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EFFECT OF CORE TRAINING PROGRAM ON RESPIRATORY FUNCTION AND INSPIRATORY MUSCLE STRENGTH IN SWIMMERS

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Abstract:
The aim of this study is to examine the effect of core training program on respiratory functions and inspiratory muscle strength in swimmers. 22 male swimmers between the ages of 18 and 22, who do regular swimming training, participated in the study voluntarily. The subjects were divided into experimental (n: 11) and control (n: 11) groups. A core training program was applied to the experimental group 3 days a week for 8 weeks. Both groups continued their normal swimming training. Before and after core training, the subjects' maximal inspiratory muscle strength (MIP), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume (FEV1) and forced expiration rate (FEV1 / FVC) were measured. The respiratory functions of the subjects were determined by using a Spirometer and the respiratory muscle strengths were determined by using the MicroRPM pressure gauge device. The obtained data were analyzed by the SPSS 22.0 program. The paired Samples T tests were used for within-group comparison and Independent Samples T tests were used for the group comparison. As a result of the statistical analysis, a statistically significant difference was found in the respiratory parameters and inspiratory muscle strength values of the experimental group ($p<0.05$). In the comparison between the groups, a significant difference was found in the respiratory parameters and inspiratory muscle strength values in favor of the experimental group ($p<0.05$). As a result, it can be said that the 8-week core training program positively affected the respiratory functions and inspiratory muscle strength in swimmers.

Keywords: core training, respiratory functions, inspiratory muscle strength, swimming

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1. Introduction

Swimming is accepted as one of the most popular and basic sports branches in the world. In developed countries it has an important place in sports activities (1). In swimming, the abdominal and lower extremity muscles work together with the arm, shoulder and chest muscles (2). Core exercises are important in swimming training and for the performance improvement. "Core" is an English word which means "center". The area expressed by the word "core", in sports, is expressed as the center of gravity of the body (3). During the physical activity, muscle groups move together and thus the core muscles act as support and have a positive effect during exercise (4). Core muscles support the spine during strength exercises as well as daily activities. Body control and the risk of injury can be reduced (5, 6).

For healthy individuals and athletes, respiratory functions and strong respiratory muscles have a great importance (7). During exercise, the respiratory muscles work intensely (8). Respiratory strength has an effect as well as muscle strength on the increase of athlete's performance. It is known that especially the diaphragm muscle strengthens in training for the respiratory muscles. However, tidal volume increases, breathing frequency decreases at rest, and ventilation increases with maximal exercises (9). During physical activity, auxiliary respiratory muscles come into play during inspiration. Especially the muscles that raise the rib cage up give the inspiration for it. Expiration takes place by the pressure of the intercostal muscles and abdominal muscles. The strength of the auxiliary respiratory muscles enables the ventilatory air flow to reach the maximum level (10).

Regular training is very important to determine the lung capacity of athletes in terms of training norms. The exercise capacity it develops with the adaptations of the cardiovascular, respiratory and musculoskeletal systems (11). Studies from the past years shows, that the respiratory and cardiovascular systems of elite athletes develop with regular high-intensity exercises. (12, 13, 14, 15). In swimming sports, there are just little time differences between race performances. The purpose of the training for swimmers, is to improve their performance and race times. Considering the importance of respiratory muscle and functions in swimming, it is thought that core training programs will contribute athletes with effective muscle contractions and should be used as an alternative training method for trainers and swimmers.

The aim of this study is to examine the effect of a regular 8-week core training program on respiratory functions and inspiratory muscle strength.

2. Methods

2.1. Experimental Design and Subjects

22 male swimmers between the ages of 18 and 22, who do regular swimming training, participated in the study voluntarily. The athletes were divided into a experimental (n: 11) and a control (n: 11) group. A 60-minute core training program was applied to the

experimental group for 8 weeks, 3 days a week. Both groups continued their normal swimming training. Respiratory functions and respiratory muscle strength tests were performed simultaneously. Exercise and high-intensity physical activities were not allowed. Maximal inspiratory muscle strength (MIP), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume (FEV1) and forced expiration rate (FEV1 / FVC) values were measured before and after the core training. The respiratory functions of the subjects were determined by using a Spirometer and the respiratory muscle strength by using Micro RPM device.

