

The effect of aerobic training program on cardiopulmonary parameters and oxygen saturation in elite judokas

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Abstract

The aim of this study is to examine the effect of aerobic training program on cardiopulmonary parameters and oxygen saturation in elite judokas. Total of 22 male elite judokas, aged between 18 and 25 participated in the study voluntarily. Subjects were randomly divided into two groups as experimental group (n=11, age:21.60±2.06) and control group (n=11, age:20.50±1.77). The experimental group was given an aerobic exercise program for 3 days a week for 8 weeks. Before and after the aerobic exercise program, body weight, body mass index (BMI), body fat percentage (BF%), systolic blood pressure (SBP), diastolic blood pressure (DBP), resting heart rate (RHR), maximal heart rate (HRmax), maximal work rate (WRmax), maximal minute ventilation (VEmax) and maximal oxygen consumption capacity (VO₂max) were measured. Individual oxygen consumption capacities were determined using the Ramp protocol in the gas analysis system. Paired Sample t test was used for intra-group comparison and Independent Sample t test was used for statistical analysis of the data. The level of significance was determined as p<0.05. When the pre-test and post-test results of the aerobic training program applied to the experimental group were compared, p<0.05 significance was found in the experimental group, SBP, DBP, RHR, HRmax, %BF, VO₂max, WRmax, VEmax and SpO₂ values. Significant differences were found between the groups in favor of the experimental group (p<0.05) for SBP, DBP, RHR, HRmax, WRmax, VEmax, VO₂max and SpO₂ values. It can be said that the aerobic training program applied to the judokas has a positive effect on cardiopulmonary parameters and oxygen saturation.

Keywords: Aerobic training, Judo, Cardiopulmonary parameters

INTRODUCTION

Defensive sports have been the interest of researchers as a popular sport. Defensive sports are used by the child or adult for the purpose of self-defense, body development, fitness and discipline (7, 25).

Anthropometric and physiological parameters are of great importance for maximal performance in judo sport (2, 6). VO₂max is considered to be the best value showing cardiovascular performance and aerobic exercise capacity (6).

Cardiopulmonary exercise tests are the most widely used test method to determine exercise performance. In these tests, a gradual stress is applied on the systems with the exercise and the response of the body is evaluated. The parameters used during the evaluation and interpretation of

Subjects

exercise tests give information about the functions of the systems and how these functions are performed (18, 22). In the human body, oxygen is transported in the blood due to large amounts of hemoglobin. Oxygen saturation (SpO₂) is the ratio of oxygen in the blood to hemoglobin (1). The markers that play a role in the oxygenation of the body due to the determining effect of the oxygen content in the blood on aerobic exercises have become an interesting research topic in terms of sports sciences (12).

The aim of this study was to investigate the effect of aerobic training program on cardiopulmonary parameters and oxygen saturation in elite judoists.

MATERIAL and METHOD

A total of 22 male judoist volunteers participated in the study between 18-25 years of age in Gaziantep. The subjects were randomly divided

into two groups as experimental group (n=11, age: 21.60±2.06) and control group (n=11, age: 20.50±1.77). The aerobic exercise program was applied to the experimental group for 3 days during the week for 3 days. Both groups continued their regular judo training. Ethics Committee approval was obtained from Gaziantep University Clinical Research Ethics Committee for the study. The information related to the research was given to the participants. Voluntary form was taken. During the study, they were asked not to take any supplement and to not be able to exercise hard.

Aerobic Training Model

Athletes were subjected to a run training at 70% of the target heart rate, 8 weeks, 3 days a week according to the aerobic training method. The intensity of the exercise was determined according to the karvonen method (12, 21). As a method of aerobic training, 250m (1min'), 400m (2min'), 650m (3min'), 900m (4min') - 650m (3min'), 400m (2min'), 250m (1min') were applied in unit run exercises. Subjects were given a 10 min warm-up exercise before starting the aerobic training, and a 10 min stretching exercise at the end of the aerobic training.

