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RESEARCH ARTICLE

EFFECTS OF 8-WEEK AEROBIC EXERCISE ON HEMOGLOBIN CONCENTRATION AND OXYGEN SATURATION IN 10-12 YEAR-OLD OBESE CHILDREN

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ABSTRACT

Background/Objective: The aim of this study is to evaluate the effects of 8-week aerobic exercise on hemoglobin concentration and oxygen saturation in 10-12 year-old obese children.
Methods: A total of 40 obese children volunteered in the study. Mean age and height of the children participating in the study was 11,40±0,68 years and 149,40±3,60 cm, respectively in the training group and 11,30±0,80 years and 149,20±3,55 cm , respectively in the control group. Run-walk exercise for 20-45 minutes, three days a week for 8 weeks targeted at 40-70% target heart rate was applied in the training group of obese children participating in the study. No statistically significant differences were found between pre-test and post-test body weight, body mass index, hemoglobin concentration and oxygen saturation values in the control group of obese children ($p>0,05$). On the contrary, statistically significant differences were found between the pre-test and post-test body weight, body mass index, hemoglobin concentration and oxygen saturation values in the experiment group of obese children ($p<0,05$).
Results: In conclusion, regular physical activity can be suggested to have an important place in healthy development and growth of children and in the treatment of negative effects of respiratory system complications that develop in the metabolism as a result of obesity.

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INTRODUCTION

Obesity is a chronic disease developed as a result of increased body fat ratio to non-fat body mass due to a higher amount of energy caused by metabolism of the ingested food compared to the energy we consume as a result of the metabolic events in the body and physical activities. Incidence of obesity has been increased in many countries recently and has become a serious problem. Obesity due to a sedentary life style causes many complications in the body. Some of these complications related with the respiratory system are sleep apnea and obesity hypo ventilation syndrome. In addition to the increasing upper respiratory resistance due to excess body weight, weakness occurs in chemoreceptor functions and air flow due to decreased lung volume in obesity hypoventilation syndrome. Decreased oxygen saturation level is among the findings of this condition.

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On the other hand, sleep apnea is repetitive ceasing of air passage during sleep due to collapse of the respiratory tract. Increased neck circumference explains the association of obesity and the disease in those individuals (Katz *et al.,* 1990). A study performed in patients with sleep apnea and a high body mass index demonstrated changes in the function of upper airway tract instead of its structure after weight loss (Rubinstein *et al.,* 1988). Many chemical reactions used to obtain energy in living creatures would be impossible without oxygen. Therefore, the amount of oxygen delivered to the tissues is important. An adequate amount of hemoglobin molecules, arterial oxygen saturation and a normal cardiac function is necessary in order to carry an adequate amount of oxygen to the tissues (Ercin, 2006). Hemoglobin molecule that is found in erythrocytes and includes protein and iron is an important factor affecting the oxygen saturation, since the inspired oxygen is carried to the tissues by binding to an hemoglobin molecule. One mole of O2 is carried in a molecule of hemoglobin bound by one of four iron groups in it (Guyton, 1986). A decreased level of binding of oxygen to hemoglobin

(desaturation) is dangerous when the level is lower than 90% (Sugerman, 1992).

Objectives

Regular and planned physical activity of the individuals of a society helps to eliminate the negative effects of sedentary life style associated with the quality of life. The most significant effect of training is benefits of increasing oxygen diffusion capacity. Oxygen diffusion capacity is at the same time a marker of diffusion rate from alveoli to blood (Günay *et al.,* 2005). Regular exercise performed two or three times a week has been demonstrated to create positive effects on human health. Positive changes in body composition can be suggested to occur in all age groups (Açıkada, 1990; Lohman, 1995). Therefore regular physical activity should be adopted as a habit in a society starting from young ages (Çelebi, 2008). The aim of this study was to evaluate the effects of aerobic exercise on oxygen saturation and hemoglobin concentration levels.

METHODS

Participants

A total of 40 obese children, 20 in the experiment and 20 in the control group, living in the city center of Gaziantep in an age of 10-12 years and BMI ≥30 volunteered in the study. Subjects participating in the study were informed of the study protocol.

Collection of Data

Testing Procedure

Measurement of Height: The height of the subjects was measured using a stadiometer (SECA, Germany) with a sensitivity of 0.01 according to the measurement technique of the device (Lohman *et al.,* 1988).

Measurement of Weight: Body weight of the subjects was measured using an electronic scale with a sensitivity of 0.1 kg (SECA, Germany) according to the measurement technique compatible with an electronic scale (shorts and t-shirt). Measurement of Body Mass Index: BMI value of the subjects was obtained by using the formula, weight/square meter of height (Ergün and Ertan, 2004).

Measurement of Hemoglobin Concentration: Blood samples from fingertips of the subjects in the experiment and control groups were obtained by specially trained healthcare personnel prior to and after an 8-week aerobic training period. Measurement of total hemoglobin levels of the blood samples was performed in the HemoCue device, a spectrophotometric device that measured blood obtained from the fingertip.

