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ORIGINAL ARTICLE

The Effect of Regular Exercises on Aerobic and Anaerobic Capacity Development

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ABSTRACT
Exercise is a planned, structured and repeated form of physical activity with the aim of improving health or wellness. As the intensity, extent and length of exercise changes, its effect on metabolism also changes. The aim of the study is to investigate the effects of regular exercise on the development of aerobic and anaerobic capacity. Nine women and 14 men with a mean age of 19.17 ± 0.98 years, who had previously been involved in different sports branches (volleyball, handball, football and athletics) participated in this study. Participants applied a special exercise program for aerobic and anaerobic capacity development for six months. Before starting the exercise program of the participants, their height, body weight, 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump measurements were made. The training effect was observed by repeating the measurements every month. Descriptive analyses, Repeated Anova and Paired Sample T Tests were used for statistical evaluation. Bonferroni Analysis, one of the Post-Hoc Tests, was performed to determine the differences between the data ($p<0.005$). Statistically significant differences were found between the results of the 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump test results in the first month of the participants and the same test results at the end of the 6th month ($p<0.001$). There were statistically significant differences between the 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump test results repeated every month ($p<0.001$, $p<0.005$). It was concluded that the exercise program applied had a positive effect on the development of aerobic and anaerobic capacity.
Keywords: Sports performance, exercise effect, aerobic capacity, anaerobic capacity.

INTRODUCTION
Adaptation to training is the sum of the changes that occur with the systematic repetition of the exercises. Athletes who have provided the right training and adequate adaptation show the most improvement in a shorter time (Bompa., 2003). In order for regular exercises or training to improve and strengthen physiological functions in the organism, the intensity, duration and frequency must be planned very well. The amount of adenosine triphosphate (ATP) required for contraction of skeletal muscles during exercise is provided by three different energy transfer systems; 1. Ready energy: ATP-Creatine phosphate (PCr) system 2. Short term energy: Glycolytic energy system 3. Long term energy: Aerobic energy system. The duration and intensity of exercise determines which type of energy system needs to be transferred (McArdle et al.,2000; Foss., & Keteyian., 1998).

Aerobic capacity or aerobic power is the maximal oxygen transport and oxygen utilization capacity of muscle tissue. Aerobic power is also an important index of cardiovascular system capacity (Nagle., 1973). Studies have shown that training programs with an intensity of 80-90% and a duration of 15 minutes-60 minutes applied three days a week have a positive physiological effect on respiratory, circulation and blood parameters (ACSM., 1990). Aerobic capacity can also be defined as the capacity to deliver oxygen to the muscles to be used to create the necessary energy during exercise. Therefore, aerobic capacity depends on the physiological capacities of the lungs, cardiovascular and hematological components and the efficiency of the oxidative mechanisms of the muscles active during exercise. Genetics, fitness level, age, gender, exercise model and body composition can be counted among the factors affecting aerobic power generation (Yıldız., 2012).

The work capacity created by skeletal muscles using anaerobic energy transfer systems during maximal and supramaximal physical activity is defined as "anaerobic capacity". The value of this work per unit time is expressed as “anaerobic power” (kgm/sec, kgm/min, watt). Anaerobic work is a workload above the anaerobic threshold, which means the demonstration of explosive power, and is a type of physical activity that manifests itself with fatigue. In maximal activities of less than ten seconds, the required energy is provided by the phosphogen system. Anaerobic activity cannot be continued for a long time (Yıldız., 2012). If the duration of the activity lasts for 8 seconds to 3-5 minutes (such as 100 m swimming, 200-400 m brisk walking), the energy obtained by the reduction of glycogen to lactate by anaerobic metabolism and anaerobic glycolysis (lactic acid system) is used (McArdle et al.,2000; Åstrand., & Rodahl., 1986).