Data Collection

Physical Measurements

The body weights of the athletes were measured with a scale of 0.1 kg and the lengths were measured with a digital height measuring device. Subjects participated in the measurements with sportswear (shorts and t-shirts), and bare feet on the scale. The body fat percentage was calculated using the Yuhasz formula, using the skinfold caliper (Holtain, UK) (12).

Cardiopulmonary Exercise Test

The subjects were subjected to increased cardiopulmonary exercise test (Ramp protocol) on

RESULTS

Table 1 provides a comparison of the pre-test and post-test results of the data obtained after the aerobic training program applied to the experimental group. The experimental group, SBP, DBP, RHR, HRmax, BF%, VO₂max, WRmax, VEmax and SpO₂ values were found to be significant (p<0.05). The body weight and BMI of the experimental group did not show any significance (p>0.05).

the bicycle ergometer (Mec Pft Systems Ergo). The protocol increased 3 minutes of rest, 3 no-load pedals (warm-up) and 25 watts per minute. Pedaling rate was kept constant at approximately 60-70 rpm. The test was continued until the subjects could not tolerate the increased load. As soon as the test was completed, the pedal load was reduced to 25 watts and pedaled for another 3 minutes and the test was completed (3). WRmax, VEmax, HRmax and VO₂max were measured with this test.

Oxygen Saturation (SpO₂)

Oxygen saturation was measured by attaching the Pulse Oximeter to the fingertip while the subject was seated and the right hand side on the desk was facing up. The value that appears on the digital display has been saved.

SBP and DBP Measurement:

Systolic blood pressure, Diastolic blood pressure and resting heart rate measurement were measured digitally. (Omron, M6 Comfort, Omrom Healthcare Co., Ltd. Kyoto, Japan). Two measurements were made with an interval of 1 minute and means of them were recorded.

Statistical Analysis

The Statistical analysis of this study was performed with the help of SPSS statistics program (SPSS for Windows, version 20.0, SPSS Inc. Chicago, Illinois, USA). Shapiro-Wilk test was applied to determine whether the data were normally distributed and homogeneous. Independent Samples T Test was applied for the difference between experimental group and control group. Paired Samples T Test was used to compare the groups. Statistical results were analyzed at p <0.05 significance levels.

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

Variable	Pre-test	Post-test	df	t	p
	Mean ± SD	Mean ± SD			
Age (year)	21.16 ±3.45	21.16 ±3.45	-	-	-
Height (cm)	173.72±5.16	173.72±5.16	-	-	-
Weight (kg)	71.54±3.22	71.11±1.12	10	0.256	0.711
BMI (kg/m ²)	22.16±1.12	22.09±1.24	10	0.211	0.851
BFP (%)	10.44±3.21	9.69±1.73	10	3.511	0.001*
SBP (mmHg)	105.12±4.12	102.24±3.85	10	4.256	0.001*
DBP (mmHg)	69.12±4.12	67.52±3.16	10	3.412	0.001*
RHR (atm/dk)	70.22±2.46	68.12±2.56	10	9.115	0.001*
HRmax(atm/dk)	187.42±4.22	194.12±2.47	10	-8.356	0.001*
WRmax (W)	247.26±15.16	256.12±15.22	10	-5.655	0.012*
VEmax (l/min)	132.16±9.14	135.26±8.24	10	-4.122	0.004*
VO ₂ max (ml/kg/dk)	45.56±3.06	53.12±1.71	10	-7.211	0.001*
SpO ₂ (%)	96.7± 0.12	97.8 ± 1.52	10	-3.127	0.001*

