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The effects of respiratory muscle training on aerobic, anaerobic and respiration parameters

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ABSTRACT

This study was conducted to search the effect of respiratory muscle training on aerobic, anaerobic endurance, and respiratory parameters in primary school students. 32 volunteer students, between the ages of 13-14, participated in this study. The volunteers were divided into experimental (n = 15) and control groups (n = 17). The experimental group participated in the football training of the school team three days a week, with two hours of physical education lessons in a week. Also, respiratory muscle training was applied with the Powerbreathe device for 5 weeks, five days a week in the morning and evening. The control group only participated in the football training of the school team three days a week, with two hours of physical education lessons in a week. Physical measurements, pulse, systolic-diastolic blood pressure, oxygen saturation, lung volume and capacity, aerobic and anaerobic capacity, and inspiratory pressure were measured before and after the study. Physical measurements has been determined that there are differences in the values of FAT, BMR, anaerobic power and MaxVO$_2$, respiratory parameters, systolic and diastolic blood pressure ($p < 0.05$). It was observed that Inspiratory pressure measurement values were found to be statistically significant ($p < 0.05$). As a result, it can be said that five-week respiratory muscle training positively affects aerobic and anaerobic endurance, respiratory functions, respiratory muscle strength of primary school students compared to students who do regular training.

Keywords: Respiratory, training, aerobic, anaerobic, students.

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INTRODUCTION

The main purpose of children playing games should be to have fun and have a pleasant time, as well as to strengthen the heart-circulatory and respiratory systems, to develop motor characteristics such as nerve-muscle coordination, flexibility, strength, and endurance, to bring an individual who is physically and mentally healthy and whose infrastructure is ready for the sport she/he will do. The respiratory system is important for providing the necessary oxygen to the organism. Our circulatory system can only carry as much oxygen as the respiratory system can bring into the organism. We can supply oxygen to the tissues by working together with the respiratory and circulatory systems (Akgün, 1992). The ages when the respiratory system develops best is between 12 and 13 years. Children are more likely to adapt to overloads than adults (Mengütay, 2005). During the training and match, athletes breathe thousands of times with all other skeletal muscles. Also, oxygen is needed for the respiratory muscles to function properly (Amonette and Dupler, 2002). During heavy exercise, the respiratory system can negatively affect the exercise performance of our bodies by causing shortness of breath and respiratory muscle fatigue (Hajghanbari e al., 2013). Powerbreathe (The respiratory muscle device) is a recently developed device. The mode of operation is the respiratory muscle device that is electronically controlled and includes different resistance modes of operation. It is known that respiratory muscle fatigue has a negative effect on exercise performance in healthy people. In many studies conducted to reduce low performance, it has been explained that the respiratory muscle training method increases the exercise tolerance of individuals and increases the endurance of the inspiratory muscles, and causes the delay of respiratory muscle fatigue (Thomas, 2000). It will be easier for athletes to have a strong respiratory system and respiratory muscle, to overcome the intense training load applied (Öncen, 2018). As special respiratory muscle training may cause an increase in respiratory muscle function (Langer et al., 2015). Respiratory muscle training can supply an ergogenic contribution to the athlete. The increased resistance and strength in the respiratory muscle prevents the mechanisms that cause the respiratory muscle fatigue of the athletes and causes an increase in the performance of the athletes (Hajghanbari et al., 2013). When the studies on respiratory muscle training were analyzed, they stated that there was an increase in exercise performance and pulmonary (lung) functions in some studies, while other similar studies in this area stated that there was no change in breathing (ventilatory) and performance (Sheel, 2002).

There was no study on healthy individuals in this age group. Our general aim in our study is to determine the effect of primary school students on aerobic, anaerobic, and respiratory parameters after respiratory muscle training.

MATERIALS AND METHODS

Research group

Eighth-grade students, studying the secondary school in Kayseri province İncesu Kızılören Parlaklar Secondary School, voluntarily participated in this study. Before participating in the study, the content of the study was explained to the volunteers participating in the study, and informed consent forms were taken from the students and their parents.The informed consent form was obtained to enable students under the age of 18 to participate in the study with the permission of their parents.The students, participating in the study were divided into experimental and control groups as randomly. The experimental group participated in the football training of the school team three days a week, with two hours of physical education lessons in a week.The subjects included in the annual plan (basketball, volleyball) were told in the physical education lesson.

Also, respiratory muscle training was applied with the Powerbreathe device, five days a week in the morning and evening. The control group only participated in the football training of the school team three days a week, with two hours of physical education lessons in a week. The control group did not participate in respiratory muscle training. The study was conducted for five weeks. Two measurements were obtained as pre-test and post-test. All measurements taken within the scope of the study were made in the schoolyard.

Inspiratory muscle training device (powerbreathe plus)

The Powerbreathe respiratory muscle device is an inspiratory muscle training method applied to increase the strength and endurance of the muscles that individuals use to breathe (Figure 1). By strengthening the respiratory muscles, it provides resistance against fatigue in exercises. Resistance to fatigue occurs with the decrease of shortness of breath and increase in exercise tolerance after respiratory muscle training is provided (Powerbreathe, 2016). It is an inspiratory muscle training device specially used in endurance training. Powerbreathe device allows hand-held and provides gradual training. We need to adjust the tension of the spring and make sure that the hatch is opened in order to do the training. The Powerbreathe device should think of it as weight training for the respiratory muscles for those who will do the work. Repetition and intensity should be applied gradually, for the improvement of respiratory muscles (McConnell, 2011).

Measurement methods

Measurement of body composition

Identity information was used to determine the age of the volunteers who participated in the study. The volunteers' height (cm) was measured with a meter with an accuracy of 1 cm, as bare feet, feet flat on the ground, heels together, knees stretched and body in an upright position. Bodyweight, body fat percentage, body fat mass, lean body mass, total body fluid, body mass index, basal metabolic rate was measured with Tanita TBF (Japan) body fat analyzer. Measurements were done with the shorts and t-shirt. Volunteers' clothes were assumed as 0.5 kg (Özer, 2001).

Measurement of respiratory functions

Spirolab III branded spirometer device (İtalya, Medical International Research) was used to measure respiratory parameters. In the spirometer measurements, the noses of the subjects were closed with a latch and the results were recorded by reading from the digital display of the spirometer, following the maximum forcing exhalation after maximum breathing. Spirometric measurements were taken while the subject was sitting (Kürkçü and Gökhan, 2011).