It is very difficult to think of anaerobic and aerobic systems independently of each other during training. However, by looking at the intensity and duration of the activity, information can be given about which system is dominant. As physiological systems, these elements are independent. However, they are related to each other within the activity (Şenel., 1995). Although the dominance rates differ according to the branches, aerobic and anaerobic capacity is very important in the development of people who do sports. Determination of performance is the most important element of sportive success. In order to understand how effective the training program is in the development of people who do sports, measurements should be made regularly. An effective test program reveals the strengths and weaknesses of people who do sports. Training should be planned according to these results.

Performance tests provide preliminary information about the future performance of individuals, identifying weaknesses, measuring development, evaluating the success of training programs, determining the appropriate training method for individuals and providing motivation. Regular physical and physiological tests are the most basic measurements that give an idea about the performance level of people who do sports / exercise. Therefore, the aim of the study is to investigate the effects of regular exercise on the development of aerobic and anaerobic capacity.

METARIAL AND METHODS

Participants: Nine women and 14 men with a mean age of 19.17 ± 0.98 years, who had previously been involved in different sports branches (volleyball, handball, football and athletics) participated in this study.

Procedure: All participants applied a special exercise program for aerobic and anaerobic capacity development 4 days a week for 6 months (24 weeks). Considering the adaptation process in the first week, the exercise program was started with aerobic endurance exercises. Exercise program; It had a content such as endurance, speed, strength, quick strength training for the development of aerobic and anaerobic capacity. The training intensities were continued separately for men and women and adjusted according to the development levels of the participants.

Measures: Before starting the exercise program of the participants, their height, body weight, 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump measurements were made. The training effect was observed by repeating the measurements every month.

The height of all participants was measured with an ultrasonic height meter (Langen Messstab 5003, Germany). Body weights were determined with a body analysis scale (Tanita BC 401, Japan).

30-Meters Run Test: The time to cover the distance between the start and finish lines on a 30-meters track was measured in seconds (sec). The measurement was made with an electronic stopwatch (Casio HS-70W-1DF, Tokyo, Japan). The participant took a position behind the determined starting line so that his feet would not touch the line, and time was started with the first movement of his back foot. The timer was stopped when the chest crossed the finish line.

60-Meters Run Test: The time to cover the distance between the start and finish lines on a 60-meters track was measured in sec. The measurement was made with an electronic stopwatch (Casio HS-70W-1DF, Tokyo, Japan). The participant took a position behind the determined starting line so that his feet would not touch the line, and time was started with the first movement of his back foot. The timer was stopped when the chest crossed the finish line.

20-Meters Shuttle Run Test: This test measures aerobic power, which is also used synonymously with cardiovascular endurance. Cardiovascular endurance, or aerobic fitness, the ability to continue exercise without fatigue is an important component of motor performance. A person's aerobic fitness level depends on the amount of oxygen carried by the body to the working muscles and the ability of the muscles to use this oxygen. This test is used to estimate a person's maximal oxygen consumption (MaxVO2). The test consists of 23 levels and each level takes 1 minute. It starts at 8.5 km/h and includes a series of shuttles that increase 0.5 km/h at each level. One beep from the audio system indicates the shuttle is finished and 3 beeps indicate the next level starts. Participants warmed up for 5-10 minutes before the test. At the end of each shuttle, they were asked to put their feet above or beyond the 20 m line. If the participant reached the end of the shuttle before the beep, he was asked to wait for the beep and continue running. The test was terminated when the participant failed to catch the shuttle 2 or 3 times in a row. Level and number of shuttles noted. MaxVO2 values were calculated according to the formula below (Leger., & Lambert., 1982).

MaxVO2=5.857x — 19.458 (x= The speed at which the test ended)

Vertical Jump Test: Participants were asked to jump vertically upwards and their best scores from two attempts were recorded in centimeter (cm). The measurement was made by jumping from the crouching position. Before the test, the participant's feet were asked to be on the ground. The participant raised his arm closest to the wall and the distance reached by his middle finger was marked. The participant made a splash with chalk or paint and touched the highest point he could reach. The distance was recorded as the jump height.

