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Research Article

The Effect of Respiratory Muscle Exercises Applied to Smoking Athletes on Respiratory Parameters

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Abstract: The aim of the study was to determine the effect of respiratory muscle exercises on respiratory parameters of smoking athletes. Thirty athletes between the ages of 18-24 who have been doing licensed sports for at least 5 years participated in the study voluntarily. Participants were divided into 3 groups: smokers and respiratory muscle exercising group [SG, (n=10)], non-smokers and respiratory muscle exercising group [NG, (n=10)], smokers and control group without respiratory muscle exercising group [CG, (n=10)]. Respiratory parameters of all groups were determined with a spirometer. Participants in SG and NG performed respiratory muscle exercises with the triflo respiratory muscle exerciser 120 times a day for 4 weeks, 2 sets in the morning and evening every day and 30 times in each set. In the analysis of the data, two-way ANOVA test for repeated measures was applied to examine the results of different protocols (SG, NG and CG), pre-test and post-test measurements and protocol*time interaction effect. As a result of the study, FVC, FEV1, FEV1/FVC, PEF and MVV parameters of NG increased in favor of the post-test. However, no statistically significant differences were found between the groups in intergroup comparisons. However, when the percentage improvements were analyzed, it was determined that the highest improvement in all parameters was in NG.

Keywords: Respiratory muscle exercise, respiratory parameters, athlete, smoking

1. Introduction

Smoking addiction is known as a major public health problem worldwide and its prevalence is increasing. The World Health Organization has stated that smoking is linked to approximately seven million deaths each year (WHO, 2018). Smoking is directly related to nearly 20 fatal diseases, especially lung and heart diseases, but it also causes the emergence of about 50 different chronic diseases that do not result in death (Ash, 2017). Smoking causes fatal diseases not only in sedentary individuals but also in athletes, leading to shortened active sports lives and loss of physical performance. For these reasons, smoking has become an important health problem among athletes (Feinberg et al., 2015).

It has been reported that smoking in athletes can cause loss of strength due to its harmful effects on bone (Kanis et al., 2005), muscle and tendons (Kok et al., 2012), while it also causes negative effects on the respiratory system and leads to a decrease in lung volume and capacity (Clotet et al., 2004; Yıldız et al., 2024). The deterioration in lung function in smoking athletes leads to a decrease in maximal oxygen consumption (VO2max) values and a decrease in aerobic capacity (Tchissambou et al., 2004).

Lung capacity is recognized as an important indicator of the overall performance level of athletes (Schunemann et al., 2000; Verges, 2009). Increasing lung capacity increases the aerobic capacity of athletes by increasing the amount of oxygen taken into the body, which significantly affects the performance of physical activity (Olbrecht, 2000). In this context, it is stated that respiratory muscle exercises can help improve respiratory functions by increasing respiratory capacity and strength (Aktuğ et al., 2022; Verges, 2007). Respiratory muscles are structurally and functionally classified as skeletal muscles and can respond to training like skeletal muscles when exposed to an appropriate load (Kraemer et al., 2002). Therefore, it is thought that exercises to strengthen the respiratory muscles can positively improve athletes' overall performance and movement control in physical activities (Enright, 2006).

Although respiratory muscle exercises were initially started to be used in the treatment of individuals with health problems related to the respiratory system (Beckerman et al., 2005; Weiner et al., 2004), it has recently become a method frequently used on athletes to improve athletic performance (Kilding et al., 2010; McCarthy et al., 2015; Romer et al., 2002).

As mentioned above, considering the damages caused by smoking in the respiratory system and the benefits of respiratory muscle exercises in the respiratory system, how effective respiratory muscle exercises are in mitigating the respiratory impairments caused by smoking. With this in mind, the hypothesis of the study was determined as “Smoking is a limiting factor for the positive effects of respiratory muscle exercises on the respiratory muscle”.

