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The Effects of 8-Week Aerobic Training Program on Respiratory and Circulatory Parameters of Female Swimmers Between 12-14 Years Old

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Abstract

The purpose of this study is to investigate the effect of 8-week aerobic training program on respiratory and circulatory parameters in female swimmers between 12-14 years old. A total of 22 female swimmers, who were between 12-14 years old and joined to the national competitions in the province of Gaziantep, participated as volunteers. The subjects were randomly divided into two groups as experimental group (n=11, age:13.12±0.69) and control group (n=11, age:12.56±0.53). Aerobic training program was applied to the experimental group 3 days a week for 8 weeks. Both groups continued their regular swimming trainings. Resting heart rate (RHR), systolic blood pressure (SBP), diastolic blood pressure (DBP) measurements of the subjects were performed as circulatory parameters before and after training. These values were measured by Omron M6 Comfort device. Measurements of vital capacity (VC), forced vital capacity (FVC), forced expiratory volume (FEV1) and forced expiratory rate (FEV1/FVC) were performed as respiratory parameters. These values were measured by M.E.C. Pocket Spiro USB-100 instruments. For statistical analysis of data, Paired Sample t test was used for intra-group comparisons, and the Independent Sample t test was used for inter-group comparisons. The level of significance was determined as $p<0.05$. In the study we performed, the values of RHR, SBP, DBP, VC, FVC, FEV1 and FEV1/FVC were found to be significant after the aerobic training program applied to the experimental group ($p<0.05$). The circulatory parameters of the control group showed significance at $p<0.05$ level in RHR value. There was no significant difference between SBP and DBP values ($p>0.05$). The respiratory parameters of the control group were significant in FVC and FEV1 values ($p<0.05$). There was no significant difference between VC and FEV1/FVC values ($p>0.05$). As a result, it is thought that aerobic trainings have positive effects on respiratory and circulatory parameters in swimmers. It can be said that regular aerobic training improves respiratory and circulatory parameters.

Keywords: aerobic training, respiratory parameters, swimming

1. Introduction

Swimming is one of the popular and important olympic sports with respect to health in the world. Scientific researches on swimming sport performance are of great importance. While children regulate social relationships through sport, they also gain self-esteem, friendship, and competence ability by developing basic motor skills such as strength, speed and endurance. Among the sport activities aiming the mental, psychological, social and physical-physiological development of the individual, swimming branch has a great importance (Sevim, 2002; Urartu, 1995). The fact that the age of starting to training is rather small is very important in terms of acquiring lifelong sport habit of the individual. For this reason, the trainings to be done during childhood are very important for children. At the same time, at such a crucial period, unforeseeable consequences may arise due to the erroneous applications of physical activities and exercises (Brooke &Stensel, 2008). A well-established swimming activity ensures that the cardiovascular and respiratory system develops at a high level. The breathing movement during a swimming sport leads to a limited amount of breathing, increases the lung capacity along with the frequency of movement and provides continuous oxygen uptake. Both aerobic and anaerobic outcomes can be achieved with a single activity (Dolunay, 2017). The efficiency of the respiratory system increases the effectiveness of the individual. While aerobic exercises, especially endurance activities, do not affect individuals up to 10 years of age, aerobic activities performed in adolescence; that is, in the period of rapid growth and development, have highly positive effects (Rowland, et al., 1997). Aerobic exercises have a very crucial role in the child's physical and cognitive development, the establishment of social relations and managing the relations. Many physical activities are known to benefit children and adolescents. Aerobic activities are frequently recommended for healthy physical growth and cognitive development of developing children (Brooke &Stensel, 2008). In this study, the aim is to demonstrate the effect of the 8-week aerobic training program on the respiratory and circulatory parameters of the female swimmers.

2. Method

2.1 Subjects

A total of 22 female swimmers who are between 12-14 age range, joined to the national competitions and are training regularly participated in the study as volunteers. Individuals were divided into two groups randomly as the experimental group (n=11, age:13.12±0.69) and the control group (n=11, age:12.56±0.53). An aerobic training program for 3 days a week for 8 weeks was applied to the experimental group. Both groups continued their regular swimming trainings. It was drawn attention to that the age and anthropometric characteristics of the participants are close to each other. Information indicating that the research is in conformity with the ethics committee was reported to Gaziantep University Clinical Research Ethics Committee Presidency. Ethics Committee Approval was obtained. Detailed information about the study was gave to the the subjects participating in the study by Subject Disclosure Form. Volunteer consent form and certificate of parental permission were obtained from the subjects by using "Child Informed Consent Form for Research Purposes".