Statistical Analysis: SPSS 23.0 program (SPSS Inc., Chicago, IL) was used for statistical analysis of the study. Mean body weights and heights were calculated by descriptive statistical analysis. Whether the data showed normal distribution or not was analyzed with the Shapiro-Wilk Test. Comparison analysis of the data before and after the exercise program was performed with the Paired-Sample T Test. Measurement data repeated every month was analyzed with the Repeated Anova Measures Test. Bonferroni Analysis, one of the Post-Hoc Tests, was performed to determine the differences between the data. Statistical significance level was accepted as $p<0.005$.

RESULTS

The comparison data of height, body weight, 30-meters run test, 60-meters run test, 20-meters shuttle run test and vertical jump test results measured in the first and last month of the exercise program of all participants are shown in Table 1.

According to the results of the Paired-Sample T-Test analysis, statistically significant differences were found between the results of 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump measured in the first month and the results measured in the last month. The 30 and 60-meters run tests results measured in the sixth month were significantly lower than the data measured in the first month ($p=0.000$; Table 1). MaxVO2 and vertical jump values of the participants in the last month were found to be significantly higher than in the first month ($p=0.000$; Table 1).

Repeated Anova and Post-Hoc Analysis data of 30-Meters and 60-Meters Run Test measurement data repeated every month are shown in Tables 2 and 3, respectively.

As shown in Table 2, significant differences were found between the results of the 30-meters run test, between the 1st month and all months, and between the 6th month and all months ($p<0.005$, $p<0.001$). In addition, between the 2nd month test results and the 1st 4th 5th month, between the 3rd month and the 1st and 6th month, between the 4th month and the 1st and 2nd month, between the 5th month and the 1st and 6th month differences between were significant ($p<0.005$, $p<0.001$).

There was a significant difference between the 60-meter running test results between the 1st month and all months, and between the 6th and the 1st, 2nd, 3rd and 4th months (Table 3; $p<0.001$). There was a significant difference between the 2nd month test results and the 1st and 6th month results, between the 3rd month test results and the 1st and 6th month results, and between the 4th month test results and the 1st and 6th months. (Table 3; $p<0.001$). There was no significant difference between the results of the 5th month test results and the results in any month.

Repeated Anova and Post-Hoc Analysis data of the monthly 20 Meter Shuttle Run and Vertical Jump Test measurement data are shown in Tables 4 and 5, respectively.

Table 1. Paired-Sample T-Test analysis of participants' first and last month data.

(N= 23)		x̄ and SD	t	p
Height (cm)	1st Mth	170.70 ± 8.51	-2.152	0.043
	6th Mth	170.87 ± 8.45		
Body Weight (kg)	1st Mth	63.35 ± 12.64	0.979	0.338
	6th Mth	62.61 ± 10.86		
30-Meters Run (sec)	1st Mth	4.29 ± 0.56	7.217	0.000*
	6th Mth	4.11 ± 0.53		
60-Meters Run (sec)	1st Mth	8.73 ± 0.94	7.192	0.000*
	6th Mth	8.54 ± 0.98		
20-Meters Shuttle Run ($MaxVO_2$)	1st Mth	65.04 ± 13.61	-10.850	0.000*
	6th Mth	80.74 ± 12.57		
Vertical Jump (cm)	1st Mth	44.26 ± 8.39	-6.111	0.000*
	6th Mth	50.30 ± 5.93		

Note: N; Number of participant, x̄ and SD; Mean ± Standard Deviation, Mth; Month. *p<0.001, **p<0.005.

Table 2. Inter-month analysis of 30-Meters RunTest data.