Figure 1. Powerbraethe plus red.

Forced vital capacity (FVC)

Volunteer; at first s/he inspired and expired normally. S/He made a strong maximal inspiration. S/He exhaled as fast as possible for 6 seconds.

Slow vital capacity (SVC)

Volunteer; s/he inspired and expired normally at four times. S/He inspired as deep as possible. S/He expired slowly.

Maximum voluntary ventilation (MVV)

After the inspiration and expiration normally (three times), volunteer inspired and expired as deep and fast as possible. After the finishing guidance, the airflow data, obtained by stopping record, were recorded. The software automatically recorded the volume and data to the device based on the recorded air data (Pina et al., 1995).

Heart rate measurement

Heart rate was determined with the stethoscope and meter. The diaphragm of the stethoscope was placed in the volunteer sitting position, slightly below his/her left breast and towards the armpit. Lap and dap sounds were listened during 15 seconds and both sounds were considered as a number. After 15 seconds, the number of heartbeats per minute was determined by multiplying by four (Günay et al., 2013).

Blood pressure measurement

Omron brand (Omron M6, Kabushiki-gaisha, Japonya) fully automatic blood pressure meter was used for systolic and diastolic blood pressure measurements of volunteers.

In digital blood pressure measurement from the wrist of the volunteers, without using muscle strength, the device measuring from the wrist, supported by any item or other arm, was measured by holding it at heart level on the chest. The volunteers' blood pressures were measured with comfortable clothing in a noiseless and temperature-friendly environment, taking care not to be hungry, avoiding exercise and caffeinated drinks half an hour before the measurement, without crossing their legs, and resting for at least 5 minutes.

Respiratory muscle measurement

Respiratory muscle measurement, after the device was turned on and training mode was selected, the volunteer's nose was closed with a clip. The volunteer breathed until he heard the beep sound, and after the beep sound, he breathed 30 breaths. Results obtained automatically appeared on the information screen of the device (Powerbreathe, 2016).

Oxygen saturation measurement

Oxygen saturation was measured with the Nellcor Purıtan Bennett Npb-40 (Nellcor, ABD) brand pulse oximeter (PO_2) device from the left index finger.

20 meters shuttle run

Test was applied in the schoolgarden. A 20 m straight track was prepared and funnels were placed at the start and end points of the track. The volunteers were told that they should be within two meters of the start and finish lines when they heard each beep. The test started at 8 km/hour and increased by 0.5 km/hour every minute. At the end of each shuttle, it is stated from the volunteers that they should be at the start and finish lines. Every signal that the volunteer has trained is marked as a shuttle, and every shuttle that the volunteer could not reach is marked as an error. The test was terminated when the volunteer made two mistakes in a row (Meredith, 1992).

Calculation of aerobic power

There is a level form for the volunteers to be evaluated on the 20-meter shuttle table. When the volunteer completed each 20-meter running line, a sign was ticked on the evaluation form. In the test result, it was calculated by looking at the signs that the volunteers received as a result of the test, and the $MaxVO_2$ values of the volunteers were determined as an estimate in ml/kg/min from the evaluation table (Günay et al., 2013).

Vertical jumping test

The vertical jumping test was determined by measuring the distance between the extreme point that the volunteers could reach by extending their arms (soles of the feet on the ground) and the extreme point they could reach by jumping. The volunteers were asked to jump up with a pair of feet by taking power from the arms and legs by bending the knees and touching the high point as much as they could touch. Volunteers repeated this practice twice. The best result from the two applications was evaluated in the study. The jump distances were determined by subtracting the first measurement value from the distance touched by jumping (Kamar, 2008).

Calculation of anaerobic power

The anaerobic power calculation was made with the Lewis formula given below:

$P = (\sqrt{4.9}*\text{bodyweight} \sqrt{D}$
P = vertical jumping
D = vertical jumping distance (as a meter)

Respiratory muscle training program

Respiratory muscle training was applied to the volunteers on the same days in the morning and evening, respectively:

1st day: Powerbreathe device, at level 0, 30 dynamic breathing-out
2nd day: Powerbreathe device, at level 1, 30 dynamic breathing-out
3rd day: Powerbreathe device, at level 2, 30 dynamic breathing-out

Respiratory muscle training continues by increasing 1 level every day. However, ıf the volunteer has a hard time breathing in-out, the power breath device will continue to work by reducing one level. The 30 dynamic breathing levels that she does easily will determine the level of the volunteer in the study to be done. Each volunteer whose level was determined was given respiratory muscle training for 5 weeks, 5 days in a week, and morning and evening, together with the level of the device increased by 1 level. No respiratory muscle training was applied to the control group.

Football training program

The football training program is shown in Table 1.

Statistical analysis

SPSS 22.0 statistic program was used in the data analysis. The data obtained in the study were presented as arithmetic mean (X) and standard deviation (SD). Normality distribution was analyzed with the Kolmogorov-Smirnov test. Since the data showed normal distribution, an independent sample t-test was used for comparison of independent groups, and paired sample t-test was used for comparison of dependent groups. The significance level of the data was taken as $p < 0.05$.

Table 1. Football training program.

Training day and hour	Monday (01.00 p.m – 02.30 p.m)	Wednesday (01.00 p.m – 02.30 p.m)	Friday (01.00 p.m – 02.30 p.m)
1 week	15 minutes warm-up, direction, and speed change training, running practice, soccer game, 10 minutes cooling down exercises.	15 minutes of technical warm-up with the ball, in-foot, inside-upper, on the foot, with the outer upper kick techniques, 10 minutes cooling exercises	15 minutes warm-up, shooting training, tactical play, 10 minutes cooling down exercises
2.week	15 minutes warm-up, attacking jogging with the action of taking the floor, soccer game, 10 minutes cooling down exercises	15 minutes of technical warm-up with the ball, face-to-face, lateral and front-back and blocking and marking exercises, 10 minutes cooling exercises	15 minutes warm-up, coordination training, tactical play, 10 minutes cooling down exercises
3.week	15 minutes warm-up, speed change action jogging training, soccer game, 10 minutes cooling down exercises	15 minutes technical warm-up exercises with the ball, trick exercises without ball, 10 minutes cooling exercises	15 minutes warm-up, coordination enhancing movements, technical exercises in the football game, 10 minutes cooling exercises
4.week	15 minutes warm-up, straight and turn-around running training, football match, 10 min cool-down exercises	15 minutes technical warm-up, crown and corner exercises, 10 minutes cooling exercises	15 minutes warm-up, slolom and shot exercises, flexibility exercises, 10 minutes cool-down exercises
5.week	15 minutes warm-up, football match,10 minutes cool-down exercises	25 minutes technical warm-up, standing ball exercises, 10 minutes cooling exercises	20 minutes warm-up, football match,10 minutes cool-down exercises

