Scholars Journal of Arts, Humanities and Social Sciences **ISSN 2347-5374(Online)**
Abbreviated Key Title: Sch. J. Arts Humanit. Soc. Sci. **ISSN 2347-9493(Print)**

(An International Publisher for Academic and Scientific Resources) DOI: 10.36347/sjahss.2018.v06i06.018

Effect of Physical Activity Program on Iron and Iron-Binding Capacity in Obese Children

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Article History
Received: 12.06.2018
Accepted: 27.06.2018
Published: 30.06.2018

Abstract: The purpose of this study is to investigate the effect of a four-week, low-intensity physical activity program on iron, iron binding and total iron-binding capacity in obese and overweight boys. The study included 27 boys between the ages of 12-14 divided into two groups, as the obese group consisting of 12 boys and overweight group consisting of 15 boys. The children who participated in the study were included in a three-day-a-week program for four weeks, which consisted of 60 minutes of selected sports games and a walk that gradually increased in duration. Iron, iron binding and total iron- binding levels were quantified from plasma blood samples collected while resting at the beginning and end of the study. Statistical analysis of the data obtained in the study was performed using SPSS package program SPSS 22.0 statistics software (SPSS Inc., Chicago, Illinois, USA). 2x2 mixed factor ANOVA test was used in data analysis. According to the results of 2x2 mixed factor ANOVA test, there was no effect of time in groups. At the end of the application, according to the pre- and post-test measurements of the obese group, body weight was significantly reduced in favor of the post-test, whereas other values did not exhibit any significant changes. The body weight and BMI values of the overweight group were significantly reduced in comparison to the pre-test results, whereas there was no significant change in iron, iron binding and total iron binding levels. None of the difference values between the two groups exhibited a significant change ($p>0.05$). In conclusion, it can be stated that applying a four-week low intensity physical activity program does not significantly change iron, iron binding and total iron-binding levels in children between the ages of 12-14.
Keywords: Physical activity, Iron, Iron-binding level.

INTRODUCTION

Although obesity is simply defined as the result of energy intake being higher than the energy spent, obesity that occurs as a result of the complex interaction of genetic structure, conditions affecting energy metabolism, eating habits and sociocultural factors is a complicated condition closely associated with many diseases such as hypertension, cardiovascular disease, diabetes, degenerative arthritis and thrombophlebitis, etc. It is considered to be a disease that concerns all age and socioeconomic groups with extremely serious social and psychological effects [1,2]. Obesity is a global epidemic which also affects children [3]. It is well known that obesity is associated with many diseases in the short and long term and that the onset of obesity in the majority of adult obese individuals extends back to their childhood [4].

Physical inactivity constitutes the main cause for the development of obesity. In modern communities, the ability to perform work by expending less energy and spending more time watching TV, especially during childhood, causes the body to store this unspent energy as fat. The human organism's capacity for physical activity decreases and the organism loses its fitness in a sedentary lifestyle. Muscles become weaker and joints lose functionality, thus obesity develops as a result of weight gain due to insufficient expenditure of the consumed energy sources [5-7]. Physical activity is an important function of living systems. It can affect biochemical parameters, as well as many systems. It is also known that biochemical levels change depending on the type, intensity and duration of exercise [8].

Iron is necessary and important for the production of iron proteins that have a role in oxygen transport and consumption [9]. Iron catalyzes many metabolic events such as oxygenation, hydroxylation, etc. as it can transform from ferrous (Fe+2) to ferric (Fe+3) states and vice versa [10]. Total amount of iron in the body is approximately 3-4 grams. Most of the iron is present in hemoglobin within erythrocyte structure [11]. Hemoglobin, myoglobin and cytochromes that contain iron comprise 70-90% of the total iron in the body. The remaining iron is stored in the liver, spleen and bone liver as ferritin and hemosiderine [9]. Heme and hemoglobin that are produced by erythrocyte degradation are taken up by hemopexin and haptoglobin, and transported to the liver to be stored or to the bone marrow for use in erythrocyte production [12]. In the light of this information, the purpose of this study is to investigate the effect of a four-week, low- intensity physical activity program on iron and iron-binding capacity in obese and overweight boys.

MATERIALS AND METHODS

Experimental Design

The children who participated in the study were included in a three-day-a-week program for four weeks, which consisted of 60 minutes of selected sports games and a walk that gradually increased in duration. Iron, iron binding and total iron- binding levels were quantified from fasting blood samples collected while resting in the morning as well as body weight, and BMI values one day before and one day after the four-week exercise program.