30-Meters Run (sec)				
(N= 23)	x̄ and SD	F	p	Post Hoc Benforroni Test
1st Mth	4.29 ± 0.56	13.705^b	0.000*	1-2*, 1-3*, 1-4*, 1-5*, 1-6*
2nd Mth	4.27 ± 0.57			2-1*, 2-4*, 2-5**, 2-6*
3rd Mth	4.24 ± 0.56			3-1*, 3-6*
4th Mth	4.21 ± 0.56			4-1*, 4-2*, 4-6**
5th Mth	4.15 ± 0.54			5-1*, 5-2**, 5-6**
6th Mth	4.11 ± 0.53			6-1*, 6-2*, 6-3*, 6-4**, 6-5**

Note: N; Number of participant, x̄ and SD; Mean ± Standard Deviation, Mth; Month. *p<0.001, **p<0.005.

Table 3. Inter-month analysis of 60-Meters RunTest data.

60-Meters Run (sec)				
(N= 23)	x̄ and SD	F	p	Post Hoc Benforroni Test
1st Mth	8.73 ± 0.94	15.065^b	0.000*	1-2*, 1-3*, 1-4*, 1-5*, 1-6*
2nd Mth	8.69 ± 0.95			2-1*, 2-6*
3rd Mth	8.66 ± 0.96			3-1*, 3-6*
4th Mth	8.63 ± 0.96			4-1*, 4-6*
5th Mth	8.61 ± 1.01			-
6th Mth	8.55 ± 0.98			6-1*, 6-2*, 6-3*, 6-4*

Note: N; Number of participant, x̄ and SD; Mean ± Standard Deviation, Mth; Month. *p<0.001.

Table 4. Inter-month analysis of 20-Meters Shuttle Run ($MaxVO_2$) data.

20-Meters Shuttle Run (MaxVO2-mL/kg/min)				
(N= 23)	x̄ and SD	F	p	Post Hoc Benforroni Test
1st Mth	65.04 ± 13.61	20.705^b	0.000*	1-2**, 1-3*, 1-4*, 1-5*, 1-6*
2nd Mth	69.26 ± 13.08			2-1**, 2-3**, 2-4**, 2-5*, 2-6*
3rd Mth	73.22 ± 13.59			3-1*, 3-2**, 3-6*
4th Mth	75.35 ± 13.83			4-1*, 4-2**, 4-5**, 4-6**
5th Mth	78.35 ± 12.85			5-1*, 5-2*, 5-4**
6th Mth	80.74 ± 12.57			6-1*, 6-2*, 6-3*, 6-4**

Note: N; Number of participant, x̄ and SD; Mean ± Standard Deviation, Mth; Month. *p<0.001, **p<0.005.

Table 5. Inter-month analysis of Vertical Jump Test data.

Vertical Jump (cm)				
(N= 23)	x̄ and SD	F	p	Post Hoc Benforroni Test
1st Mth	44.26 ± 8.39	8.288b	0.000*	1-2**, 1-3*, 1-4**, 1-5*, 1-6*
2nd Mth	46.22 ± 7.70			2-1**, 2-3**, 2-4**, 2-5**, 2-6**
3rd Mth	47.91 ± 7.17			3-1*, 3-2**
4th Mth	48.30 ± 6.83			4-1**
5th Mth	49.57 ± 6.65			5-1*, 5-2**
6th Mth	50.30 ± 5.93			6-1*, 6-2**

Note: N; Number of participant, x̄ and SD; Mean ± Standard Deviation, Mth; Month. *p<0.001, **p<0.005.

There was a significant difference between the 1st month and all months, as well as between the 2nd and all months in the 20-Meter Shuttle Run test results (Table 4; p<0.005, p<0.001). There were significant differences between the 3rd month test results and the 1st and 2nd month results, and between the 4th month test results and the 1st, 2nd and 6th month results. The differences between the 5th month test results and the 1st, 2nd and 4th months, and between the 6th month test results and the 1st, 2nd, 3rd and 4th months were also significant (Table 4; p<0.005, p<0.001).