FINDINGS

As a result of the dependent sample t-test, it was seen that the difference in body weight and BMR values of the experimental group within the group was statistically significant ($p < 0.05$), but there was no statistically significant difference in other parameters ($p > 0.05$). It seemed that there was a statistically significant difference ($p < 0.05$) in BMR values in the control group, but there was no statistically significant difference in other parameters ($p > 0.05$) (Table 2).

As a result of the dependent sample t-test, it was seen that there was a statistically significant difference ($p < 0.001$) in the MaxVO$_2$ and anaerobic power values of the experimental group, but there was no statistically significant difference in other parameters ($p > 0.05$). In the control group, a significant difference was observed in systolic-diastolic blood pressure, MaxVO$_2$, and anaerobic power values ($p < 0.05$), while no significant difference was observed in pulse and oxygen saturation values ($p > 0.05$) (Table 3).

As a result of the dependent sample t-test in Table 4, it was seen that there was a statistically significant difference in the power ($p < 0.001$), flow ($p < 0.001$), and total energy values of the experimental group in Powerbreathe measurements ($p < 0.05$). While a statistically significant difference was observed in the power value in the control group ($p < 0.001$), it was observed that there was no significant difference in flow and total energy values ($p > 0.05$).

In the dependent sample t-test performed within the group, the difference in the FVC, FEV1, PEF, MVV, and VC values of the experimental group was found to be statistically significant ($p > 0.05$). It seemed that there was no significant difference ın the other parameters ($p > 0.05$).

While a statistically significant difference was observed in the FEV1, PEF, and MVV values of the control group ($p < 0.05$), it has seemed that there was no significant difference in other variables ($p > 0.05$) (Table 5).

As a result of the independent sample t test in Table 6, there was no statistically significant difference in the values obtained from the pre-test-post-test measurements ($p > 0.05$).

As a result of the comparison of independent samples t test posttest measurements, while a significant difference was observed in systolic-diastolic blood pressure and MaxVO$_2$ values ($p < 0.05$), a statistically significant

Table 2. Comparison of physical properties of in-group students.

Parameter		EG (n = 15)			CG (n = 17)		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
Age	Pre-test	13.33 ± 0.48			13.47 ± 0.51		
	Post-test	13.33 ± 0.48			13.47 ± 0.51		
Height (cm)	Pre-test	153.00 ± 5.27			155.52 ± 8.14		
	Post-test	153.00 ± 5.27			155.53 ± 8.14		
Weight (kg)	Pre-test	42.60 ± 6.69	2.978	**0.010***	44.70± 7.59	-0.675	0.509
	Post-test	41.53 ± 5.99			44.94 ± 7.57		
Body fat index (fat)	Pre-test	13.34 ± 7.47	1.483	0.160	14.38 ± 6.63	0.654	0.522
	Post-test	13.16 ± 7.25			14.27 ± 6.88		
Body fat mass (fat mass)	Pre-test	6.08 ± 3.93	-0.096	0.925	6.74 ± 3.59	-1.679	0.113
	Post-test	6.04 ± 3.94			7.03 ± 3.70		
Lean body mass (ffm)	Pre-test	36.91 ± 4.31	-0.760	0.460	37.88 ± 5.28	-0.935	0.363
	Post-test	37.06 ± 4.17			38.02 ± 5.59		
Total body liquid (Tbw)	Pre-test	27.03 ± 3.16	0.778	0.449	28.03 ± 4.44	0.787	0.443
	Post-test	26.58 ± 3.76			27.67 ± 5.48		
Body mass index (kg/height^2)	Pre-test	18.31 ± 2.47	-1.485	0.160	18.84 ± 2.74	0.954	0.354
	Post-test	18.4 ± 2.47			18.75 ± 2.68		
Basal metabolism rate (bmh)	Pre-test	1354.93 ± 113.15	-3.326	**0.005***	1381.94 ± 151.02	-2.384	**0.032***
	Post-test	1361.27 ± 111.67			1391.41 ± 158.94		

EG: experimental group; CG: control group; cm: centimeter; kg: kilogram; FAT: Body fat index; FAT MASS: Body fat mass; FFM: Lean body mass; TBW: Total body liquid; BKI: body mass index; BMH: basal metabolism rate. $p < 0.05$*, $p < 0.001$***.

Table 3. Comparison of physiological properties of in-group students.

Parameter		EG (n = 15)			CG (n = 17)		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
Pulse (beat/minute)	Pre-test	80.33 ± 10.70	-0.847	0.411	88.18 ± 7.81	0.959	0.352
	Post-test	80.80 ± 11.62			87.76 ± 7.65		
Systolic blood pressure (mmHg)	Pre-test	106.20±18.87	1.700	0.111	111.00 ± 13.85	-3.810	**0.002***
	Post-test	111.67±11.77			121.65 ± 7.03		
Diastolic blood pressure (mmHg)	Pre-test	64.53± 14.96	-2.090	0.055	75.29 ± 16.61	-2.874	**0.011***
	Post-test	71.13 ± 8.47			83.41 ± 12.56		
Oxygen saturation (%)	Pre-test	95.27 ± 4.06	1.334	0.203	96.71 ± 2.11	0.808	0.431
	Post-test	94.27 ± 5.24			96.47 ± 1.87		
MaxVO$_2$ (ml/kg/dk)	Pre-test	36.06 ± 7.92	-12.717	**0.001*****	30.8529 ± 8.37	-2.731	**0.015***
	Post-test	40.08 ± 8.22			32.0471 ± 8.68		
Anaerobic power (Watt)	Pre-test	18.91 ± 1.79	-5.386	**0.001*****	18.7958 ± 1.53	-3.616	**0.002***
	Post-test	19.41 ± 1.81			19.0232 ± 1.63		

EG: experimental group; CG: control group; pulsation: rate of heart beating in a minute; mmHg: milimeter mercury; Watt: the amount of produced energy per unit of time; MaxVO$_2$: maximum oxygen consumption. $p < 0.05$*, $p < 0.001$***.