2. Materials and Methods

2.1. Research Group

The population of the study consists of 258 students studying in the 1st education program of Niğde Ömer Halisdemir University Faculty of Sports Sciences, Department of Coaching Education. A sample of 30 people was selected from this population using purposive sampling method. The criteria sought in the purposive sampling method were that the participants should be between the ages of 18-24, be active athletes and have a license for at least 5 years. In addition, participants who smoked at least 10 cigarettes per day for the last 2 years were included in the study. Participation was completely voluntary, and participants successfully completed a four-week respiratory muscle exercise program.

Table 1. Demographic Variables of the Participants

	SG	NG	CG
Age (years)	19.30±1.33	21.00±1.33	20.70±1.25
Height (cm)	174.00±5.31	173.00±9.71	172.30±10.85
Body weight (kg)	70.40±8.83	64.40±17.26	69.20±9.21

2.2. Research Design

In this study, it was aimed to determine whether respiratory muscle exercises applied for 4 weeks were effective on respiratory functions in smokers and non-smokers, so it was conducted according to the pretest-posttest design with control experimental group from quantitative research designs. In the study, the participants were randomly divided into three groups: smokers and respiratory muscle exercising group [SG, (n=10)], non-smokers and respiratory muscle exercising group [NG, (n=10)], and smokers but not respiratory muscle exercising control group [CG, (n=10)]. Respiratory parameters of all groups were determined with a spirometer. The tests were performed twice in total, at the beginning of the study and at the end of the fourth week, and the progress of the participants was monitored.

2.3. Data Collection Tools

2.3.1. Determination of Lung Volume and Capacity

Lung volume and capacity measurements were performed twice, at the beginning of the study and at the end of the fourth week. For these measurements, the MIR (Medical International Research) Spirolab spirometer device, which complies with the American Thoracic Society measurement criteria, was used (Culver et al., 2017). The measurement was performed by placing a clip on the participant's nose after at least five minutes of rest and placing the mouthpiece of the device between the lips so that no air leakage occurred. To increase the reliability of the test, each measurement was repeated twice, and the best value was included in the study data. Forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), forced expiratory ratio (FEV1/FVC%), peak expiratory flow rate (PEF) and maximum voluntary ventilation (MVV) parameters were used in the study.

2.4. Respiratory Muscle Exercises

Triflo respiratory muscle exerciser device was used for respiratory muscle exercises. There are different models of this device with single, double, triple and quadruple balls; the triple ball model was preferred in our study. The working principle of the triflo respiratory muscle exerciser is based on the movement of the balls inside with inspiration or expiration. Both expiration and inspiration exercises can be performed with the device, and in our study, an inspiration exercise was performed. Participants placed the device between their lips in such a way that no air leakage occurred and drew air through the mouthpiece. The aim was to first raise the first ball and then the other balls in sequence and to keep the balls in the air for five seconds. In our study, SG and NG performed respiratory muscle exercise with the triflo respiratory muscle exerciser 120 times a day, 2 sets in the morning and evening, 30 times in each set, every day of the week. CG did not perform respiratory muscle exercise.

2.5. Data Analysis

In this study, the assumption of normality for quantitative variables was evaluated both visually, using histograms and probability plots, and analytically through the Shapiro-Wilk test. Given that the quantitative variables exhibited a normal distribution, they were reported as mean and standard deviation. A two-way repeated measures ANOVA was conducted to examine the effects of different protocols (SG, NG, and CG), pre-test and post-test measurements, as well as the protocol*time interaction. To determine variance homogeneity, Mauchly's test of sphericity was applied, and the Greenhouse-Geisser correction was used when necessary. Partial eta squared (ηp^2) values were computed to assess effect sizes, with statistical significance established at $p < 0.05$.

2.6. Ethics Committee Permission

This study was conducted with ethical approval from the Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee. The application was submitted under protocol number 2024/110, and approval was granted with decision number 2024/120 on 12.12.2024. Before data collection, participants were thoroughly informed about the study through a detailed presentation and subsequently provided written consent. The research was carried out in accordance with the ethical guidelines of the Declaration of Helsinki.