There was a significant difference between the 1st month and all months, as well as between the 2nd and all months in the Vertical Jump test results (Table 5; p<0.005, p<0.001). There were significant differences between the 3rd month test results and the 1st and 2nd month results, and between the 4th month test results and the 1st month results. Finally, there were significant differences between the 5th month test results and the 1st and 2nd month results, and between the 6th month test results and the 1st and 2nd month results (Table 5; p<0.005, p<0.001).

DİSCUSSİON

Twenty three participants with a mean age of 19.17 ± 0.98 years participated in this study, which aimed to examine the effect of regular exercises on the development of aerobic and anaerobic capacity. According to the results of the Paired-Sample T-Test analysis, statistically significant differences were found between the results of 30-meters run, 60-meters run, 20-meters shuttle run and vertical jump measured in the first month and the results measured in the last month. The 30 and 60-meters run tests results measured in the sixth month were significantly lower than the data measured in the first month (p=0.000; Table 1). MaxVO2 and vertical jump values of the participants in the last month were found to be significantly higher than in the first month (p=0.000; Table 1).

In the study of Alan et al., they found that a 12-week submaximal level aerobic training program increased the MaxVO2 values of the participants by 9% (Alan et al., 2000). Chromiak et al. 2004 stated that at the end of the strength training program performed for 4 days a week and for 10 weeks, the anaerobic power and capacity of the participants with an average age of 22.2 years increased (Chromiak et al., 2004). In a study conducted to examine the relationship between anaerobic endurance and vertical jump, it was determined that there was a significant relationship between the anaerobic endurance of athletes and vertical jump performance. In this correlation, it was observed that as the vertical jump performance increased, the anaerobic performance also increased. In addition, it was determined that one unit change in vertical jump affected anaerobic endurance by 21% (Serin, & Taşkın., 2016). In another study examining the effects of 16-week football skill training on the physical, motoric, physiological and skill development of football players, when the pre-test and post-test values of the exercise program were compared; Statistically significant difference was observed in anaerobic endurance values. It was stated that after the skill training applied, there was an increase in the vertical jump test and anaerobic endurance improved (İri et al., 2009). In the study conducted by Çolakoğlu, & Çolakoğlu 1993 a significant relationship was found between alactacid anaerobic power (Margaria-Kalamen anaerobic power) and 30 m sprint time in elite Turkish athletes (r= -0.467, p<.001) (Çolakoğlu, & Çolakoğlu, 1993).

In our study, it was observed that regular exercises increased the aerobic and anaerobic capacities of the participants according to the results of the performance tests, and it is compatible with the literatüre (Alan et al., 2000; Chromiak et al., 2004; Serin, & Taşkın., 2016; İri et al., 2009; Çolakoğlu, & Çolakoğlu, 1993). In addition, the statistical differences between the months in the performance tests repeated every month show that the planned exercise program provides the effect of improving aerobic and anaerobic capacity. Athletes' success is closely related to improving their physical performance. Aerobic and anaerobic capacity, which should be developed according to the characteristics of the sports branch, are the main factors of sportive performance. Trainers should create appropriate training programs by taking into account the physical and physiological characteristics of the athletes. However, physical capacity development is necessary not only for professional athletes but for all people. The lack of physical activity and the sedentary lifestyle of people bring along important health problems such as coronary heart diseases, peripheral vascular diseases and hypertension. By providing physical capacity development together with physical activities to be done, we can protect ourselves against the risks of diseases caused by lack of movement. In addition, when the characteristics of creative and productive individuals in the society are examined, it is seen that they have high physical activity and life levels, and have healthy and regular sports habits (Yorulmaz., 2005).

CONCLUSİONS

The results of this study showed that the exercise program applied improved the aerobic and anaerobic capacities of the participants. It is thought that studies in which different exercise programs are applied and measured with more participants will be beneficial in the future.

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