Selection of Subjects

The study included 27 boys between the ages 12-14 divided into two groups as the obese group consisting of 12 and the overweight group consisting of 15 voluntary boys. In order to determine obesity and to form the groups, Body Mass Index (BMI), calculated by dividing the individual's body weight (kg) by the square of his height (m) (BMI=kg/m2), was used [13]. The subjects participating in the study were informed of the physical activity program and the laboratory tests that would be performed. The approval of the projects unit of Directorate of National Education was obtained before starting the study. Informed consent forms and participation permissions were obtained from families of the subjects.

Procedure

Physical Activity Program

The children who participated in the study were included in a three-day-a-week program for four weeks, which consisted of 60 minutes of selected sports games and a walk that gradually increased in duration. The physical activity program was prepared by considering the age and condition of children, at the intensity to achieve a heart rate between 120-140 (13).

	1. Week	2. Week	3. Week	4. Week
Day 1	30-minute walk	15-minute warmup / 15-minute basketball	15-minute warmup / 30-minute football	45-minute walk
Day 2	45-minute walk	15-minute warmup / 20-minute basketball	15-minute warmup / 45-minute football	60-minute walk
Day 3	60-minute walk	15-minute warmup / 25-minute basketball	15-minute warmup / 60-minute football	75-minute walk

Blood Testing Procedure

Venous fasting blood samples from the right arm were obtained from the children that participated in the study between 9:00-10:30 am at the Central Laboratory of the pediatric hospital, one day before and one day after the four-week physical activity program. The collected blood samples were centrifuged for seven minutes at 4000 rpm in a Nüve-NF800 device to separate the serum. Iron, iron binding and total iron-binding levels were tested in serum.

STATISTICAL ANALYSIS

Statistical analysis of the data obtained in the study was performed using SPSS package program SPSS 22.0 statistics software (SPSS Inc., Chicago, Illinois, USA). 2x2 mixed factor ANOVA test was used in data analysis. According to the results of 2x2 mixed factor ANOVA test, there was no effect of time in groups.

RESULTS

The statistical analysis of the pre-test and post-test values of the obese and overweight group is provided in the tables.

According to Table 1, body weight and BMI values of obese subjects were reduced in favor of the post-test, and this decrease was found to be significant in favor of the body weight post-test ($p<0.05$). Iron levels were elevated whereas iron binding and total iron-binding levels were reduced. However, these changes were not statistically significant ($p>0.05$).

Table-1: Analysis of the values measured in obese subjects (n=12) between pre- and post-tests

		Mean	Std. Dev.
Weight	pre-test	79,4750	9,63612
	post-test	76,5583	**8,99338***
BMI	pre-test	28,7583	2,14707
	post-test	27,8500	3,15436
Iron	pre-test	72,6667	23,81113
	post-test	80,0000	37,26075
Iron binding capacity	pre-test	343,1667	89,15445
	post-test	334,0000	59,15158
Total iron binding	pre-test	423,1667	67,95832
	post-test	422,8333	56,26210

***Significant difference between pre- and post-test

Table-2: Analysis of the values measured in overweight subjects (n=15) between pre- and post-tests

		Mean	Std. Dev.
Weight	pre-test	69,9067	4,85158
	post-test	66,8133	4,61811*
BMI	pre-test	26,3600	,24437*
	post-test	25,2200	,43458
Iron	pre-test	76,8000	17,60763
	post-test	84,6667	30,35661
Iron binding capacity	pre-test	338,9333	45,97277
	post-test	324,8667	59,65839
Total iron binding	pre-test	415,7333	41,17292
	post-test	399,7333	42,20269

***Significant difference between pre- and post-test

According to Table 2, body weight and BMI values of overweight subjects were reduced in favor of the post-test, and this decrease was found to be statistically significant in favor of the post-test ($p<0.05$). Iron levels were elevated whereas iron binding and total iron-binding levels were reduced. However, these changes were not statistically significant ($p>0.05$).

Table-3: Intergroup analysis of pre-post test differences of measured values in obese and overweight subjects

		Mean	Std. Dev.
Weight	obese	-3,0917	1,05353
	overweight	-3,0933	1,22618
BMI	obese	-1,5000	1,02336
	overweight	-1,1400	0,50114
Iron	obese	-7,3333	32,21895
	overweight	7,8667	27,96648
Iron binding capacity	obese	-9,1667	78,46346
	overweight	-14,0667	65,43204
Total iron binding	obese	-,3333	42,25536
	overweight	-16,0000	46,65527

According to Table 3, there were no statistically significant differences in the intergroup analysis of the pre and post-test values of obese and overweight subjects ($p>0.05$).

