

Full Length Research Paper

The influence of aerobic exercise on health-related physical fitness and lipid profiles in obese female adolescents

Özcan Saygın^{1*} and Mehmet Ali Öztürk²

¹School of Physical Education and Sports, Mugla University, Mugla, Turkey.

²Sakarya University, Serdivan, Sakarya, Turkey.

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The aim of this study was to investigate the effects of 12 week aerobic exercise program on health related fitness components and blood lipids in obese girls. In this study, a total of 40 girls were recruited as exercise group (n = 20) and control group (n = 19). Participants joined sessions for 60 min per day, 3 days per week for 12-week. There were significant differences in weight, body mass index (BMI), flexibility, sit-ups, hand grip for both hands, VO_{2max}, skin fold measurements (thigh, triceps, biceps, abdomen, suprailiac, subscapula, chest, body fat percent, heart rate, high density lipoproteins (HDL), low density lipoproteins (LDL), total cholesterol, and triglyceride between pre-test and post test scores in the exercise group (p<0.05). It was concluded that regular aerobic exercise may affect health related fitness components and blood lipids positively in girls. Furthermore, it may result in decreasing obesity in girls.

Key words: Blood lipids, flexibility, muscle strength, body mass index (BMI), max. VO₂, aerobic exercise.

INTRODUCTION

Childhood obesity is an increasing problem in Turkey (Tuna, 2003). Effective early strategies for the prevention of obesity are needed. Although the physical activity is one of the widely accepted strategies for the treatment of obesity; the role of physical activity in the prevention of obesity is still unclear (Steinbeck, 2001).

Pediatric obesity tends to be more severe and is associated with more extreme psychosocial and physical morbidity, which may contribute disproportionately to the cost of adult obesity. Earlier prevention strategies for kids may have decrease obesity in their later life (Steinbeck, 2001; Nassiss et al., 2005).

Obesity is associated with increased systemic blood pressure, decreased aerobic fitness, cardiopulmonary function, increased rate of Type 2 diabetes Mellitus and cardiovascular diseases (Rahmouni et al., 2005; Sorof and Daniels, 2002). Earlier studies showed that highly active children had higher HDL cholesterol and/or lower total cholesterol levels when compared to their inactive

peers.

Although there are several reports in the literature regarding the effects of exercise on health related physical components and blood lipids in obese girls (Karacabey, 2009), the effect of exercise on preventing obesity should be highlighted with more specific research.

The aim of this study was to examine the effect of 12 week aerobic exercise training on health related physical fitness components and blood lipids in obese girls aged between 10 and 12 years.

METHODS

Participants

In this prospective study, the study group consisted of 39 obese girls aged between 10 to 12 years. They were selected from two elementary schools in Mugla in 2008/2009 season, and were randomly and equally assigned to the exercise (N = 20) and the control groups (N = 19) by using a numbering table for randomization.

General physical examination, blood lipid, body composition,

*Corresponding author. E-mail: ozsaygin@hotmail.com.

flexibility and muscular strength assessment tests were performed for all participants both before and after 12 week exercise program. Participants and their parents were informed about this study's aims and details. Informed consent was given and signed to their parents at the beginning of the study.

Measurements and tools

All the measurements were performed 3 days before the exercise treatment and 2 days after exercise program terminated for both (exercise/control) groups.

Height and weight

Height (without shoes) was measured by one investigator to the nearest 0.1 cm with the portable height measure (Seca, Marsden, UK). Weight (in light clothing) was measured to the nearest 0.1 kg on medical scales (Seca 770, Marsden, UK).

The BMI was calculated as weight/height^2 (kg/m^2).

Body composition measurements

All measurements were made on the right side of the body. Caliper was placed 1 cm away from thumb and finger, perpendicular to skin fold, and halfway between crest and base of fold and left for 1 to 2 s (and not longer) before reading the caliper. Duplicate measures were taken at each site.

Body fat percentage

Body fat percentage was calculated by using Durnin-Womersley Formula for kids as follows:

Boys: $D = 1.1553 - 0.0643 \times X$

Girls = $1.1369 - 0.0598 \times X$

$\text{Logx} = (\text{Biceps} + \text{Triceps} + \text{Subscapular} + \text{Suprailiac})$

$$\% \text{ Fat} = \frac{(4.95 - 4.5)}{\text{BD}} \times 100$$

Aerobic fitness test

In this study Max.VO₂ was calculated by 20 m shuttle run test was used to determine aerobic fitness level (Tomkinson et al., 2003; Saygin et al., 2009; Yoshida et al., 1986).

Heart rate

Resting heart rate was measured in the morning immediately after the participants were awake. Measurement was taken from the radial artery with forefinger and the middle finger of the right hand placed horizontally across the subject's wrist while sitting on the chair. After that, the number of pulse beats multiplied by two to give the 1 min heart rate.

Blood pressure: It was measured by using sphygmomanometer and stethoscope. The cuff was normally placed smoothly and snugly around an upper arm, at roughly the same vertical height as the heart while the subject was seated with the arm supported. The systolic blood pressure and diastolic blood pressure were recorded.