2.2. Measurements

The MIP measurement was performed by using an electronic Micro RPM (CareFusion Micro Medical, Kent, UK) mouth pressure meter. During the measurements, the subject is sitting on a chair. Nasal plug was used in measurements. The subjects had maximum expiration. In addition, the subject was asked to make a maximum inspiration against the closed respiratory tract and was asked to continue for 1 to 3 seconds. Two measurements were taken, and the best result was recorded in cmH2O (16). During the measurements, M.E.C. Pocket Spiro USB-100 model devices was used. Detailed information was given to the subjects about the test they participated in. It has been said that a maximal effort is required for the measurement results to be accurate. The nose of the subjects was covered with a gag. The use of mouthpieces has been carefully provided so that there is no gap at the rim edges. While measuring, the subjects were motivated verbally. With this test, VC, FVC, FEV1 and FEV1/FVC (%) values were obtained (17).

2.3. Core Training Program

A 60-minute core training program was applied to the experimental group 3 days a week for 8 weeks. A core training program was not applied to the control group. Both groups continued their normal swimming training. For the experimental goup,1- Russian twists, 2- side planks, 3- push-ups, 4- abdominal crunches, 5- vertical leg crunches, 6- jack knifes, 7- reverse crunches, 8- superman's, 9-cat-camel stretches, 10- plane jack exercises, which is known as core exercises, were applied. All movements were applied as 2 * 10 (set * repetitions) in the first 2 weeks, 2 * 15 in the second 2 weeks, 3 * 12 in the third 2 weeks and 3 * 15 repetitions in the fourth 2 weeks. Rest was given for 60 seconds between sets and 15 seconds between repetitions (18, 19). The intensity of the applied core training continued increasingly considering the individual performances of the athletes. The core training program applied to the experimental group lasted about 60 minutes and the athletes were given a warm-up time of 10 to15 minutes before training.

2.4. Statistical Analysis

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

3. Results

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

	Pre-test (n:11)	**Post-test (n:11)**		
Variable	**$\bar{X}$±SD**	**$\bar{X}$±SD**	t	**p**
Age (year)	21.12±2.47	21.12±2.47	-	-
Height (cm)	180.24±1.22	180.24±1.22	-	-
Weight (kg)	74.12±3.54	74.12±3.54	-	**-**
VC (lt)	4.81±1.96	5.39±1.87	-2.12	**0.001***
FVC (lt)	4.27±1.74	4.98±1.81	-2.29	**0.001***
FEV1 (lt)	3.26±0.76	3.95±0.63	-2.14	**0.001***
FEV1/FVC (%)	91.11±2.41	92.89±2.64	-2.52	**0.001***
MIP (cmH_2O)	156.02±12.28	166.43±14.34	-3.56	**0.001***
*p<0.05				

In Table 1, comparison of the pre-test and post-test measurement results regarding the data obtained after the core training program applied to the experimental group. As a result of statistical analysis, the increase in respiratory parameters and maximal inspiratory muscle strength values in the experimental group was found to be statistically significant (p<0.05).

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

	Pre-test (n:11)	**Post-test (n:11)**		
Variable	**$\bar{X}$±SD**	**$\bar{X}$±SD**	t	**p**
Age (year)	20.47±1.21	20.47±1.21	-	-
Height (cm)	179±0.74	179±0.74	-	-
Weight (kg)	73.36±4.56	73.36±4.56	-	**-**
VC (lt)	4.71±1.22	4.82±1.52	-1.33	0.137
FVC (lt)	4.32±1.28	4.41±1.09	-1.22	0.259
FEV1 (lt)	3.55±1.14	3.59±1.28	-1.61	0.251
FEV1/FVC (%)	88.96±2.29	89.52±2.11	-1.75	0.127
MIP (cmH_2O)	154.26±5.25	156.32±5,.57	-1.83	0.114
*p<0.05				

In Table 2, comparison of the pre-test and post-test measurement results of the control group. No significance was observed in the values of the control group (p>0.05).