3. Results

Table 2. Intragroup and Intergroup Comparison of Dynamic Lung Volumes and Capacities

n=30	Pre	Post	Δ	%	Two-way Repeated ANOVA		
Variable	M±SD	M±SD	TB-Tend	TB-Tend	Time	Group	Time*Group
				FVC			
SG	4.84±0.57	4.87±0.64	0.03±0.07	0.61	F = 13.62	F = 0.91	F = 1.62
NG	4.41±1.11	4.56±1.08*	0.15±0.03	3.40	p < 0.001	p < 0.415	p < 0.21
CG	4.26±0.90	4.40±0.90*	0.14±0.00	3.28	ηp2 = 0.33	ηp2 =0.06	ηp2 = 0.10
				FEV1			
SG	3.95±0.78	3.96±0.79	0.01±0.01	0.25	F = 9.81	F = 0.31	F = 5.24
NG	3.55±1.03	4.05±0.74*	0.05±0.29	14.08	p < 0.004	p < 0.73	p < 0.01
CG	3.70±0.87	3.72±0.83	0.02±0.04	0.54	ηp2 =0.26	ηp2 =0.02	ηp2 =0.28
				FEV1/FVC			
SG	81.18±11.33	82.03±9.34	0.85±1.99	1.04	F = 5.02	F = 0.63	F = 3.98
NG	80.03±9.41	89.43±5.74*	9.04±3.67	11.74	p < 0.033	p < 0.539	p < 0.030
CG	84.50±4.41	84.42±5.47	0.08±1.06	-0.09	ηp2 =0.15	ηp2 =0.04	ηp2 =0.22
				PEF			
SG	7.86±3.24	8.04±2.97	2.94±0.27	2.29	F = 18.00	F = 1.22	F = 6.90
NG	5.19±2.17	8.03±2.19*	2.84±0.02	54.72	p < 0.000	p < 0.309	p < 0.000
CG	5.95±2.39	6.81±2.13	0.86±0.26	14.45	ηp2 = 0.40	ηp2 =0.08	ηp2 = 0.33
				MVV			
SG	137.17±28.18	140.11±25.81	2,94±2,37	2.14	F = 11.38	F = 0.20	F = 1.86
NG	124.48±36.56	140.36±27.59*	15,88±8,97	12.75	p < 0.002	p < 0.817	p < 0.175
CG	126.37±28.62	135.34±30.93	8,97±2,31	7.09	ηp2 =0.29	ηp2 =0.15	ηp2 =0.12

*Δ = Change; Pre= Pre-intervention; Post= Post intervention; ηp2: Partial eta squared; * Indicates significant difference between pre-test and post-test at p< 0.05 level.*

For the FVC parameter, a statistically significant difference was identified in both the NG and CG groups (F = 13.62, p = 0.001, eta = 0.33), whereas no such difference was observed in the smoking group. Additionally, statistical comparisons between groups did not reveal any significant differences (F = 0.91, p = 0.415, eta = 0.21). There was a statistical difference in the group*time interaction (F = 1.62, p = 0.21, eta = 0.10). When percentage-based improvement levels were examined, the NG group demonstrated the most pronounced increase. For the FEV1 parameter, a statistically significant improvement was observed in the NG group (F = 9.81, p = 0.004, eta = 0.26), whereas no notable difference was identified in the other groups. Additionally, comparisons across groups did not reveal any statistically significant variations (F = 0.31, p = 0.73, eta = 0.02). There was a statistical difference in the group*time interaction. (F = 5.24, p = 0.01, eta = 0.28). When the percentage-based improvement levels were examined, the NG group exhibited the highest degree of progress. For the FEV1/FVC parameter, a statistically significant difference was observed in the NG group (F = 5.02, p = 0.033, eta = 0.15), whereas no such difference was detected in the other groups. Additionally, comparisons between groups did not yield any statistically significant results (F = 0.63, p = 0.539, eta = 0.04). There was a statistical difference in the group*time interaction. (F = 3.88, p = 0.030, eta = 0.22). When the percentage-based improvement levels were examined, the NG group exhibited the highest increase. For the PEF parameter, a statistically significant difference was observed in the NG group (F = 18.00, p = 0.000, eta = 0.40), whereas no significant change was detected in the other groups. Additionally, comparisons between groups did not yield any statistically significant differences (F = 1.22, p = 0.309, eta = 0.08). There was a statistical difference in the group*time interaction. (F = 6.90, p = 0.000, eta = 0.33). When percentage-based improvement levels were examined, the greatest increase was recorded in the NG group.