Blood lipids measurements: Blood samples were drawn in a medical center in the morning after participants had their breakfast. Low density lipoproteins (LDL), high density lipoproteins (HDL), total cholesterol (TC) and triglycerides measurements were performed by physicians by using Beckman Coulther STKS device.

Flexibility

Flexibility was measured by the "sit-and-reach" test (Clark et al., 1989). After a warm-up, the participants sat on the floor with their legs straight out in front of them, heels touching the side of a box. Their fingertips were positioned on the 0 cm edge of the box that was marked in centimeters towards the opposite edge. They were then asked to bend forward with arms outstretched towards their toes. The farthest test score of the three trials was recorded. The sit-and-reach test was conducted to measure flexibility of the hamstrings and lower back.

Muscle strength and endurance tests

1 min sit-up test

The subjects lied on their back, with their knees at right angles (90°) and feet flat on the floor. The subject was then attempted to perform one complete sit-up during 1 min. Number of performed sit-ups was counted (Sparling, 1997; Zorba, 2000).

Handgrip strength test

The handgrip strength of the right and left hands was evaluated using a Takei handgrip dynamometer (Takei, Tokyo, Japan). The test was performed in the standing position. The subject held the dynamometer in the hand to be tested with the arm at right angles and the elbow by the side of the body. Subject was then asked to squeeze the dynamometer with her maximum isometric effort for a 5 s period. Test was repeated 2 times with both hands. 30 s resting intervals were provided between measurements and the highest score was recorded (ACSM, 2000).

Protocol of aerobic exercise training

Subjects in the exercise group were performed aerobic exercises at an intensity of 50 to 60% of their target heart rates. Training was performed three days in a week during 12 week each 60 to 90 min period. During the first 5 training days, nutrition knowledge which is about how subjects consume fluid and caloric facts of nutrients was given to all subjects at the beginning of each exercise session. Each exercise class started with 10 to 12 min warming-up exercises and ended with 8 to 10 min cooling down exercises.

The exercise intensity and target heart rate was determined by using Karvonen method for each subject individually.

Max. heart rate = $220 - \text{age}$

Target HR = $\%HR (\text{Max HR} - \text{Resting HR}) + \text{Resting HR}$ (Tamer, 1996)

Subjects in the control group were instructed to continue their normal routine and not participate in any formal exercise program for the duration of the 12-week portion of the study.

Statistical analyses

SPSS 15.0 Statistical package was used for analyzing data.

Table 1. Aerobic exercise program.

Week	1	2	3	4	5	6	7	8	9	10	11	12
Training duration (min)	50+20 (20 min nutrition)	50+2 (20 min nutrition)	60	65	70	75	80	85	90	90	90	90
Training intensity (%)	20	25	30	35	40	45	45	50	55	55	60	60
Training frequency (Dy/W)	3	3	3	3	3	3	3	3	3	3	3	3

Differences between groups were evaluated with independent t-tests and pre-test and post test differences was compared with paired t-tests ($p < 0.05$).

RESULTS

In the baseline measurements, the mean height of exercise group was 142.84 ± 9.32 , while the mean height of control group was 142.00 ± 6.59 (Table 2).

Paired sample t-tests results revealed significant differences from pre-test to post-test measurements in the exercise group for weight, BMI, flexibility, sit-ups, hand grip for both hands, Max.VO₂, skinfold measurements (thigh, triceps, biceps, abdomen, suprailiac, subscapula, chest, body fat percentage, resting heart rate, HDL, LDL, total cholesterol, and triglycerides ($p < 0.001$)) scores. Furthermore, systolic and diastolic blood pressure scores were also significantly decreased in the exercise group from pre-test to post-test measurements ($p < 0.05$).

In control group, however, there were significantly negative changes in all variables (weight, BMI, flexibility, sit-ups, hand grip for both hands, Max.VO₂, skinfold measurements (thigh, triceps, biceps, abdomen, suprailiac, subscapula, chest, body fat percentage, resting heart rate, HDL, LDL, total cholesterol, and triglycerides) (Table 1).

DISCUSSION

The main finding of this study was that 12 weeks of aerobic training improved flexibility, sit-ups, hand grip for both hands, VO_{2max} and impaired LDL, total cholesterol in obese girls. These results were also in line with the previous literature that found improvements in health related parameters of obese participants as a result of regular exercise participation (Haslofça, 2000; Korsten et al. 2007; Steinbeck, 2001; Karacabey, 2009). Moreover, similar results have been reported in adults (Dengel et al., 1998; Wong et al., 2008).

In a recent study, for example, conducted by Wong et al. (2008), the effects of a 12-week exercise training on some health parameters of 13 to 14 years old obese boys were examined. In addition to typical physical education sessions, subjects participated in a combination of circuit based resistance and aerobic exercises 2 times in a week to monitor changes in aerobic fitness, body composition and serum C-reactive protein (CRP) and lipids levels. The results indicated that exercise training significantly improved lean muscle mass, body mass index, fitness, resting HR, systolic blood pressure and triglycerides in the exercise group. Similar results were also found in this present study.