2.2 Research Protocol

Subjects were randomly divided into two groups as the experimental group and the control group. For the experimental group, aerobic training program was applied for 3 days a week in addition to regular swimming training for 8 weeks. The control group continued swimming training only and did not perform any other training. Pre-test measurements were taken 3 days before the aerobic training and the final test measurements were taken 3 days after the aerobic training. The subjects were not subjected to an additional nutritional program but both groups were informed about feeding before and after the training. Moreover, they were also expressed about the necessities of not performing the activities they need to spend a high level of physical effort, except for their trainings. The anthropometric, respiratory and circulation parameters of the participants were measured at Physiology Laboratory of Gaziantep University Physical Education and Sports High School.

2.3 Aerobic Training Program

For the experimental group, aerobic training program was applied for 3 days a week in addition to regular swimming training for 8 weeks. The control group continued swimming training only and did not perform any other training. Aerobic trainings were held 3 days a week. For the experimental group, an aerobic training program composed of firstly 10 min of general warm-up and then 3-minute interval running program at 70% of the maximal heart rate for 4 times was applied. Three-min jog was applied at 30% intensity of the maximal heart rate between each run (Helgerud, et al., 2001). The target heart rate, which is the factor determining 70% of the subjects' training intensity, was determined by heart rate reserve (Garber, et al., 1992). After aerobic training, 5-minute cooling exercises were applied. For the intensity of the training, a 15-second count was made immediately after the end of the training by touching the carotid artery of the neck with the sign and middle fingers. The obtained value was multiplied by 4 to calculate one-minute heart rate (Garber, et al., 1992; Günay, et al., 2006).

2.4 Anthropometric Measurements

Body heights and weights were measured by using device with N.A.N. brand. Subjects were measured in shorts, t-shirts and bare feet, and the body heights and weights were measured in cm and kg, respectively.

2.5 SBP and DBP Measurements

Resting heart rate (RHR), systolic blood pressure (SBP), diastolic blood pressure (DBP) measurements of the subjects were performed as circulation parameters before and after the training. These values were measured with Omron M6 Comfort device.

2.6Respiratory Parameter Measurements

Respiratory parameter measurements were realized by using M.E.C. Pocket Spiro USB-100 device. During the measurement, the subjects were wanted to wear sports clothes. Information about the measurement was given to the subjects. It was said that a maximal effort was required to make the measurement results accurate. Measurements were taken when the subject was sitting. A separate mouthpiece was used for each individual. The subject’s nose was covered with a plug and the mouthpiece usage was provided so that there was no gap in the mouth edges. During the measurements, the subject was motivated by voice.

VC measurement: The subject made gentle inspiration maximally after 3-time normal ventilation together with the signal, again expired slowly all the air in the lungs after filling the lungs with air and completed the measurement (Günay, et al., 2006).

FVC measurement: After the subject normally breathes three times during the test, the measurement was completed by rapid and deep expiration after a deep and strong maximal inspiration. FVC, FEV1 and FEV1/FVC values were obtained by this test (Miller, et al., 2005).

2.7 Data Analysis

Statistical analyzes of the data obtained were performed with SPSS (SPSS for Windows, version 22.0, SPSS Inc. Chicago, Illinois, USA) statistics program. Mean and standard deviation values were used as descriptive statistics. Shapiro-Wilk test was applied to determine whether the data was normally distributed and homogeneous before examining the statistical procedures. Independent Samples T Test was used to assess the significance between the experimental and control groups. Paired Samples T Test was applied for intra-group comparisons. Statistical results were analyzed at the significance level of $p<0.05$.

3. Results

Table 1. Pre-test and post-test analysis results of the experimental group

Variable	Pre-test Mean ± SD	Post-test Mean ± SD	df	t	p
Age (year)	13.12 ± 0.69	13.12 ± 0.69	10	-	-
Height (cm)	152.44 ± 9.49	152.44 ± 9.49	10	-	-
Weight (kg)	42.33 ± 6.24	42.33 ± 6.24	10	-	-
RHR (beat/min)	86.49 ± 11.32	77.12 ± 12.54	10	4.62	**0.001***
SBP (mmHg)	115.46 ± 8.46	106.51 ± 6.63	10	3.42	**0.001***
DBP (mmHg)	76.52 ± 10.42	66.63 ± 7.12	10	1.005	**0.012***
VC (lt)	2.85 ± 0.51	3.12 ± 0.45	10	-4.61	**0.001***
FVC (lt)	3.12 ± 0.54	3.45 ± 0.52	10	-11.92	**0.001***
FEV1 (lt)	2.58 ± 0.62	3.09 ± 0.71	10	-8.46	**0.001***
FEV1/FVC (%)	82.61 ± 2.63	90.12 ± 3.12	10	-4.04	**0.001***

*($p<0.05$)

Table 1 provides a comparison of pre-test and post-test measurement results of the data obtained after the aerobic training program applied to the experimental group. After the aerobic training program applied to the experimental group, the values of RHR, SBP, DBP, VC, FVC, FEV1 and FEV1/FVC were found significant ($p<0.05$).