*p<0.05

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

Variable	Pre-test	Post-test	df	t	p
	Mean ± SD	Mean ± SD			
Age (year)	21.72±2.11	21.72±2.11	-	-	-
Height (cm)	175.09±2.16	175.09±2.16	-	-	-
Weight (kg)	74.17±2.95	75.12±2.52	10	-0.623	0.696
BMI (kg/m ²)	22.74±2.08	22.96±1.04	10	-0.254	0.653
BFP (%)	11.74±1.56	10.57±3.41	10	0.623	0.041*
SBP (mmHg)	112.00±8.09	110.91±6.87	10	2.269	0.032*
DBP (mmHg)	71.12±2.34	70.08±1.60	10	0.185	0.002*
RHR (atm/dk)	70.69±1.42	69.50±1.22	10	1.124	0.025
HRmax(atm/dk)	185.66±2.46	186.00±2.21	10	-1.478	0.363
WRmax (W)	239.54±10.45	243.08±9.12	10	-1.690	0.072
VEmax (l/min)	130.33±5.12	131.52±4.21	10	-0.296	0.452
VO ₂ max (ml/kg/dk)	44.22±1.56	45.32±1.69	10	-2.789	0.151
SpO ₂ (%)	97.11 ± 0.89	97.52 ± 1.12	10	-2.175	0.322

*p<0.05

Table 2 provides a comparison of the pre-test and post-test results of the control group. Significant values were found in the control group, RHR, SBP,

DBP and BF% values of p<0.05. There was no significant difference in the other data of the control group (p>0.05).

Table 3. Comparison of experimental and control groups

Variable	Experimental Group		Control Group		df	t	p
	Difference		Difference				
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD			
Weight (kg)	0.43 ± 1.18	-0.95 ± 0.44	20	2.136	0.213		
BMI (kg/m ²)	0.07 ± 0.52	-0.22 ± 0.41	20	1.356	0.512		
BFP (%)	0.75 ± 0.92	1.17 ± 1.05	20	2.162	0.057		
SBP (mmHg)	2.88 ± 3.52	1.09 ± 1.56	20	2.542	0.032*		
DBP (mmHg)	1.60 ± 0.97	1.04 ± 1.03	20	1.221	0.044*		
RHR (atm/dk)	2.10 ± 0.63	1.19 ± 1.02	20	2.114	0.001*		
HRmax(atm/dk)	-6.70 ± 2.45	-0.34 ± 1.19	20	-5.412	0.001*		
WRmax (W)	-8.86 ± 3.63	-3.54 ± 3.21	20	-3.863	0.001*		
VEmax (l/min)	-3.10 ± 1.64	-1.19 ± 1.85	20	-2.157	0.003*		
VO ₂ max (ml/kg/dk)	-7.56 ± 2.11	-1.10 ± 1.58	20	-7.765	0.001*		
SpO ₂ (%)	-1.10 ± 0.59	-0.41 ± 1.14	20	-2.245	0.042*		

*p<0.05

Table 3 presents the comparison of measurement results after cardiopulmonary exercise test applied to the experimental and control groups. Among the groups, significant differences were

found in SBP, DBP, RHR, HRmax, WRmax, VE_{max}, VO₂max and SpO₂ values in favor of the experimental group (p<0.05). There was no

significant difference in Weight, BMI and BF% values ($p>0.05$).

DISCUSSION

Cardiopulmonary Parameters

Cardiopulmonary exercise tests allow for individual's strength status and the solution of problems according to organism's response to the stress applied to the individuals in changing workloads. At the same time, they are important in terms of meeting increased energy need and continuing to the exercise during exercise (24).

$VO_2\max$ has an important role in long-term physical activities (19). It has been reported that breathing is accelerated during the aerobic exercise, and the heart starts to be stronger and faster (4, 23). VE_{\max} values are known to increase with exercise (16). However, in subjects with regular training, the increase in VE is less during exercise than sedentary.

In our study, $VO_2\max$, VE_{\max} , WR_{\max} , SBP, DBP, RHR and HR_{\max} values were found to be significant at $p<0.05$ level after the aerobic training program of the experimental group. RHR SBP and DBP values of the control group were significant at $p<0.05$ level. No other significance was found in the other data of the control group ($p>0.05$). Among the groups, $VO_2\max$, VE_{\max} , WR_{\max} , SBP, DBP, RHR and HR_{\max} values were found to be significant in favor of the experimental group ($p<0.05$).