Table 3: Comparison of the experimental and control groups

	Experimental Group Difference	Control Group Difference		
Variable	$\bar{X}$**±SD**	$\bar{X}$**±SD**	t	**p**
VC (lt)	-0.58±0.53	-0.11±0.09	-2.009	**0.011***
FVC (lt)	-0.71±0.14	-0.09±0.12	-2.026	**0.001***
FEV1 (lt)	-0.69±0.42	-0.04±0.79	-1.362	**0.001***
FEV1/FVC (%)	-1.78±1.98	-0.56±1.42	-1.452	**0.001***
MIP (cmH$_2$O)	-10.41±3.92	-2.06±3.22	2.789	**0.001***
*p<0.05				

The comparison of the measurement results of the respiratory muscle training program applied to the experimental group and the control group participating in the research and the data obtained afterwards are given in Table 3. Significance was found in VC, FVC, FEV1, FEV1 / FVC% and MIP values in favor of the experimental group ($p<0.05$).

4. Discussion

22 male swimmers between the ages of 18 and 22, who do regular swimming training, participated in the study voluntarily. The athletes were randomly divided into two different groups as experiment (n: 11, age: 21.12 ± 2.47) and control group (n: 11, age: 20.47 ± 1.21). A 60-minute core training program was applied to the experimental group 3 days a week for 8 weeks. Both groups continued their regular swimming training. Care was taken to ensure that the age and anthropometric characteristics of the subjects were similar. In this study, a significant increase was found in VC, FVC, FEV1, FEV1/FVC (%) and MIP values after the 8-week core training program applied to the experimental group ($p<0.05$).

During exercise, an increase in respiratory volume occurs to provide the necessary O2 with an increased metabolic rate. Regular exercise strengthens the respiratory muscles and increases respiratory volume (20). Exercises which effect the lungs showed positive effects on them. Among athletes, swimmers have the highest respiratory capacity (21). The performance of the respiratory muscles affects the demanding respiratory parameters (chest and abdominal muscles). Swimming actively affects the muscles of this area. Horizontal posture is beneficial for the respiratory muscles. Therefore, swimming provides natural respiratory development (22).

Core training provides strength, conditioning and postural control of the trunk muscles. The diaphragm muscles are responsible for maintaining breathing demands (23). The diaphragm, which is the important muscle of the core region, acts as the roof of the nucleus and is most important for respiration, especially the inspiration muscle (24, 25). According to this information, it can be said that the core training program in our study will positively affect respiratory functions and respiratory muscle strength. In a study conducted on swimmers, the values of 17 swimmers (FIV1, FEV1) were found to increase after inspiratory and expiratory muscle training compared to the control group (26).

According to another study conducted on healthy individuals participating in a 6-week core training program, a statistically significant improvement was found in FVC, FEV1 and PEF, FVC and FEV1 values (27). Kim and Lee (28) found statistical significance in FVC and FEV1 values after strength exercises for the core region. There are many studies showing that regular physical activities improve respiratory function (29, 30, 31). The results of our study are similar to the studies investigating the effect of core training program on respiratory functions.

In a study conducted on 24 subjects, it was found that 10-week Core training increased the MIP value (6.13%) (32). In a study conducted with runners, MIP values increased by 20.09% in the experimental group and 6.78% in the control group (33). In a study conducted with young soccer players, it was found that core strength training positively affected some pulmonary functions and respiratory muscle strength (34). Core strength training provides muscle hypertrophy and neural adaptations of the muscles and contributes to performance improvement by increasing possible force generation (24). Core exercises result, it is believed that the shoulder, arm and leg muscles lead to greater maximal strength and more efficient use (35). Studies in the literature have found that training programs have positive effects on respiratory functions and respiratory muscle strength. In our study, improvement was observed in respiratory parameters and maximal inspiratory muscle strength values after core training applied to the experimental group 3 days a week for 8 weeks. It can be said that this improvement is the result of core exercises applied to subjects, the increase in respiratory muscle strength and the increase in lung volume and capacity. Our study supports the literature.