Table 4. Comparison of powerbreathe K5 measurements of in-group students.

Parameter		**EG (n = 15)**			**CG (n = 17)**		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
Power (Watt)	Pre-test	2.44 ± 0.96	-9.481	**0.001*** **	1.68 ± 1.27	-4.301	**0.001*** **
	Post-test	5.40 ± 1.56			2.65 ± 0.85		
Flow (Litre/second)	Pre-test	1.67 ± 0.38	-7.432	**0.001*** **	1.21 ± 0.63	-0.282	0.781
	Post-test	2.39 ± 0.51			1.24 ± 0.28		
Total Enerji (Joules)	Pre-test	54.56 ± 19.85	-3.093	**0.008***	34.32±17.11	1.502	0.153
	Post-test	61.47 ± 16.36			37.21±12.42		

EG: experimental group; CG: control group; Watt: the amount of produced energy per unit of time; Joules: energy unit; p < 0.05*, p < 0.001***

Table 5. Comparison of respiratory function values of in-group students.

Parameter		**EG (n = 15)**			**CG (n = 17)**		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
FVC (L)	Pre-test	2.83 ± 0.45	-3.112	**0.008***	2.63 ± 0.62	1.925	0.072
	Post-test	2.98 ± 0.40			2.62 ± 0.64		
FEV1 (L)	Pre-test	2.21 ± 0.49	-3.217	**0.006***	2.07 ± 0.63	2.755	**0.014***
	Post test	2.26 ± 0.46			2.04 ± 0.63		
FEV/FVC (%)	Pre-test	81.46 ± 5.44	0.968	0.349	78.7 ± 6.04	**0.000**	1.000
	Post-test	80.93 ± 6.31			78.7 ± 6.00		
PEF (L/sn)	Pre-test	3.58 ± 1.45	-2.691	**0.018***	3.15 ± 1.19	2.404	**0.029***
	Post-test	3.95 ± 1.24			3.13 ± 1.20		
MVV (L/dk)	Pre-test	94.89 ± 17.09	-3.823	**0.002***	94.25 ± 19.29	2.423	**0.028***
	Post-test	100.58 ± 17.08			93.08 ± 19.25		
VC	Pre-test	2.79 ± 0.50	-3.716	**0.002***	0.73 ± 0.61	1.618	0.125
	Post-test	2.94 ± 0.42			0.73 ± 0.65		
ERV (L)	Pre-test	0.88 ± 0.26	1.241	0.235	2.53 ± 0.31	-0.606	0.553
	Post-test	0.86 ± 0.25			2.47 ± 0.32		

EG: experimental group; CG: control group; FVC: forced vital capasity; FEV1: air volume ejected in the first second of forced expiration; PEF: peak expiratory flow rates; MVV: maximum voluntary ventilation: VC: vital capasity; ERV: expiratory resudual volume. p < 0.05*, p < 0.001***.

difference was not found in other parameters (p > 0.05). While there was a significant difference in the heart rate values in the pretest measurements (p < 0.05), it seemed that there was no significant difference in the other variables (p > 0.05) (Table 7).

As a result of the comparison of independent sample t-test posttest measurements, it seemed that there was a significant difference in power, flow, and total energy values (p < 0.001). In the pre-test measurements, while there was a statistically significant difference in flow and total energy values (p < 0.05), it seemed that there was no significant difference in power value (p > 0.05) (Table 8).

As a result of the comparison of independent samples t test posttest measurements, while there was a statistically significant difference in VC values (p < 0.05), no significant difference was found in other parameters (p > 0.05). It was seen that there was no statistically significant difference in the values obtained from the pretest measurements (p > 0.05) (Table 9).

Table 6. Comparison of students' physical properties of between groups.

Parameter		Pre-test (n = 15)			Post-test (n = 17)		
		x ± ss	t	p	x ± ss	t	p
Age	Experimental	13.33 ± 0.48	-0.771	0.447	13.33 ± 0.48	-0.771	0.447
	Control	13.47 ± 0.51			13.47 ± 0.51		
Height (cm)	Experimental	153.00 ± 5.27	-1.026	0.313	153.00 ± 5.27	-1.026	0.313
	Control	155.52 ± 8.14			155.53 ± 8.14		
Weight (kg)	Experimental	42.60 ± 6.69	-0.827	0.415	41.53 ± 5.99	-1.398	0.172
	Control	44.70± 7.59			44.94 ± 7.57		
Body fat index (fat)	Experimental	13.34 ± 7.47	-0.421	0.677	13.16 ± 7.25	-0.444	0.662
	Control	14.38 ± 6.63			14.27 ± 6.88		
Body fat mass (Fat Mass)	Experimental	6.08 ± 3.93	-0.501	0.623	6.04 ± 3.94	-0.701	0.488
	Control	6.74 ± 3.59			7.03 ± 3.70		
Lean body mass (ffm) (ffm**)**	Experimental	36.91 ± 4.31	-0.563	0.577	37.06 ± 4.17	-0.546	0.589
	Control	37.88 ± 5.28			38.02 ± 5.59		
Total body liquid (Tbw)	Experimental	27.03 ± 3.16	-0.725	0.474	26.58 ± 3.76	-0.647	0.523
	Control	28.03 ± 4.44			27.67 ± 5.48		
body mass index (kg/height^2)	Experimental	18.31 ± 2.47	-0.574	0.57	18.4 ± 2.47	-0.378	0.708
	Control	18.84 ± 2.74			18.75 ± 2.68		
basal metabolism rate (bmh)	Experimental	1354.93 ± 113.15	-0.566	0.576	1361.27 ± 111.67	-0.613	0.545
	Control	1381.94 ± 151.02			1391.41 ± 158.94		

cm: centimeter; kg: kilogram; FAT: body fat index; FAT MASS: body fat mass; FFM: lean body mass; TBW: total body liquid; BKI: body mass index; BMH: basal metabolism rate. $p < 0.05$*, $p < 0.001$***.