A statistically significant change was detected in the MVV parameter within the NG group (F = 11.38, p = 0.002, eta = 0.29), whereas no notable difference was identified in the other groups. Additionally, comparisons between groups did not reveal any statistically significant variations (F = 0.20, p = 0.817, eta = 0.15). Likewise, the group*time interaction did not demonstrate statistical significance (F = 1.86, p = 0.175, eta = 0.12). When examining percentage-based improvement levels, the NG group exhibited the highest degree of progress.

4. Discussion

It has been reported that cigarette smoking negatively affects lung function and reduces its functionality and this negative effect is caused by various chemical components in cigarette smoke (Baydur et al., 2001). Carbon monoxide, one of the chemical components, tends to bind to hemoglobin approximately 200 times more than O_2. For this reason, carbon monoxide binds to hemoglobin and decreases its oxygen carrying capacity and thus leads to a decrease in the oxygen concentration reaching the tissues (Dalack et al., 1993; Krupski, 1991). As a result, it negatively affects cardiopulmonary functions, weakens respiratory and lung functions and significantly affects the performance of athletes (Baydur et al., 2001; Santos, 2012). In order to minimize these problems, respiratory muscle exercises stand out as an effective solution. It has been widely documented in the literature that respiratory muscle exercises have positive effects on improving respiratory muscle strength and functions (Aktuğ et al., 2022; Kutlu, 2024; Pardy et al., 1988; Weiner et al., 1999). These exercises reduce the perception of shortness of breath that occurs as a result of decreased inspiratory muscle strength and provide a significant increase in exercise capacity, especially with its strength-enhancing effect on inspiratory muscles (Hill et al., 2010). In this context, the aim of this study was to investigate the effects of respiratory muscle exercises on respiratory function in smokers.

As a result of our study, while there was an increase in the FVC, FEV1, FEV1/FVC, PEF and MVV parameters of NG in favor of the post-test, there was no statistically significant difference between the groups. However, when the percentage improvements were analyzed, it was determined that the highest improvement in all parameters was in NG.

In a study examining the effects of respiratory muscle exercises on healthy smokers, Pişkin et al. (2023) found that device respiratory muscle training led to significant improvements in FVC, FEV1, PEF, FEV1/FVC %, and MIP parameters in both smokers and non-smokers. Similarly, Bostancı et al. (2019) conducted a study in which healthy smokers and non-smokers performed device respiratory muscle exercises daily for four weeks. Their findings indicated that smokers showed enhancements in FVC, FEV1, FEV1/FVC, MVV, SVC, and IC parameters. The use of a pressure-adjustable respiratory muscle exerciser in the studies mentioned above, whereas the use of a non-pressure-adjustable triflo device in our study may be one of the reasons for the different results in the respiratory parameters of smokers. Because in respiratory muscle exercises performed with a pressure-adjustable device, the resistance always remains the same and this resistance is adjusted according to the person's maximal inspiratory pressure (MIP). However, since there is no pressure adjustment in the triflo, the resistance of the exercise is constantly changing, and the load of the exercise does not strain the individual. In addition, the lack of significant improvement in smokers despite respiratory muscle exercise may be due to the damaging effects of cigarette smoke on the respiratory system. Cigarette smoke causes chronic airway inflammation and structural damage at the alveolar level, which limits the improvement in exercise capacity and muscle function.