As a result, the 8-week core training program is thought to positively affect respiratory functions and inspiratory muscle strength in swimmers. It can be recommended to add core strength training in addition to swimming training for top level performance, respiratory functions and respiratory muscle strength development in swimming.

Conflict of Interest

There are no potential conflicts of interest between authors of this article.

About the Authors

Serdar Karapolat is a graduate student at Gaziantep University, Faculty of Sport Sciences. This study is a part of Serdar Karapolat's master thesis.

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References

1) Bozdoğan A. (2005). Yüzme. İstanbul: Morpa Kültür Yayınevi, s:6-7.
2) Lucero, B. (2012). Strength Training for faster Swimming. Meyer & Meyer Sport.

3) Mcgill, S. (2010). Core training: Evidence translating to better performance and injury prevention. J Strength Cond Res, 32(3): 33-46.
4) Condron, D. (2006). Swiss Ball and Core Workout. New York: Sterling, p. 6.
5) Fig G. (2005). Strength training for swimmers: Training the core. Strength and Conditioning Journal, 27(2) p:40–42.
6) Herrington L., Davies R. (2005). The influence of Pilates training on the ability to contract the transverses abdominis muscle in asymptomatic individuals. Journal of Bodywork and Movement Therapies, 9(1):52-57.
7) Shin Y. S., Yang S. M., Kim J. H., et al. (2017). Respiratory function of the Korean elite judo athletes and non-athletes. Arch Budo, 13 : 297-307.
8) Amonette W. E., Dupler T. L. (2002). The effects of respiratory muscle training on VO2max, the ventilatory threshold and pulmonary function. Journal of Exercise Physiology, 5(2): p. 29-35.
9) Bassett, D. R., Jr., & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. Med Sci Sports Exerc, 32(1), s. 70-84.
10) Ergen E., Zergerlioğlu A. M., Ülkar B., Demirel H., Turnagöl H., Güner R., Başoğlu S. (2002). Egzersiz Fizyolojisi. Ergen E (Ed). Nobel Yayın Dağıtım Ltd. Şti., Ankara, s.39-81.
11) Wilson M. G., Ellison G. M., Cable N. T. (2016). Basic science behind the cardiovascular benefits of exercise. British journal of sports medicine, 50(2): 93-99.
12) Lazovic B., Mazic S., Suzic-Lazic J., Djelic M., Djordjevic-Saranovic S., Durmic T., Zikic D., Zugic V. (2015). Respiratory adaptations in different types of sport. Eur Rev Med Pharmacol Sci, 19(12): 2269-2274.
13) İşleyen, G., Dağlıoğlu, Ö. (2020). The Effect of Aerobic Exercise on Pulmonary Function and Aerobic Capacity in Sedentary Men . International Journal of Sport Exercise and Training Sciences - IJSETS , 6 (3) , 80-87 .
14) Gücenmez, E., Dağlıoğlu, Ö., & Dağlıoğlu, T. (2017). The Effect of Aerobic Exercise on Oxygen Consumption Capacities and Body Composition in Football Players. Atabesbd, *19*(4), 136-147.
15) Kalkan, M. K., & Daglioglu, O. (2018). The Effects of 8-Week Aerobic Training Program on Respiratory and Circulatory Parameters of Female Swimmers between 12-14 Years Old. Journal of Education and Training Studies, 6(12), 202-207.
16) Barğı G., Güçlü M. B., Arıbaş Z., Akı Ş. Z., Sucak G. T. (2016). Inspiratory muscle training in allogeneic hematopoietic stem cell transplantation recipients: a randomized controlled trial. Supportive Care in Cancer, 24(2):647-59.
17) Miller M. R., Crapo R., Hankinson J. et al. (2005). General considerations for lung function testing. Eur Respir, 26:153-161.
18) Özdal M. (2016). Influence of an eight-week core strength training program on respiratory muscle fatigue following incremental exercise. Isokinetic sand. Exercise Sci., 24(3):225-230.