Table 7. Comparison of students' physiological properties of between groups.

Parameter		Pre-test (n = 15)			Post-test (n = 17)		
		x ± ss	t	p	x ± ss	t	p
Pulse (beat/minute)	Experimental	80.33 ± 10.70	-2.388	**0.023***	80.80 ± 11.62	-1.973	0.060
	Control	88.18 ± 7.81			87.76 ± 7.65		
Systolic blood pressure (mmHg)	Experimental	106.20 ± 18.87	-0.827	0.415	111.67 ± 11.77	-2.863	**0.009***
	Control	111.00 ± 13.85			121.65 ± 7.03		
Diastolic blood pressure (mmHg)	Experimental	64.53 ± 14.96	-1.915	0.065	71.13 ± 8.47	-3.194	**0.003***
	Control	75.29 ± 16.61			83.41 ± 12.56		
Oxygen saturation (%)	Experimental	95.27 ± 4.06	-1.233	0.232	94.27 ± 5.24	-1.543	0.141
	Control	96.71 ± 2.11			96.47 ± 1.87		
MaxVO$_2$ (ml/kg/dk)	Experimental	36.06 ± 7.92	1.800	0.082	40.08 ± 8.22	2.677	**0.012***
	Control	30.8529 ± 8.37			32.0471 ± 8.68		
Anaerobic power (Watt)	Experimental	18.91 ± 1.79	0.204	0.839	19.41 ± 1.81	0.648	0.522
	Control	18.7958 ± 1.53			19.0232 ± 1.63		

pulsation: rate of heart beating in a minute; mmHg: millimeter mercury; Watt: the amount of produced energy per unit of time; MaxVO$_2$: maximum oxygen consumption. $p < 0.05$*, $p < 0.001$***.

Table 8. Comparison of students' powerbreathe K5 measurements of between groups.

Parameter		Pre-test (n = 15)			Post-test (n = 17)		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
Power (Watt)	Experimental	2.44 ± 0.96	1.895	0.068	5.40 ± 1.56	6.035	**0.001*** **
	Control	1.68 ± 1.27			2.65 ± 0.85		
Flow (Litre/second)	Experimental	1.67 ± 0.38	2.460	**0.020***	2.39 ± 0.51	7.716	**0.001*** **
	Control	1.21 ± 0.63			1.24 ± 0.28		
Total Energy (Joules)	Experimental	54.56 ± 19.85	3.098	**0.004***	61.47 ± 16.36	4.759	**0.001*** **
	Control	34.32 ± 17.11			37.21 ± 12.42		

Watt: the amount of produced energy per unit of time; Joules: energy unit; $p < 0.05$*, $p < 0.001$***.

Table 9. The comparison of students' respiratory function values of between groups.

Parameter		Pre-test (n = 15)			Post-test (n = 17)		
		x ± ss	**t**	**p**	**x ± ss**	**t**	**p**
FVC (L)	Experimental	2.83 ± 0.45	1.009	0.321	2.98 ± 0.40	1.876	0.070
	Control	2.63 ± 0.62			2.62 ± 0.64		
FEV1 (L)	Experimental	2.21 ± 0.49	0.678	0.503	2.26 ± 0.46	1.099	0.281
	Control	2.07 ± 0.63			2.04 ± 0.63		
FEV/FVC (%)	Experimental	81.46 ± 5.44	1.349	0.187	80.93 ± 6.31	1.022	0.315
	Control	78.7 ± 6.04			78.7 ± 6.00		
PEF (L/sn)	Experimental	3.58 ± 1.45	0.918	0.366	3.95 ± 1.24	1.887	0.069
	Control	3.15 ± 1.19			3.13 ± 1.20		
MVV (L/dk)	Experimental	94.89 ± 17.09	0.099	0.922	100.58 ± 17.08	1.158	0.256
	Control	94.25 ± 19.29			93.08 ± 19.25		
VC	Experimantal	2.79 ± 0.50	1.323	0.196	2.94 ± 0.42	2.351	**0.026***
	Control	0.73 ± 0.61			0.73 ± 0.65		
ERV (L)	Experimental	0.88 ± 0.26	1.452	0.157	0.86 ± 0.25	1.198	0.240
	Control	2.53 ± 0.31			2.47 ± 0.32		

FVC: forced vital capasity; FEV1: air volume ejected in the first second of forced expiration; PEF: peak expiratory flow rates; MVV maximum voluntary ventilation; VC: vital capasity; ERV: expiratory residual volume. $p < 0.05$*, $p < 0.001$***.

DISCUSSION AND CONCLUSION

In this study, a statistically significant difference was observed in body weight and basal metabolic rate values.ın a similar study, it was stated that there was no statistically significant difference in body weight in the experimental and control groups (Kido et al., 2018). After this study, it was explained that there was no significant difference in body weight values in the experimental and control groups (Bağıran et al., 2019). After a similar study, it was said that there was no significant difference in BMH values (Akgül, 2016). At the end of the study on wrestlers, it was stated that there is no statistically significant difference in BMR values (Alpay et al., 2015). The studies conducted are not similar to our study. In another study, when BMR pre-test and post-test values of women who exercise were examined, it was stated that there was a statistical increase in the post-test values (Zileli et al., 2017). The reason for the significant difference in our study may be due to the training program implemented by the students. This study seems to be similar to our study.

In this study, a significant difference was observed in the number of heartbeats in pre-test and post-test measurements. After a continuous exercise, there is a decrease in the number of heartbeats. Therefore, the number of resting heartbeats differs from trained and untrained individuals (Fox et al., 1999). After the study by Ramsook et al., they explained that there is no significant difference in heart rate values (Ramsook et al., 2017). They stated that there is no significant difference in heart rate values after 12 weeks of respiratory muscle training by handball athletes (Hartz et al., 2018). In our study, it is seen that training affects the number of heartbeats. The reason why there was a significant difference in the pre-test measurements of the number of heartbeats of the students may be due to the fact that they came running to the measurements in the school garden between breaks, the excitement during the pre-measurement lesson time, and the social relationship between the boys and girls with their friends in adolescent students.