CONCLUSION AND DISCUSSION

The purpose of this study is to investigate the effect of a four-week, low-intensity physical activity program on iron, iron binding and total iron-binding capacity in obese and overweight boys. According to the conducted analyses, as a result of the physical activity, body weight of the obese group significantly changed in favor of the post-test ($p<0.05$), whereas BMI, iron, iron binding and total iron- binding capacities also changed but this change was not found to be statistically significant ($p>0.05$). Body weight and BMI values of the overweight group were significantly reduced in favor of the post-test ($p<0.05$); whereas the change in iron, iron binding and total iron-binding capacities were not statistically significant ($p>0.05$).

Iron is a trace element that is essential for life and used in oxygen transport and storage, electron transport, oxidative systems, cell growth and proliferation and catalysis of essential reactions. The total amount of iron in the body is approximately 3-5 g and the majority of this iron is present in the hemoglobin molecule [14, 15]. 95% of the iron necessary for erythrocyte production in adults is obtained from erythrocyte degradation, whereas the amount of iron obtained from erythrocyte degradation in children is only 70% due to rapid growth. In this period, 30% of the iron required for erythropoiesis and other vital functions should be obtained from the diet, and hence deficiencies associated with nutrition may cause iron deficiency more easily. One of the most important consequences of childhood iron deficiency is the potential of future mental impairments that would continue for years and even affect adulthood even though iron deficiency is treated later. Excess iron cannot be easily eliminated from the organism and it may cause oxidative damage by acting as a free radical. Therefore, it is important that iron intake and metabolism are in balance [16].

In our study, there was an increase in iron levels of the obese and overweight groups after the physical activity program. However, this increase was not statistically significant ($p>0.05$). It is thought that this increase varies depending on exercise and a diet rich in foods of animal origin. Ausk *et al*. found that serum iron levels were significantly low and serum ferritin levels were significantly high in obese and overweight individuals in comparison to those with normal weight without a change in hemoglobin levels in a study they conducted on a large study group [17]. The amount of absorbed iron increases with increased level of digested iron. However, the percentage of iron absorption decreases when iron intake is excessive. In healthy individuals, nearly 10% of the iron consumed with the diet is absorbed [18]. Iron absorption in children is generally higher than absorption in adults [19].

In examining the iron metabolism, measurement of serum iron and iron- binding capacity generally constitutes the baseline. Total iron-binding capacity (TIBC) is an indirect measure of transferrin, and indicates the amount that the iron will bind to. Serum iron indicates *100/TIBC transferrin saturation and normal values range between 20-45% [20]. Transferrin receptors are transmembrane proteins with disulfide bond that are mostly present on cell surface and that facilitate the entry of iron bound to transferrin into the cell. Their amount increases in iron deficiency [20]. In our study, there was a significant decrease in iron binding and total iron-binding capacity in favor of the post-test. However, this decrease was not statistically significant. The constant balance between the iron taken with the diet and the iron eliminated with the degradation of cells in the skin, urinary system and gastrointestinal system facilitates preserving the iron stores in the body. This balance is provided with iron absorption. Regulation of iron absorption is the basis of normal iron balance. Achieving this balance is closely associated with the iron need of the body, state of iron stores in the body, hypoxia and nutrition [10]. In a study by Arslan *et al*. [21], it was found that female athletes had high TIBC and low Fe^{++} levels in comparison to the controls who did not exercise. In iron deficiency, work capacity max. VO_2 is reduced in addition to other clinical symptoms as a result of hemoglobin decrease and TIBC increase [22, 23].

In some studies comparing obese and non-obese children, it was shown that obese children had lower serum iron levels [24-26]. It was emphasized that the possible mechanisms which can explain this result can be dilutional hypoferremia, low iron intake with the diet, reduced iron absorption in obese individuals or increased iron need. However, the exact etiology of hypoferremia associated with obesity is still unknown [27, 28]. In our study, no relation such as obese-iron deficiency was detected in obese and overweight groups. In conclusion, it can be stated that a four-week low-intensity physical activity program causes a change in iron, iron binding and total iron-binding capacity in obese and overweight boys.

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