhood and adolescent obesity has also been associated with changes in the activity types from outdoor games to indoor entertainment such as computer games, internet and television (3). A major factor in developing countries is the lack of playgrounds and open spaces in settlement places and schools (4). Playing outside, walking and other outdoor activities are usually accepted to be unsafe in these countries (5). On the other hand, previous studies showed that adolescents who continuously joined in outdoor activities had lower prevalence of obesity, with the threat being three times higher in those not joining in such activities (6). Regular physical exercise has been used as a significant practice for protection and treatment of obesity by developing physical qualities that positively modify psychosocial well-being, body composition, metabolic activity and cardiorespiratory fitness by attenuating the comorbidities related with excess fat tissue (7).

It is a proven fact that regular physical exercise influences the function of many glands and the level of their hormones. One of the hormones influenced is the thyroid (8). Thyroid gland secretes thyroid hormones known as triiodothyronine (T3) and tetraiodothyronine (T4), which are effective on the regulation of growth, tissue differentiation and general metabolism as well as gene expression (8). It is also proven that thyroid hormones play a role in thermoregulation and fatty acid oxidation (9). Thyroid hormones and body composition seem to be closely associated since the thyroid hormones act in the regulation of basal metabolism, food intake, lipid and glucose metabolism (10). In accordance with this evidences, it is well known that hypothyroidism leads to an increase in fat tissue together with a decrease in thermogenesis and basal metabolic rate (11).

A negative relationship, primarily in the early stages of life, has been showed between exercise intensity and development of obesity, (12, 13). These beneficial effects include changes in lipid and hormone profiles, changes in the antioxidant defense system and adaptation of the receptor and transport protein (14). However, how regular exercise affects the thyroid hormone metabolism is still not completely clear in obese children. Considering these aspects, the present study was conducted to evaluate the effects of 12-week aerobic exercise program on serum thyroid hormone levels in obese boys.

MATERIALS AND METHODS

Study Populations

The study groups consisted of 10 obese boys (aged 13-15) who are students of a private secondary school in Nevşehir, Turkey; and ten healthy age and gender matched boys, student of the same school.

Data Collection

This study was carried out in Erciyes University, Faculty of Pharmacy, Biochemistry Department Laboratories and Nevşehir Special Versa Hospital. Before starting the research, T3 results from previous studies, which conduct on obese children, were taken into consideration. A sample size of 7 reaches 95% power to detect a mean of paired differences of 0.25 with a known standard deviation of differences of 0.15 and with a significance level (alpha) of 0.05000 using a paired t test assuming that distribution is normal (15). Control and obese boys were randomly selected from a private secondary school using body mass index (BMI) percentile curves. Exercise protocol applied only to children in the obese group. Thus, this research can be described as interventional study. In this study, we excluded boys with known thyroid disease or who were treated with drugs that affect thyroid function. No restrictions were imposed on the dietary regulation of children, and they were able to continue their eating habits.

The body weights and heights of the children were measured with G-TECH brand and GL-150 model electronic balance and stadiometer. The height measurements were made in vertical position with the bare foot and feet parallel, the shoulder and gluteal region touching the device. Also, their weights were determined to the nearest 0.1 kg on a standard beam scale with the subjects dressed only in light underwear but without shoes. Specific BMI percentile curves prepared for children and adolescents, and adjusted according to their ages and sexes, were used. Children were evaluated to be normal when the body mass index was between the 5th and 85th percentile, overweight when the body mass index was between the 85th and 95th percentile and obese when the body mass index was higher than the 95th percentile (16).

Exercise Protocol and Training arrangement

Obese children were given aerobic exercise for 3 days a week for 12 weeks and 10 ml blood samples were taken twice (pre-exercise and post-exercise). The fitness levels of obese children were determined according to physical activity readiness inventory, physical activity index and phys-

ical fitness. In order to increase the level of physical fitness, the training intensity must be above 130 beats/min (17). For this reason, moderate aerobic exercises were applied in the running band by following the polar brand pulse counting time between 130-150 beats/min. The maximal oxygen use (Max VO₂) levels of obese children were determined by the 20 m shuttle running test (18). It was built at the optimum level of exercise in order to obtain the targeted level of fitness. The carvone formula for each obese child was used to determine the optimal fitness status.

Karvonen Formula: This formula provides the calculation of the training pulse percentage equivalent to the percentage of Max VO₂.