As a result of our findings, a statistically significant difference was observed in systolic-diastolic blood pressure values. Blood pressure is the pressure the heart exerts on the walls of the veins while it is pumping blood (Günay et al., 2013). It shows that changes in blood pressure, exercise, and body position have pressures exerted on the cardiovascular system (Tamer, 2000). He stated that there was a statistically significant difference between the systolic-diastolic blood pressure values of the 8-week respiratory muscle training performed on tennis players, between measured values at three different times (Köroğlu, 2020). In his study, Othman explained that the difference between systolic blood pressure measurements values pre-test and post-test values was statistically significant (Othman, 2018). Özdemir stated that there there was no change in the blood pressure of the people who participated in the aerobic-step and pilates exercises (Özdemir, 2014). Blood pressure can be affected by some conditions such as age, gender, excitement, circadian rhythm, climate, posture, food intake (Günay, 1999). In our study, the reason for the difference in systolic-diastolic blood pressure values may be due to the excitement of the students for participating in such a study for the first time and their food intake between breaks.

In our study, no statistically significant difference was found in oxygen saturation values. Oxygen saturation is defined as the amount of oxygen in the blood that is transported depending on hemoglobin (Acartürk, 2009). It was stated that there was no statistically significant difference in the oxygen saturation of the athletes after the respiratory muscle training applied on Taekwondo athletes (Koç, 2017). At the end of a similar study, it was stated that there was no significant difference in oxygen saturation value (Granados et al., 2015). Our study is similar to studies done by Granados et al. (2015) and Koç (2017).

In our study, it was determined that there were significant differences in MaxVO$_2$ values between the experimental and control groups, and this difference was greater in the experimental group. Generally, Aerobic capacity is explained as the body's ability to carry and use oxygen (Willmore and Costill, 2004). The high aerobic capacity of the athletes is important in terms of ensuring that the recovery of the athletes is much faster during the breaks and after training not during the training. They stated that there was a significant increase in MaxVO$_2$ values in tennis players after respiratory muscle training applied to tennis players training on the grass-court for four weeks and five days a week (Pawar et al., 2018). At the end of a similar study, they explained that there was no significant difference in MaxVO$_2$ values (Bağıranet al., 2019). In our study, we think that the reason why the increase in MaxVO$_2$ values was higher in the experimental group was due to the respiratory muscle training applied in addition to the normal training of the students. We think that the reason why there was no significant difference in their study was the difference in the training program applied.

As a result of our study, it seemed that there were significant increases in anaerobic power values in the experimental and control groups, but this increase was more in the experimental group. Anaerobic performance is one of the important factors in the success of sports branches that include explosive movements (speed, quickness, direction change, etc.) in sports (Stone and Sands, 2007). In a study involving basketball player, it was observed that the average values of anaerobic power of the experimental group increased compared to the control group after four weeks of respiratory muscle training of the experimental group, according to the results obtained from the anaerobic power test (Çevik, 2018). Similarly, it was stated that 6 weeks of respiratory muscle training, on cyclists, increases anaerobic power (Johnson et al., 2007). Applied respiratory muscle training increases the rate of respiratory muscle contraction (Hajghanbarı et al., 2013). Respiratory muscle training combined with regular training can be a positive effect on the increase of the anaerobic performance of athletes. Our study is in parallel with similar studies in this field.

As a result of our study, it was determined that there are statistically significant increases in power values. Griffiths said in his study of rowing athletes that respiratory muscle training increased average inspiratory power (Griffiths, 2010). At the end of a similar study, Witt et al. (2007) stated that the inspiratory muscle strength increased statistically. In sports, power is important for all muscles. It is a well-known fact that people have a strong respiratory system and their importance in exercises (McConnell, 2011). Power is considered a measure of performance that combines the strength and speed of movement of muscles. Stronger muscles show a high level of resistance in jobs at a certain level and a decrease in shortness of breath occurs (Powerbreathe, 2020). Our study parallels the studies in this field.

After our findings, it was seen that the flow values were statistically significant in favor of the experimental group. In the studies, the resistance, which is used without a target, has a high resistance load potential for breathing (inspiration). However, for this potential to occur there must be sufficient inspiratory flows (Sperlich et al., 2009). At the end of the 8-week training applied to tennis players, he said that the flow values and group time interaction were statistically significant (Köroğlu, 2020). In a sımılar study, it was explained that there was a significant difference in the flow values of the experimental group at the end of the 12-week respiratory muscle training (Haghighi et al., 2020). In our study, we think that the reason for the significant difference in flow values is that the increase in the respiratory muscle device we use increases the rate of respiratory muscle and the speed of respiratory muscles. Our study parallels the studies in this field.

After our study, it was seen that the total energy values were statistically significant in favor of the experimental group. Energy is defined as a measure of the mechanical work of breathing during training. As a result of this, ıt is provided to collect the volume of the breath we exhaled with the force applied by the inspiratory muscles. We reach the more breath energy, the higher and longer it allows our inspiratory muscles to do what we do (Powerbreathe, 2020). In the study conducted on Taekwondo athletes, it was stated that the applied respiratory muscle training for 8 weeks positively increased the inspiration energy of the athletes (Koç, 2017). As a result of a similar study, he explained that there are significant increases in total energy values in tennis players (Köroğlu, 2020). İn our study, We think that the reason for the significant difference in total energy values is that the respiratory muscle device we used together with the applied training increased the strength and contraction speed of the students' inspiratory muscles. Our study parallels the studies in this field.

In our findings, it was seen that the increases in FEV1 and PEF values in both groups were statistically significant, but these increases were much higher in the experimental group. On the other hand, significant increases were observed in FVC values in favor of the experimental group. It is stated that the improved lung volume and capacity increases the endurance of the respiratory muscles and enables fatigue to occur at a later time (McConnell, 2011). Applied respiratory muscle training plays an important role in reducing or delaying respiratory muscle fatigue after training (Gigliotti et al., 2006). At the end of the study, they stated that there was a significant increase in FVC and FEV1 values in the group that applied inspiratory muscle training (Ahn et al., 2017). Ramsook et al. (2017) stated in their study that there is no significant difference in FVC, FEV1, FVC / FEV1 values. The study by Martinez et al. (2017) stated that there was no increase in FVC, FEV1, and PEF values. As a result of students regularly participating in training and increasing their respiratory muscle training regularly and gradually the pressure values Increase in speed, strength, and flow rate in respiratory muscles may be the reason for the significant difference in FEV1, FVC, and PEF values. Although our study shows parallelism with similar studies in this field, it is seen that it has different results.