Ingham et al. (2007) Olympic and club-level rowing athletes examined the amount of oxygen consumption in their work, the club athletes $VO_2\max$ value of 55.6 ± 1.2 , the Olympic athletes have determined the $VO_2\max$ value of 61.1 ± 0.6 ml/kg/min (14). In a study on badminton players, $VO_2\max$ values were 61.8 ± 5.9 in males and 50.3 ± 4.1 ml/kg/min in females (11). In a study conducted on footballers, after 8 weeks of aerobic exercise program, WR_{\max} , VE_{\max} and $VO_2\max$ parameters were found statistically significant in experimental group (13). It is known that VE_{\max} value increases with training and exercises (16). However, VE increase is lower in the individuals who exercise regularly than ones living sedentarily at rest and during low intensity exercise. In another study, a statistically significant difference was found between BMI, DBP, $VO_2\max$ and WR_{\max} values after the cardiopulmonary exercise test applied to the experimental and control groups. VE_{\max} values were increased in favor of the experimental group (10).

In our study, the experimental group reached a larger workload (WR_{\max}) and increased $VO_2\max$ in the cardiopulmonary exercise test performed after the aerobic exercise program according to the control group. Therefore, it can be said that the $VO_2\max$ value of the experimental group is higher than the control group after the aerobic exercise program. It can be said that VE_{\max} is higher in favor of the experimental group and that the volume of breath is increased in the experimental group.

As the body starts to respond to heart rate, stroke volume and blood pressure increase. As the exercise continues, the heart rate, blood pressure and heart rate are fixed, the number of respiration increases (4).

In a study conducted, 8-week submaximal aerobic exercise applied to young males found a significant decrease in RHR values (9). In another study on handball players, a significant decrease in RHR values was obtained as a result of the aerobic training program (15).

In our study, there were significant decreases in the number of heart rates in the experimental group as a result of aerobic exercise. It can be said that this condition is due to hypertrophy in the left ventricle of the heart. Significance was not found in the control group. The results of our study are parallel with the literature.

Stewart et al. (2005) had the subjects make aerobic exercise and obtained significance SBP and DBP values in favor of the post- test at the end of program in their study (20). In a study conducted on swimmers, there was a significant decrease in DBP values (10). There are many studies that found a decrease in SBP and DBP values after training and aerobic exercise (5, 9, 13).

In our study, as a result of aerobic exercise in the experimental group, significant decreases were obtained in SBP and DBP values. This result can be said to increase the pressure in the blood vessels during exercise.

Oxygen Saturation

In the human body, oxygen is transported in the blood due to large amounts of hemoglobin. Oxygen saturation (SpO_2) is the ratio of oxygen in the body to hemoglobin in the body (1).

In a study conducted on young male individuals, a significant increase was found in SpO₂ values after 8 weeks of submaximal aerobic exercise (9). In another study, it was determined that short-term exercise decreased oxygen saturation in football players (8). In a study to investigate the effect of aerobic training on SpO₂, an increase of 97.85±0.88% was obtained from 97.23±0.93% of the SpO₂ values of the experimental group (17). In our study, there was a significant increase in SpO₂ values of the experimental group after 8 weeks of aerobic training program. We think that the increase in SpO₂ values is due to the increase in blood hemoglobin level due to the effect of training as a result of the development of respiratory muscles.

CONCLUSION

As a result, it can be said that 8-week aerobic training program applied to elite judokas affects the cardiopulmonary parameters and oxygen saturation positively. It is suggested that aerobic exercise programs should be included in the annual training planning regularly and planned, together with judo training for the development of high performance, cardiopulmonary parameters and oxygen saturation in judo training.

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