For 70% max VO₂ THR = Intensity 70% X (MHR-RHT)
+ RHR

For 80% max VO₂ THR = Intensity 70% X (MHR-RHT)
+ RHR

THR (Target Heart Rate)

MHR (Maximal Heart Rate)

RHR (Resting Heart Rate)

Personalized exercise prescriptions were created using the most appropriate fitness situation for each of the obese children. The exercises were continued for 3 days a week for 12 weeks. In each unit training, 400 kcal of energy loss was targeted and tried to reach 1200 kcal of energy loss per week (16, 17).

An exercise session consists of the following sections:

1. Warm-up (5-10 min.)
2. Condition (20-60 min) (aerobic exercises, muscle strengthening and endurance exercises)
3. Cooldown (5-10 min.)

Laboratory measurements

Blood samples were centrifuged at 3000 rpm for 10 minutes at 30 °C to separate the sera. Creatinine kinase (CK), creatinine kinase-MB (CK-MB), Total Cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL) and triglyceride (TG) were analyzed using Toshiba DDS kits and T3, T4 Beckman Coulter machine Access 2 model using the original Beckman Coulter Kits in the Nevsehir Special Versa Hospital laboratory.

Statistical analysis

Statistical analyses were conducted using SigmaStat 3.5 and SPSS software version 15.0 statistical packages.

For calculate sample size in this study, power analysis was performed with GPower software 3.1 (Düsseldorf University, Germany). Data normality distributions were assessed by the Kolmogorov-Smirnov test. The mean values of the groups were compared with the independent sample t test. The Mann-Whitney U test was used for intergroup comparisons of continuous data. Wilcoxon test was used for pre exercise and post-exercise comparisons in obese children. The continuous variables were expressed as mean±standard deviation. Statistical significance was determined as 0.05.

Ethical Declaration

Permission letter dated 06.11.2012 and number 2012/684 was obtained from Erciyes University clinical research ethics committee and Helsinki Declaration rules were followed to conduct this study. Written informed consent was obtained from the parents of all participants.

RESULTS

Anthropometric data and the biochemical parameter levels of obese and control group are shown in Table 1. There was no statistically significant difference between the groups in terms of age, educational status and sociodemographic data. The ages of healthy volunteers and obese children were 13-15 (14±1.0 years), and the sex of all of them was male (Table 1).

The mean TG levels (104.5±12.6) was significantly lower while HDL levels (53.5±4.40) higher in the control than those of pre-exercise obese children (140.6±8.36 and 41.8±2.85, respectively, p<0.001). Nevertheless, there was no statistically significant difference between control and post-exercise obese children in terms of TG and HDL (104.5±12.6; 53.5±4.40 and 104.0±3.77; 53.4±4.06, respectively).

The mean TC (172.9±12.1) and LDL levels (85.9±7.29) was significantly lower in the control than those of pre-exercise (140.6±8.36 and 41.8±2.85, respectively, p<0.001) and post-exercise obese children (193.7±2.90 and 103.9±2.35, respectively p<0.001). Moreover, the mean TC (193.7±2.90), TG (104.0±3.77) and LDL levels (103.9±2.35) was significantly lower while HDL levels (53.4±4.06) higher in the post-exercise obese children than those of pre-exercise obese children (227.4±12.9; 140.6±8.36; 124.3±2.86 and 41.8±2.85, respectively, p<0.001).

The mean T₃ levels of the control group (1.63±0.17) and post-exercise obese children (1.70±0.10) were significantly higher than those of pre-exercise obese children (1.19±0.81; Figure 1, p<0.001). The mean T₄ levels of the control group

(9.80±0.93) and post-exercise obese children (10.1±0.54) were significantly higher than those of pre-exercise obese children (7.37±0.47; Figure 2, p<0.001). On the other hand, there was no significant difference between the control

group (1.63±0.17 and 9.80±0.93, respectively) and post-exercise (1.70±0.10 and 10.1±0.54, respectively) in terms of the T₃ and T₄ levels (p=0.518 and p=0.553, respectively).