In our study, it was seen that there was a significant difference in MVV values between the experimental and control groups, and this difference was more important in the experimental group than the control group. MVV is defined as the amount of air that a person can take into her/his lungs with fast and deep breathing, which is maximum per minute (Günay, 1999). Hartz et al. explained that there was a significant difference in the experimental group in MVV values after respiratory muscle training performed on 19 handball athletes (Hartz et al., 2018). In a study involving 34 children aged 10-12 years with kyphosis illness, a significant increase in MVV values was observed after respiratory muscle training applied three days a week for six weeks (Meamari et al., 2017). It was stated that after 6 weeks of respiratory muscle training applied to cycling athletes, maximum voluntary ventilation increased (Walker, 2013). In our study, the increase in MVV values may be due to the strengthening of the respiratory muscles of the students, the increase in vital capacity, and forced vital capacity values. Our work is in parallel with the work done in this field.

As a result of the eight-week respiratory muscle training, it was seen that the VC values were statistically significant in favor of the experimental group. In another study, they explained that respiratory muscle training applied on 20 healthy people increased VC values (Enright et al., 2006). Bağıran et al. (2019) stated that there is a significant difference in VC values after the respiratory muscle training they applied to 20 swimming athletes five days a week for six weeks. In our study, we think that the reason for the increase in VC values, it is the positive effect of training on the efficiency of the respiratory system and the increase in respiratory muscles.

In our study, it was seen that there was no statistically significant difference in ERV values. After respiratory muscle training on tennis players, no statistically significant difference was found on ERV (Köroğlu, 2020). It has been stated that there is a statistically significant difference in respiratory muscle training and expiratory reserve volume in people having respiratory problems (Esposito, 2010). There is not a positive effect on ERV values that may have been caused by the absence of any health problems in the lungs of the students.

It seemed that the 5-week respiratory muscle training contributes to the aerobic and anaerobic endurance of primary school students. The regular application of respiratory muscle training by the athletes who are active in a team and individual sports in the company of trainers and teachers will allow the increase of the existing performance of the students. We think that the large sample size in the studies to be carried out in this field, the fact that the study is under the supervision of the person conducting the study, applying the respiratory muscle training to be applied for a much longer period will contribute much more to the understanding of the importance of the study to be done.

The limitation of the study is that the sample group consists of 32 students between the ages of 13-14 studying at the Kızılören secondary school in the district of İncesu, Kayseri. The students do not have a chronic medical problem.

REFERENCES

Acartürk, E. (**2009**). Correlation of Oxygen Saturation with Pulse Oximetry with Arterial Blood Gas Examination in COPD Patients and Factors affecting this Correlation. Published dissertation. Süreyya paşa Thoracic and Cardiovascular Diseases Training and Research Hospital, Istanbul.

Akgül, M. N. (**2016**). The Effect of 6-Week Competition Period Training on Body Composition in Boxers. Published Master’s Thesis. Selçuk University, Konya.

Akgün, N. (**1992**). Exercise Physiology. Ege University Press. 4th Edition. İzmir.

Alpay, C. B., Ersöz, Y., Karagöz, Ş., and Oskoueı, M. M. (**2015**). Comparison of pre-competition weight loss body composition and some mineral levels in elite wrestlers. International Journal of Science Culture and Sport, 4(3): 38-48.

Amonette, W., and **Dupler**, T. (**2002**). The effects of respiratory muscle training on VO$_2$max the vantilatory threshold and pulmonary function. Journal of Exercise Physiology, 5(2): 29-35.

Bağıran, Y., Dağlıoğlu, Ö., and Bostancı, Ö. (**2019**). The effect of respiratory muscle training on aerobic power and respiratory parameters in swimmers. International Journal of Sport, Exercise and Training Sciences, 5(4): 214-220.

Çevik, A. (**2018**). The effect of 4-week Respiratory Muscle Training on Performance in Male Basketball Players. Published master’s thesis, Hitit University.

Enright, S. J., Unnithan, V. B., Heward, C., Withnall, L., and Davies, D.H. (**2006**). Effect of high-intensity inspiratory muscle training on lung volumes, diaphragm thickness and exercise capacity in subjects who are healthy. Physical Therapy, 86(3): 345-354.

Esposito, F. (**2010**). Effect of respiratory muscle training on maximum aerobic power in normoxia and hypoxia. Respiratory Physiology and Neurobiology, 170(3): 268-272.

Fox, E., Bowers, R. W., and Foss, M. L. (**1999**). Physical education and physiological bases of sport. Ankara, Bağırgan Press. pp. 269-303.

Gigliotti, F., Binazzi, B., and Scano, G. (**2006**). Does training of respiratory muscles affect exercise performance in healthy subjects? Respiratory Medicine, 100(6): 1117-1120.

Granados, J., Gıllum, T. L., Castıllo, W., Chrıstmas, K. M., and Kuennen, M. R. (**2015**). Functional respiratory muscle training during endurance exercise causes modest hypoxemia but overall is well tolerated. Journal of Strength and Conditioning Research, 30(3): 755–762.

Griffiths, L. A. (**2010**). The application of respiratory muscle training to competitive rowing. Published Doctoral Thesıs, Brunel University, London.

Günay, M. (**1999**). Exercise Physiology. Second edition. Ankara. Bağırgan Press.

Günay, M., Tamer, K., and Cicioğlu, İ. (**2013**). Sport physiology and performance measurement. Ankara, Gazi book store. pp. 429-489.

Haghighi, M., Dari, A. H., and Ghasemikahrizsangi, G. (**2020**). The effect of ınspiratory muscle training on the thoracic spine curve, ınspiratory volume and cardio-respiratory endurance in boys with hyper-kyphosis. International Journal of Health Studies, 6(2): 24-27.

Hajghanbarı, B., Yamabayashı, C., Buna, T. R., Coelho, J. D., Freedman, K. D., Morton, T. A., Palmer, S. A., Toy, M. A., Walsh, C., Sheel, A. W., and Reıd, W. D. (**2013**). Effect of respiratory muscle training on performance in athletes: Asystematic review with meta-analyses. Journal of Strength and Conditioning Research, 27(6): 1643–1663.