Measurement of Oxygen Saturation (SpO2): Measurement of Oxygen Saturation was performed by a pulse oxymeter device (Spirolab III, Medical International Research). Oxygen saturation is calculated as the ratio of oxygenated hemoglobin to total valid hemoglobin or functional hemoglobin. Pulse oxymeter operates by absorption of the pulsatile frequency of infrared light using the principle that infrared light can be measured only by two wavelengths considering the fact that pulse in the tissue is produced by arterial blood (Pole, 2002; Tosun and Tutluoğlu, 2000). As an oxygen saturation level higher than 95% is accepted as normal, levels under 93% point out necessity of oxygen treatment and close observation of the individual (Akansel and Yıldız, 2010). During the measurements, the oxymeter probe was checked and cleaned prior to each measurement.The nails of the subjects were cleaned and nail polishes and any material that had the potential to interfere with the measurement, if any were removed and no bright fluorescein lamps were used in the room of measurement. The subjects were provided a rest prior to the measurement and subsequently the oxymeter probe was placed on the finger of the subjects (Andersson *et al.,* 2002). Measurement of each subject was performed for 10 minutes (Çalışkan *et al.,* 2008). Aerobic Exercise Protocol: Run-walk exercise for 20-45 minutes, three days a week for 8 weeks targeted at 40-70% target heart rate was applied in the subjects. Obese children performed 5 to 10 minutes of warming exercises before running and 5 to 10 minutes of stretching after the end of exercise. The intensity of the exercise was determined by the heart rate measured for 10 seconds on the carotid artery in the neck according to the heart beat reserve (Karvonen) method (Karacan and Günay, 2003).

Karvonen Formula

Maximal Heart Rate: 220-age,

Heart Beat Reserve = Maximal Heart Rate – Resting Heart Rate

Target Heart Rate = (60-70% x Heart Beat Reserve) + Resting Heart Rate

Training Program Applied

Change/week	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Period of Training (min.)	20	25	30	35	40	40	45	45
Intensity of Training (%)	40	45	50	55	60	65	70	70
Frequency of Training (day)	3	3	3	3	3	3	3	3

Statistical Analysis: Statistical Analysis was performed using SPSS 20.0 package program. The results of the statistical analysis were evaluated using a significance level of $p<0.05$ in a confidence interval of 95%. Independent Samples T-Test was used to analyze differences between the training and control groups since the measurements of the groups were normal and homogeneously distributed.

RESULTS

No statistically significant differences were found in body mass index, body weight, hemoglobin concentration and oxygen saturation between experiment and control groups when pre-test values were compared (Table 2) ($p>0.05$). However, body weight, body mass index, hemoglobin concentration and oxygen saturation values obtained in the post-test were significantly different between the experiment and control groups ($p<0,05$). No significant difference was found in body weight, body mass index, hemoglobin concentration and oxygen saturation between pre-test and post-

Table 1. Physical properties of the subjects participated in the study

Parameters		Mean	Std. Deviation
Training Group (n=20)	Age (year)	11,40	0,68
	Height (cm)	149,40	3.60
Control Group (n=20)	Age (year)	11,30	0,80
	Height (cm)	149,40	3,55

Table 2. Comparison of pre-test and post-test values of experiment and control groups

Parameters			Mean	Std. Deviation	T	P
Body weight	Pre-test	Training Group	70,45	2,78	0,115	0,909
		Control Group	70,35	2,74		
	Post-test	Training Group	65,90	2,40	-6,168	0,000*
		Control Group	71,00	2,81		
Body Mass Index	Pre-test	Training Group	31,55	1,03	-0,126	0,900
		Control Group	31,59	0,89		
	Post-test	Training Group	29,12	1,35	-5,855	0,000*
		Control Group	31,48	1,19		
HGB	Pre-test	Training Group	12,98	0,56	0,331	0,742
		Control Group	12,92	0,58		
	Post-test	Training Group	13,73	0,38	4,998	0,000*
		Control Group	13,01	0,52		
SpO2	Pre-test	Training Group	95,20	0,70	0,417	0,679
		Control Group	95,12	0,50		
	Post-test	Training Group	95,89	0,47	4,359	0,000*
		Control Group	95,08	0,69		

*P<0,05

Table 3. Comparison of pre-and post-test values of experiment and control groups of the study

Parameters			Mean	Std. Deviation	T	P
Body weight	Training Group	Pre-test	70,45	2,78	9,739	0,000*
		Post-test	65,90	2,40		
	Control Group	Pre-test	70,35	2,74	-2,041	0,055
		Post-test	71,00	2,81		
Body Mass Index	Training Group	Pre-test	31,55	1,03	11,054	0,000*
		Post-test	29,11	1,35		
	Control Group	Pre-test	31,58	0,89	0,597	0,558
		Post-test	31,48	1,19		
HGB	Training Group	Pre-test	12,98	0,56	-7,917	0,000*
		Post-test	13,73	0,38		
	Control Group	Pre-test	12,91	0,58	-1,571	0,133
		Post-test	13,01	0,52		
SpO2	Training Group	Pre-test	95,20	0,70	-7,889	0,000*
		Post-test	95,90	0,47		
	Control Group	Pre-test	95,12	0,50	0,494	0,627
		Post-test	95,08	0,69		

*P<0,05

test in the control group (Table 3) (p>0,05). On the other hand, statistically significant differences were found in body weight, body mass index, hemoglobin concentration and oxygen saturation between pre-test and post-test in the experiment group (p<0,05).