Table 2. Pre-test and post-test analysis results of the control group

Variable	Pre-test Mean ± SD	Post-test Mean ± SD	df	t	p
Age (year)	12.56 ± 0.53	12.56 ± 0.53	10	-	-
Height (cm)	148.23 ± 4.36	148.23 ± 4.36	10	-	-
Weight (kg)	40.42 ± 3.42	40.42 ± 3.42	10	-	-
RHR (beat/min)	82.28 ± 5.22	79.59 ± 5.36	10	2.34	**0.034***
SBP (mmHg)	107.12 ± 2.23	105.72 ± 2.14	10	1.12	0.146
DBP (mmHg)	71.93 ± 5.12	69.12 ± 4.54	10	1.05	0.129
VC (lt)	2.26 ± 0.21	2.39 ± 0.23	10	-1.62	0.219
FVC (lt)	2.44 ± 0.29	2.55 ± 0.12	10	-2.41	**0.034***
FEV1 (lt)	2.10 ± 0.24	2.27 ± 0.27	10	-4.78	**0.022***
FEV1/FVC (%)	87.21 ± 3.06	87.71 ± 1.52	10	-1.12	0.152

*($p<0.05$)

Table 2 provides a comparison of pre-test and post-test measurement results of the control group. RHR, FVC and FEV1 values of the control group were found to be significant at $p<0.05$ level. There was no significant difference in SBP, DBP, VC and FEV1/FVC values ($p>0.05$).

Table 3. Comparison of the experimental and control groups.

Variable	Experimental Group Difference Mean ± SD	Control Group Difference Mean ± SD	df	t	p
RHR (beat/min)	9.37 ± 5.72	2.69 ± 2.54	20	2.257	**0.022***
SBP (mmHg)	8.95 ± 3.52	1.40 ± 2.94	20	1.856	**0.001***
DBP (mmHg)	9.89 ± 5.52	2.81 ± 2.74	20	3.162	**0.001***
VC (lt)	-0.27 ± 0.45	-0.13 ± 0.12	20	-2.162	**0.016***
FVC (lt)	-0.33 ± 0.09	-0.11 ± 0.08	20	-3.542	**0.001***
FEV1 (lt)	-0.51 ± 0.27	-0.17 ± 0.85	20	-2.251	**0.002***
FEV1/FVC (%)	-7.51 ± 3.62	-0.50 ± 2.51	20	-2.267	**0.026***

*$p<0.05$

The comparison of the measurement results of respiratory and circulatory parameter scores of the experimental and control groups is presented in Table 3. Among the groups, significant differences were found in RHR, SBP, DBP, VC, FVC, FEV1 and FEV1/FVC values in favor of the experimental group ($p<0.05$).