Table 1. Comparison of study groups in terms of lipid profiles, creatine kinase and thyroid hormone

| Parameters | Study Groups | | | Comparisons | | |
|--------------------------|----------------|---------------------|----------------------|----------------------|-----------------------|----------------------------|
| | Control (n=10) | Pre-exercise (n=10) | Post-exercise (n=10) | Control pre-exercise | Control/post-exercise | Pre-exercise/post-exercise |
| Age | 14±1.0 | 14±1.0 | 14±1.0 | p>0.05 | p>0.05 | p>0.05 |
| Height (cm) | 170±3.45 | 170±2.90 | 170±2.90 | p>0.05 | p>0.05 | p>0.05 |
| Education time (year) | 7.00±2 | 7.00±2 | 7.00±2 | p>0.05 | p>0.05 | p>0.05 |
| Weight (kg) | 68±2.75 | 90±2.87 | 84±2.02 | P<0.001 | P<0.001 | P<0.001 |
| BMI (kg/m ²) | 23.5±2.06 | 31.1±1.05 | 29.2±1.02 | P<0.001 | P<0.001 | P<0.001 |
| TC (mg/dl) | 172.9±12.1 | 227.4±12.9 | 193.7±2.90 | P<0.001 | P<0.001 | P<0.001 |
| HDL (mg/dl) | 53.5±4.40 | 41.8±2.85 | 53.4±4.06 | P<0.001 | p=0.998 | P<0.001 |
| LDL (mg/dl) | 85.9±7.29 | 124.3±2.86 | 103.9±2.35 | P<0.001 | P<0.001 | P<0.001 |
| TG (mg/dl) | 104.5±12.6 | 140.6±8.36 | 104.0±3.77 | P<0.001 | p=0.992 | P<0.001 |
| CK (U/L) | 142.7±4.11 | 165.3±2.49 | 151.8±3.70 | P<0.001 | P<0.001 | P<0.001 |
| CKMB(U/L) | 17.1±2.88 | 18.8±5.97 | 17.3±9.79 | p=0.844 | p=0.998 | p=0.876 |
| T3 (ng/ml) | 1.63±0.17 | 1.19±0.81 | 1.70±0.10 | P<0.001 | p=0.518 | P<0.001 |
| T4 (µg/dl) | 9.80±0.93 | 7.37±0.47 | 10.1±0.54 | P<0.001 | p=0.553 | P<0.001 |

Note: The data are presented as mean±standard deviation for continuous variables. BMI: body mass index, CK: Creatinine kinase, CKMB: creatinine kinase-MB, HDL: high density lipoprotein, LDL: low density lipoprotein, TC: Total Cholesterol, TG: triglyceride, T3: triiodotironin and T4: tetraiodotironin.

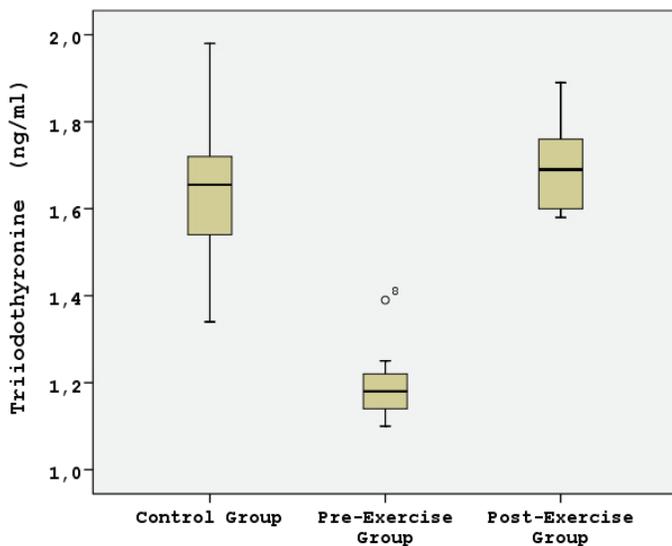


Figure 1. Comparison of pre-exercise and post-exercise with control in terms of triiodothyronine levels (ng/ml).

The mean CK levels of the pre-exercise obese children (165.3±2.49) were significantly higher than those of control (142.7±4.11) and post-exercise obese children (151.8±3.70; Figure 3, p<0.001). On the other hand, the mean CK levels of post-exercise obese children (151.8±3.70) were found to be statistically significantly lower than those of control group (142.7±4.11; p<0.001). There was no significant difference between the groups in terms of CK-MB levels (Figure 4; p>0.05).

DISCUSSION

The present study results provide evidence that exercise do not have only positive effect on weight loss but also have effect on regulating of lipid profiles, CK activity, and thyroid gland metabolism in obese boys. However, we found that there was no significant difference between control and post-exercise obese children in terms of TG and HDL. Moreover, the mean TC, TG and LDL levels were significantly lower while HDL levels higher in the post-exercise obese children than those of pre-exercise obese children.