DISCUSSION

Physicalactivity is important in the healthy growth and development of children in youngages and it creates positive psychological and physiological effects in both child hood and in the laterphases of life since it also effects the future years (Harro, 1997). Therefore, regular exercising should be started in adolescency in order to prevent some possible disorders. Activities including large muscle groups should be added in regular exercise in order to consume more energy. Obese children in 10-11 years burn 200-250 kcal when performing such exercises for 30-45 minutes. However, thisamount is variable according to the intensity of the exercise and the body mass of thechild (Gutin *et al.,* 1995). In this present study, no statistically significant differences were found in body weight and body mass index between the pre-test and post-test values in the control group (p>0,05). On the other hand, statistically significant differences were found in body weight and body mass index between the pre-test and post-test in the experiment group (p<0,05). Mertens *et al.* (1998) reported decreases in body weight from 70,7 kg to 65,6 kg and in body mass index from 27,2±1,3 kg/m2 to 25, 2±1,7 kg/m2 following a training program of daily walking for 12 months in 4 female and 8 male obese individuals. In a study by Taskin (2007), mean body weight of the training group prior to and after exercise was found to be 61,65±8,126 kg and 56,50±7,112 kg, respectively in their study evaluating the effects of 12-week aerobic exercise on body composition and blood lipids in obese children. The exercise program to be applied in children is as important as theeffects of the exercise of child health since fat is mainlyused as energy during aerobic exercise (Guy and Gauthıer, 1988). The exercise program used in this present study was an aerobic exercise program andthis had positive effects on the results of the study. In this present study, no statistically significant differences were found in the hemoglobin and SpO2 levels between pre-test and post-test values in the control group (p>0,05). On the contrary, statistically significant differences were found in the

hemoglobin and SpO2 levels between pre-test and post-test values in the experiment group (p<0,05). When the studies on the effects of exercise on oxygen saturation are evaluated, a study by Gokhan *et al.* (2010) can be found and it analyzes the effects of 8-week swimming training on some metabolic parameters in sedentary young males. A statistically significant difference (level of significance: p<0,05) was found between the first measurements of pre-and post-test oxygen saturation. A statistically significant difference was also found between the second and third measurements (level of significance: p<0,01). In another study, heart beat rate was found to be significantly decreased after a three-week camp period. In the same study, hemoglobin values were significantly increased and pre- and post- test oxygen saturation levels were similar after the three-week campperiod (Coşkun *et al.,* 2014). Increase in apnea hypopnea index was found to be closely associated with weight gain in a study performed on sleep apneadisease which is generally seen in obese individuals (Paul *et al.,* 2000). Approximately 3-4% fall in oxygensaturation is seen in patients with apnea whoalso have a regular airflow of 30% of normal (Fairbanks, 1994). This demonstrates us that changes in oxygen saturation levels occur as a result of complications developing in the body of individuals with excess weight. When studies on hemoglobin concentration are evaluated, it can be seenthat Nieman *et al.* (1999) found a statistically significant increase in hemoglobin levels following exercise performed by sedentary individuals.

In another study, Gallagher et al reported statistically significant increases in hemoglobin levels following an 8-week aerobic exercise (Gallagher *et al.,* 2000). Erdemir *et al.* (2013) observed significant increase in hemoglobin levels in a study evaluating the effects of morning and evening exercise on blood parameters. Ibis et al (2010) found no significant changes in hemoglobin concentration values following aerobic exercise. In a study by Unal (Ünal,, 1998) on theeffects of anaerobic and aerobic chronic exercise on immune parameters, significant increase was demonstrated in the hemoglobin levels of theindividualsparticipating in thestudy. Koc et al (2010) determined a significant difference in favor of athletes in a study comparing hematological parameters in athletes and sedentary individuals. Increased Blood Oxygen Concentration is seen secondary to increased cardiaco utput due to hypertrophied heart muscle and development of respiratory system due to aerobic exercise and hemoglobin number increases by exercise. Physical exercise results in an increased oxygen exchange in the cellular level. There as on of this is suggested to be the improvement in there spiratory muscles secondary to endurance training.

Conclusion

In conclusion, regular physical activity is an important factor in the healthy growth and development of children, helping them to acquire a social environment and refrain from bad habits and to prevent possible chronic disorders in the future.

Recommendation

We recommend that all children have as much physical activity as possible. It should also be remembered that these activities will improve children from both the talent and social perspective.

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