Hartz, C. S., Sindorf, M. A. G., Lopes, C. R., Batista, J., and Moreno, M. A. (2018). Effect of ınspiratory muscle training on performance of handball athletes. Journal of Human Kinetics, 63: 43-51.

Johnson, M. A., Graham, R. S., and Peter, I. B. (**2007**). Inspiratory muscle training improves cycling time-trial performance and anaerobic work capacity but not critical power. European Journal of Applied Physiology, 101(6): 761-770.

Kamar, A. (**2008**). Sporda Yetenek and Performans Testleri. Ankara, Nobel Basın Yayın. s.175–185.

Kido, S., Katakura, A., Nakajima, Y., Tanaka, T., Miyasaka, T., Sakurai, S., and Yu, W. (**2018**). The physiological effects of combined training with breathing resistance and sustained physical exertion in healthy young adults. Journal of Novel Physiotherapies, 8(1): 376.

Koç, M. (**2017**). The Effect of Respiratory-Muscle Training on Aerobic and Anaerobic Endurance in adolescent Taekwondo players. Published Master’s Thesis, Erciyes University, Kayseri.

Köroğlu, Y. (**2020**). The Effect of Respiratory-Muscle Training on Aerobic Power and Respiratory Functions in Tennis Players. Published doctoral thesis, Erciyes University, Kayseri.

Kürkçü, R., and **Gökhan**, İ. (**2011**). The effects of handball training on some respiratory and circulatory parameters of 10-13 year old students. International Journal of Human Sciences, 8(1): 135-143.

Langer, D., Charususin, N., Jacome, C., Hoffman, M., McConnell, A., Decramer, M., and Gosselink, R. (**2015**). Efficacy of a novel method for inspiratory muscle training in people with chronic obstructive pulmonary disease. Physical Therapy, 95(9): 1264-1273.

McConnell, A. K. (**2011**). Breathe Strong, Perform Better. Champaign, Human Kinetics, USA.

Meamari, H., hromi, M. K., Fallahi, A., and Sheikholeslam, R. (**2017**). İnfluence of Structural Corrective and Respiratory Exercises on Cardiorespiratory Indicesof Male Children Afflicted with Kyphosis. Archives of Rehabilitation, 18(1): 51-62.

Mengütay, S. (**2005**). Movement development and spor in children. Morpa Kültür publishing. İstanbul.

Meredith, M. D. (**1992**). Cooper Institute for Aerobics Research The Prudential Fitnessgram: Test administration manual. Journal of Physical Activity and Health, 3(2): 90-202.

Othman, S. T. (**2018**). Research of the Effects of Walking and Running Exercises on Some Blood Parameters in Adults. Published Master’s Thesis, Yüzüncü Yıl University, Van.

Öncen, S. (**2018**). The effect of high intensity interval training in normobaric hypoxia environment created with a training mask on aerobic and anaerobic performance components. Published doctoral thesis, Marmara University, Istanbul.

Özdemir, İ. (**2014**). Effects of aerobic-step and pilates exercises on body composition, blood fat and blood sugar in middle age women. published master’s thesis, Selçuk University,Konya.

Özer, K. (**2001**). Physical fitness, Nobel publications. Ankara.

Pawar, P., Kolekar, A., and Yeole, U. (**2018**). Effect of inspiratory muscle training on cardiovascular endurance in lawn tennis players. International Journal of Current Research, 10(2): 65601- 65602.

Pina, I. L., Balady, G. J., Hanson, P., Labovitz, A. J., Madonna, D. W., and Myers, J. (**1995**). Guidelines for clinical exercise testing laboratories. A statement for healthcare professionals from the Committee on Exercise and Cardiac Rehabilitation. Circulation, 91(3):912-921.

Powerbreathe-k5 (Respiratory muscle device) (**2016**). date accessed: 01.09.2016, Access addressed:http://www.powerbreathe.com/.

Powerbreathe-k5 (Respiratory muscle device) (**2020**). Date accessed: 06.05.2020. Access addressed: https://docplayer.biz.tr/.

Ramsook, A.H., Seon, Y. M., Schaeffer, M. R., Wilkie, S. S., Camp, P.G., Reid, W. D., Romer, L. M., and Guenette, J. A. (**2017**). Effects of inspiratory muscle training on respiratory muscle electromyography and dyspnea during exercise in healthy men. Journal of Applied

Physiology, 122: 1267–1275.

Sheel, A. W. (**2002**). Respiratory muscle training in healthy individuals physiologicalrationale and implications for exercise performance, Sports Medicine, 32(9): 567-581.

Sperlich, B., Fricke, H., Marees, M., Linville, J. W., and Mester, J. (**2009**). Does respiratory muscle training increase physical performance? Military Medicine, 174(9): 977–982.

Stone, M. H., and **Sands**, W. (**2007**). Principles and practice of resistance training. Champain, Human Kınetics.

Thomas, S. A., (**2000**). Respiratory muscle endurance training in chronic obstructive pulmonary disease impact on exercise capacity, dyspnea, and quality of life. American Journal of Respiratory and Critical Care Medicine, 162: 1709-1714.

Walker, D. J. (**2013**). Respiratory muscle function during a six-week period of normocapnic hyperpnoea training. Respiratory Physiology and Neurobiology, 188(2): 208-213.

Willmore, J. H., and **Costill**, D. L. (**2004**). Physiology of Sport and Exercise. 3. Edition. Human Kinetics.

Witt, J. D., Guenette, J. A., Rupert, J. L., McKenzie, D. C., and Sheel, A. W. (2007). Inspiratory muscle training attenuates the human respiratory muscle metaboreflex. The Journal of Physiology, 584(3): 1019–1028.

Zileli, R., Şemşek, Ö., Özkamçı, H., and Diker, G. (**2017**). The effect of walking exercise on some physical fitness parameters in obese and overweight women. Ataturk University: The Journal of Physical Education and Sport Sciences, 19(2): 7-17.

Citation: Köroğlu, Y. (2021). The effects of respiratory muscle training on aerobic, anaerobic and respiration parameters. African Educational Research Journal, 9(2): 405-417.