Data obtained from previous studies showed the fact that childhood obesity is related to physical inactivity; and

undesirable blood lipid levels have unfavorable effects on blood lipids. Escalante et al. demonstrated that LDL levels can decrease by 35% and triglyceride levels can decrease by 40% and HDL levels can increase up to 25% with regular physical exercise (19). Moreover, regular physical exercise is closely interrelated with HDL stated the majority of variance in HDL for boys, which further emphasizes the cardioprotective effect of habitual physical activity. The advantageous role of regular physical exercise is been attenuator of cardiovascular disease risk factors and lipid profile of obese children (20).

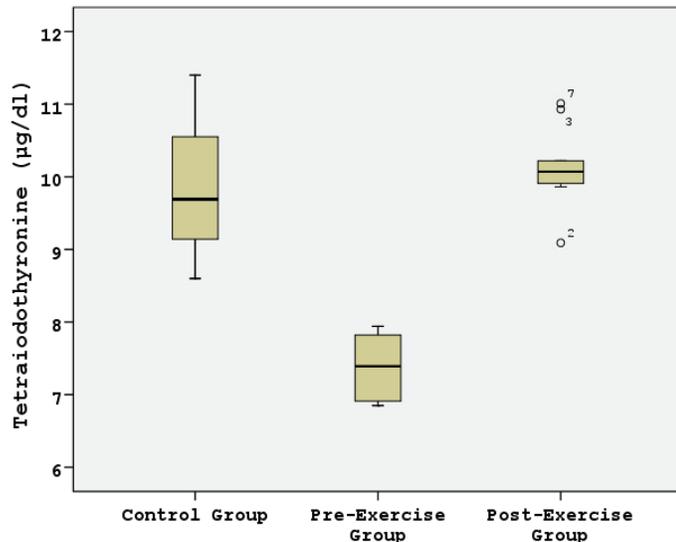


Figure 2. Comparison of pre-exercise and post-exercise with control in terms of tetraiodothyronine levels (µg/dl).

Consistent with previous studies (21), we found that the mean post-exercise TC, TG, LDL and HDL levels of obese children were found to be closer to those of the control values. Thus, our findings on regular physical exercise support current guidelines emphasizing the need for regular exercise for reducing cardiovascular disease risk in children.

Since thyroid hormones upregulate many metabolic pathways relevant for energy consumption, body weight and thermogenesis; it is not incomprehensible that reduction of thyroid hormones, which eventually also leads to a decrease in energy consumption, would reveal the difficulty of preventing obesity (22). It has also been demonstrated that there is a negative correlation between BMI and fT_4 values, even when fT_4 values remain in the normal range (23). Recently, it has also been proposed that irregularity in thyroid function may be secondary to weight excess. These alterations, however, would still be functional, as proposed by their improvement after weight loss (24). In previous researches on adult obese individuals, thyroid hormone and levels of thyroid stimulating hormone have been described as reduced, normal or elevated compared to normal weight individuals (25). Ciloglu et al. showed that as compared to

the thyroid hormone values during low-intensity exercise, there is an increase in TSH values with exercise in obese adults (14). However, according to our literature knowledge, there is no study showing how exercise affects thyroid hormones in obese children.

In our study, although there was a difference between obese and control groups in terms of T3 and T4 before exercise, we found that there was no difference between obese and control groups in terms of T3 and T4 levels after 12-week exercise programme. It may be suggested that even simple modification of habit, characterized by increased physical exercise and improvement in body composition without simultaneous alterations of BMI, also leads to an increased of T3 and T4.

Hypothyroidism is a common reason of endocrine myopathy and should be considered in patients with unexpressed resistant high levels of serum muscle enzymes, which are lower in subclinical hypothyroidism and higher in patients with overt hypothyroidism (26).

In the present study, it was found that the mean CK activity was found to be significantly lower in post-exercise obese boys than those of pre-exercise. Nevertheless, there was no difference between pre-exercise and post-exercise obese boys in terms of CK-MB. Clinically, the blood value of CK-MB is identified as a percentage of total CK and it is normally accepted that total CK increases more than 4 percent with myocardial necrosis (27). It has been reported that there was not significant difference between normal and obese subjects at rest in terms of CK-MB values; however, the slightly elevated level in obese patients may be due to their higher heart weight (27). Some researchers demonstrated a small increase of CK-MB after intense training program in runners (28).