In another study by Nassis et al. (2005), the effect of aerobic exercise training on insulin sensitivity in overweight and obese girls (N = 19) were examined. Body composition and blood lipids and lipoproteins were assessed before and after 12 weeks of aerobic training. They reported that cardiorespiratory fitness increased by 18.8% ($p < 0.05$) as a result of training. They also concluded that 12 weeks of aerobic training improved insulin sensitivity in overweight and obese girls without any significant changes in body weight, body fat percent and circulating concentrations of adiponectin, IL-6, CRP, and other inflammatory markers. In our study, on the other hand, we found that body fat percentage significantly decreased after 12 weeks aerobic exercise. The reason for this differentiation might be longer duration for exercise application and different population in our study.

Although the majority of studies have found just an inverse relationship between physical activity and body fatness in children, some studies found positive relationships. Saygin and Dukkanci (2009) have clearly documented this inconsistency in the current literature that 78% of studies found that there was negative relationship while 4% of studies found that there was positive relationship between physical activity level and body fatness. 18% of these studies also found no relationship (Saygin and Dukkanci, 2009). In our study, it was found that there were significant differences in body mass index, flexibility, back strength, number of sit ups,

Table 2. Changes in the health related physical fitness parameters and blood lipids in exercise and control group.

Variable	Exercise group (n = 20)			Control group (n = 19)		
	Pre-test	Post-test	p	Pre-test	Post-test	p
Weight (kg)	53.31±10.13	50.71±10.84	0.00	52.65±4.34	53.71±4.23	0.00
BMI (cm)	25.91±2.14	23.93±2.30	0.00	26.11±1.36	26.24±1.53	0.49
Flexibility(cm)	21.32±5.23	24.80±6.12	0.00	19.11±3.85	18.85±3.93	0.09
Sit-up (number/60 s)	11.61±9.67	23.84±6.76	0.00	9.44±6.59	8.22±5.91	0.03
RHandgrip (kg)	16.87±4.62	19.09±4.96	0.00	14.67±2.72	15.68±2.73	0.00
LHandgrip (kg)	15.60±4.94	17.07±4.91	0.00	13.46±3.34	14.44±3.31	0.00
Max. VO ₂ (ml/kg/min)	26.92±3.63	34.44±3.15	0.00	28.49±1.98	27.76±2.03	0.14
Tigh (mm)	29.53±2.29	26.90±2.22	0.00	28.04±2.56	29.05±2.45	0.00
Triceps (mm)	23.50±3.96	21.08±3.71	0.00	26.33±2.76	27.00±2.71	0.00
Biceps (mm)	20.13±4.18	17.39±4.48	0.00	22.74±2.62	23.62±2.64	0.00
Abdomen (mm)	28.43±2.62	23.93±2.39	0.00	29.40±2.58	31.46±2.48	0.00
Suprailiac (mm)	26.24±1.86	23.63±2.12	0.00	28.91±1.70	30.94±1.57	0.00
Subscapula (mm)	24.95±4.45	21.41±5.05	0.00	25.81±1.98	27.56±2.36	0.00
Chest(cm)	22.42±3.34	20.26±3.41	0.00	22.93±2.50	24.06±2.77	0.00
BFP (%)	31.35±1.48	29.64±1.98	0.00	32.58±0.97	33.24±0.97	0.00
RHR (Beat/min)	93.84±9.97	88.46±8.17	0.00	92.66±8.39	94.22±8.77	0.01
SBP (mmHg)	12.49±1.54	12.16±1.03	0.17	13.26±0.67	13.51±0.84	0.02
RHR (mmHg)	7.53±0.76	7.66±0.44	0.35	7.68±0.59	7.86±0.63	0.11
HDL (mg/dl)	43.32±8.40	52.61±8.05	0.00	43.82±4.92	41.68±4.48	0.00
LDL (mg/dl)	105.93±21.14	92.89±14.12	0.00	93.17±8.96	97.03±10.82	0.03
Total cholesterol (mg/dl)	110.07±39.48	95.78±33.04	0.00	113.96±23.78	117.14±24.39	0.00
Triglycerides (mg/dl)	165.82±27.42	140.60±21.56	0.00	150.84±18.03	153.52±17.70	0.00

p<0.05.

right and left hand handgrip strength, and Max.VO₂ values between the exercise and the control group (p<0.05). Korstn et al. (2007) investigated the effects of aerobic exercise on obese children (N = 49) aged 8 to 12 years. They found that there was significant decrease in BMI and significant increase in their aerobic capacity (p<0.001). In another study by Haslofca et al. (2000) was reported that summer sports school which was performed during 6 weeks five days in a week had positive effects on physical fitness parameters of aged 6 to 13 years children.

Conclusion

As a conclusion, it was determined that regular and long term aerobic exercises had positive effects on physical fitness values and blood lipids of obese girls. Moreover, further research is needed to understand the effects of exercise in detail and to alleviate the struggle of obesity in children.

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