19) Sato, Kimitake; Mokha, Monique (2009). Does Core Strength Training Influence Running Kinetics, Lower-Extremity Stability, and 5000-m Performance in Runners?, Journal of Strength and Conditioning Research, Volume 23 - Issue 1 - p 133-140.
20) Fox, E. L., Bowers, R. W., & Foss, M. L. (1999). Beden Eğitimi ve Sporun Fizyolojik Temelleri, Bağırgan Yayımevi, (çev:Cerit, M.), Ankara.
21) Mehrotra, P. K., Varma, N., Tiwari, S., & Kumar, P. (1998). Pulmonary functions in Indian sportsmen playing different sports. Indian journal of physiology and pharmacology, 42(3), 412-16.
22) Gupta, S. S., & Sawane, M. V. (2012). A comparative study of the effects of yoga and swimming on pulmonary functions in sedentary subjects. International journal of yoga, 5(2), 128-33.
23) Lomax M., Tasker L., Bostanci O. (2014). Inspiratory muscle fatigue affects latissimus dorsi but not pectoralis major activity during arm sonly front crawl sprinting. J Strength Cond Res., 28(8): 2262-2269.
24) Akuthota V., Nadler S. F. Core strengthening. Arch Phys Med Rehab. 2004; 85:86-92.
25) Shinkle J., Nesser T. W., Demchak T. J., McMannus D. M. (2012). Effect of core strength on the measure of power in the extremities. J Strength Cond Res., 26(2):373-380.
26) Wells, G. D., Plyley, M., Thomas, S., Goodman, L., & Duffin, J. (2005). Effects of concurrent inspiratory and expiratory muscle training on respiratory and exercise performance in swimmers. European journal of applied physiology, 94(5-6), 527-540.
27) Cavaggioni L., Ongaro L., Zannin E., Iaia F. M., Alberti G. (2015). Effects of different core exercises on respiratory parameters and abdominal strength. Journal of Physical Therapy Science, 27(10): 3249-3253.
28) Kim E., Lee H. (2013). The effects of deep abdominal muscle strengthening exercises on respiratory function and lumbar stability. Journal of Physical Therapy Science, 25(6):663-665.
29) Ozdal, M., Daglioglu, O., & Demir, T. (2013). Effect of aerobic training program on some circulatory and respiratory parameters of field hockey players. International Journal of Academic Research, 5(4), 97-103.
30) Daglioglu, O. (2013). The effect of gradually increasing exercise on oxygen consumption and lactate levels in swimmers. Annals of Biological Research, 4(10), 96-102.
31) Bağıran, Y., Dağlıoğlu, Ö., 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 - IJSETS , 5 (4) , 214-220 .
32) Özdal M. (2016) Effect of core training on inspiratory muscle strength in well-trained. Men Biology of Exercise, 12(1).

33) Bostancı, Ö., Mayda, M., Tosun, M., Kabadayı, M. (2019). Yüksek Şiddetli İnterval Antrenman Programının Fizyolojik Parametreler ve Solunum Kas Kuvveti Üzerine Etkisi. SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi , 17 (4) , 211-219.
34) Bostanci, Ö., Kabadayi, M., Yilmaz, A. K., Mayda, M. H., Yilmaz, Ç., Erail, S., & Karaduman, E. (2020). Influence of eight-week core strength training on respiratory muscle strength in young soccer players. International Journal of Applied Exercise Physiology, 9(6), 221-226.
35) Lehman G. J. (2006). Resistance training for performance and injury prevention in golf. The Journal of the Canadian Chiropractic Association, 50(1), 27–42.