4. Discussion

4.1 Circulatory Parameters

In the study we realized, there was a significant difference in RHR value after the aerobic training program applied to the experimental group ($p<0.05$). Of circulatory parameters of the experimental group, post-test RHR value was found to be significant at $p<0.05$ level. There was a significant difference between the groups with respect to RHR value in favor of the experimental group ($p<0.05$). The studies showing that RHR values decrease together with training are mentioned in the literature (Gücenmez et al., 2017; Ozdal et al., 2013). In the studies perfomed on sportsmen and physical activity, the low pulse, which is influenced by exercise and training, is an important finding. In a study conducted by Daglioglu (2013a), a significant decrease in RHR values of young men was detected after 8 weeks of submaximal aerobic exercise (Daglioglu, 2013a). In a different study, after 8 weeks of swimming training, RHR value of the experimental group was 83.10±6.70 beats/min in pre-test while the value decreased to 74.70±4.30 beats/min in post-test (Gökhan et al., 2013). In another study involving table tennis players aged 14-15 years, RHR value was found to be 77.50 beats / min (Çimen, et al., 1997). Ersöz et al. (1996) found in their study that RHR value significantly decreased with training during the season (Ersöz, et al., 1996). In our study, significant reductions in RHR values were obtained in both groups. The decrease in RHR value in the experimental group is thought to be due to the hypertrophy that occurs in the left ventricle of the heart. The decrease in the control group can be attributed to regular swimming training. The fact that the decrease in the experimental group is higher than that of the control group is thought to be caused by the swimming training combined with the aerobic training. The results in the literature and the results of our work are parallel. In the study we conducted, the values of SBP and DBP were found to be significant after the aerobic training program applied to the experimental group ($p<0.05$). There was no significant difference between SBP and DBP values of the control group ($p>0.05$). In comparison between the groups, there was a significant difference in the values of SBP and DBP in favor of the experimental group ($p<0.05$). Blood pressure values vary with age. A systolic blood pressure value of less than 90 mmHg in children starts to increase after adolescence. As the age increases, it can increase up to 150 mmHg. The normal values of diastolic blood pressure range from 60 to 90 mmHg (Kürkçü&Gökhan, 2011). Many studies have shown that blood pressure values fall with regular exercise (Gücenmez et al., 2017 ; Daglioglu, 2013 (b) ; Puffer, 2001 ; Hung, 2004). Harre (1982) stated that SBP and DBP could be 110 mmHg and 70 mmHg for children aged 11-14 years, respectively (Harre, 1982). Arida and colleagues (1996) obtained significant differences in DBP values in their study in which 12-week aerobic training program was used (Arida et al., 1996). Stewart and colleagues (2005) applied aerobic exercise in the study they conducted and obtained significance for SBP and DBP values in favor of post-test at the end of the program (Stewart, et al., 2005). The results in the literature and the results of our work are parallel. In our study, aerobic exercise resulted in significant reductions in systolic blood pressure and diastolic blood pressure in the experimental group, and this is thought to be due to increased pressure on the blood vessels during exercise. Our work supports the literature.

4.2 Respiratory Parameters

In the study we performed, there was a significant difference in VC, FVC, FEV1 and FEV1/FVC values after 8-week aerobic training program applied to the experimental group ($p<0.05$). FVC and FEV1 values were found to be significant as respiratory parameters of the control group ($p<0.05$). There was no significant difference in VC and FEV1/FVC values ($p>0.05$). VC, FVC, FEV1 and FEV1/FVC values were found significant between the groups in favor of the experimental group ($p<0.05$). During physical activity and exercise, the need of the muscles to O_2 increases. For an increasing need for O_2, a harmonization occurs in the respiratory system. Pulmonary functions depend on the type of exercise performed, the development of the respiratory muscles, the expandability of the lungs and thorax, and the flexibility of the bronchi and bronchioles (Gözü, et al., 1988). Vital capacity and forced vital capacity, which are pulmonary functions, are interpreted as normal by 80% and upper of the expected value for each individual according to age, height, gender and body weight (Weinberger & Drazen, 1998). FEV1 value under 80% points an anormality in expiration (Tamer, 1995). Pherwani et al. (1989) found that 45 swimmers performing regular swimming training on a daily basis had higher values of VC, FVC, and FEV1 than the control group (Pherwani et al., 1989). Kubiak (2005), found statistical significance in VC, FEV1 and FVC values of the swimmers between ages 12-14 as a result of a 6-month study (Kubiak, 2005). Doherty and Dimitriuo (1997) compared VC, FVC, and FEV1 values of athlete, swimmer, and sedentary individuals, and found that values were higher in the swimmers and athletes than in the control group (Doherty & Dimitriou, 1997). Kesavachandran et al. (2005) found statistically significant differences between pre-test and post-test measurements of VC and FVC values of the swimmers between ages 8-12 at different swimming styles (Kesavachandran, et al., 2005). In a study conducted, an increase in the FEV1% of the field hockey players was found after 8 weeks of aerobic training program (Ozdal et al., 2013). The values of respiratory parameters obtained in our study and the information in the literature are parallel. Considering the effects of 8-week aerobic training program on the experimental group in our study, it is found that aerobic training applied with swimming training is positively related to respiratory parameters. Since swimming is performed in a horizontal position, air enters the upper part of the lungs, too. Therefore, VC shows better development than that of sportsmen in other sport branches. It can be said that the experimental group performing aerobic training and regular swimming training 3 times a week for 8 weeks improved the respiratory parameters more than the control group performing only swimming training. This development in the breathing parameters of the experimental group is thought to be due to strengthen respiratory muscles and increased pulmonary capacity as a result of the enhancement of respiratory volume by aerobic exercise performed in addition to swimming training.

As a result, it can be said that 8-week aerobic training program applied to female swimmers between 12-14 years affects the circulatory and respiratory parameters positively. It is suggested that aerobic exercise programs should be included in the annual training planning regularly and plannedly, together with swimming training for the development of high performance, circulatory and respiratory parameters in swimming sports.

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