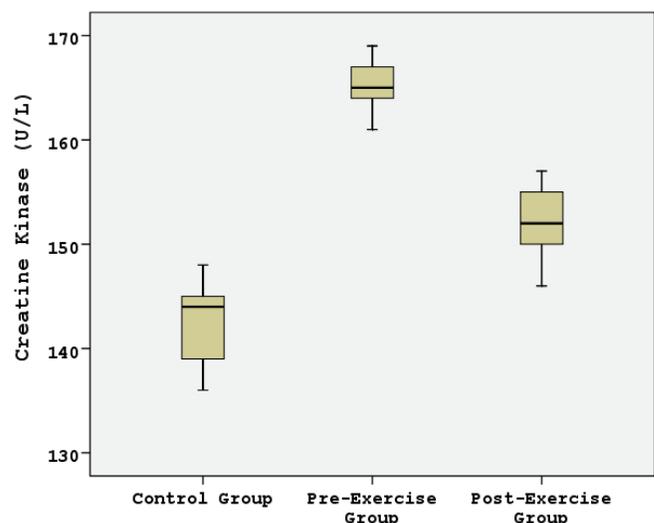


Figure 3. Comparison of pre-exercise and post-exercise with control in terms of creatine kinase levels (U/L).

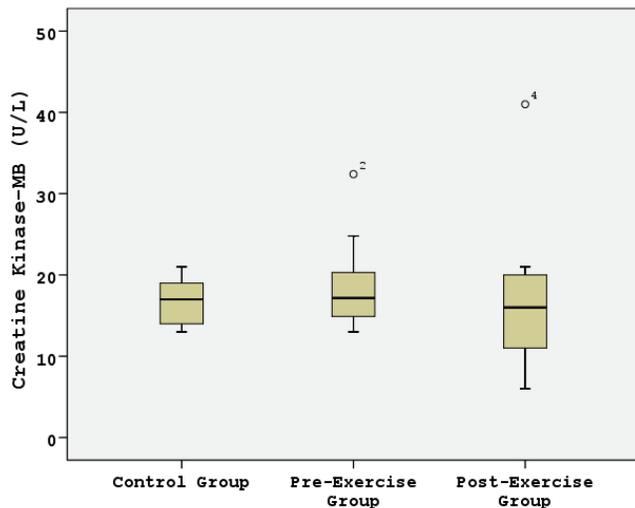


Figure 4. Comparison of pre-exercise and post-exercise with control in terms of creatine kinase-MB levels (U/L).

In this study, at the end of exercise, no considerable increase in CK-MB was determined; and it may be suggested that this is acceptable since none of the children had myocardial disorders. In previous researches, CK activity was closely connected to the severity of muscle damage, (29) while later researches revealed that CK activity was not related with the magnitude of muscle damage (30). Total CK levels depend on age, gender, muscle mass, physical activity and climatic condition. Although exercise is known to elevate CK activity, it produces a wide range of activity, based on a host of variables (31). It has been demonstrated that the obese individuals have increased total CK levels at rest, and subsequent CK levels improve with exercise compared with normal weight individuals. This aspect presumably is due to their higher body mass which is likely characterized by the increase in muscle mass as well as in fat (17) and skeletal muscle is the major source of the increase in its enzymatic activity (18). Many authors suggest assessing thyroid function in patients with muscle weakness or elevation of CK, although clinical signs of hypothyroidism may be absent (32).

There are some limitations of our study that should be noted. The sample size was small and control group samples were not analyzed after aerobic exercise, since no differences were expected in terms of the control values. Secondly, taking into account the diurnal variation, nutritional habits and the daily calorie intake could enhance the strength of this work. Lastly, the absence of the gender differences in terms of serum T3 and T4 levels.

Despite these limitations, to our knowledge, this is the first report on relationship between exercise and thyroid hormone in obese boys. On the other hand, because of the lack of similar studies in the literature, it is difficult to com-

pare the results of our study; so, the subject deserves further investigation.

CONCLUSION

Consequently, the importance of exercise has been emphasised in our study; and our results provide evidence that aerobic exercise for 3 days a week for 12 weeks do not have only positive effect on weight loss but also have effect on regulating of lipid profiles, CK activity, thyroid gland metabolism in obese boys. Thus, our findings on physical activity may suggest that thyroid hormones may have a potential role in reducing serum CK levels. Nevertheless, it is obvious that further information is required to understand the biological mechanisms underlying whether thyroid hormones have a role in reducing serum CK levels.

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