In another study, researchers investigated the impact of respiratory muscle exercises on both smokers and non-smokers. Participants engaged in these exercises twice per week over a five-week period. The findings revealed that both groups experienced an improvement in peak expiratory flow (PEF) and respiratory muscle strength (Lee et al., 2011). Kim and Lee (2012) applied balloon inflation exercises to healthy smokers and examined whether it improved lung function. Participants underwent balloon inflation exercises for 8 weeks and as a result, VC, ERV, IRV, FVC, FEV1, FEV1/FVC and PEF parameters were significantly improved. Although the balloon inflation method used in the study of Kim and Lee (2011) is not a pressure-adjustable system like the triflo device used in our study, the load created by the balloon increases as the tension of the balloon increases during respiratory muscle exercise. The use of different exercise methods and devices between the two studies may be the reason for the different results.

5. Conclusions

Within the scope of this study, it was found that respiratory muscle exercises with a device applied for 4 weeks significantly improved respiratory muscle strength and respiratory function, especially in non-smokers. This finding supports that respiratory muscle exercises performed with the device is an effective method to increase pulmonary capacity in healthy individuals. The positive effects of respiratory muscle exercises with the device on the respiratory system appear to be consistent with similar studies previously reported in the literature.

On the other hand, it was determined that the same exercise protocol applied to smokers provided limited improvement, but this improvement did not create a statistically significant difference. First of all, the fact that the triflo type respiratory exercise device used in the study was not pressure sensitive and could not adjust the individual load threshold may have provided inadequate stimulus, especially in individuals with more damaged respiratory systems. The constant low resistance of the device may not have optimized the muscle activation required for improvement.

In addition, structural and functional impairments in the airways of smokers may have limited the effect of the exercises. Factors such as airway inflammation and damage to alveolar structures caused by chronic exposure to cigarette smoke may have reduced the response to exercise in these individuals. Therefore, a four-week short-term exercise program is considered to be insufficient to achieve significant pulmonary function improvement in smokers.

In order to obtain healthier and comparable data in future studies, it is recommended that respiratory muscle exercises be applied to smokers be applied for a longer period of time (8-12 weeks). In addition, the use of more technologically advanced and resistance-adjustable respiratory exercise devices instead of the triflo respiratory muscle exerciser may be more effective in terms of muscle activation and adaptation. It is thought that optimizing parameters such as exercise frequency, duration and intensity will contribute to achieving more comprehensive results in different groups of individuals.

In conclusion, although it has been clearly demonstrated that respiratory muscle exercises have positive effects especially in nonsmokers, it is clear that more long-term, individualized and resistance-controlled exercise protocols are needed to increase the effectiveness of this method in smokers. Further studies in this context will provide important contributions in terms of both clinical applications and preventive health strategies.

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Informed Consent Statement: Before the measurements, the participants were given a detailed information presentation about the study and signed an informed consent form.

References

Aktuğ, Z. B., Kurt, S., Pişkin, N. E., Yavuz, G., & İbiş, S. (2022). Effect of inspiratory muscle training with the device on respiratory functions. *Akdeniz Spor Bilimleri Dergisi*, *5*(3), 571-581. https://doi.org/10.38021/asbid.1153587

Ash, S. Y., Harmouche, R., Ross, J. C., Diaz, A. A., Hunninghake, G. M., Putman, R. K., ... & Washko, G. R. (2017). The objective identification and quantification of interstitial lung abnormalities in smokers. *Academic Radiology*, *24*(8), 941-946. https://doi.org/10.1016/j.acra.2016.08.023

Baydur, A., Adkins, R. H., & Milic-Emili, J. (2001). Lung mechanics in individuals with spinal cord injury: Effects of injury level and posture. *Journal of Applied Physiology*, *90*(2), 405-411. https://doi.org/10.1152/jappl.2001.90.2.405

Beckerman, M., Magadle, R., Weiner, M., & Weiner, P. (2005). The effects of 1 year of specific inspiratory muscle training in patients with COPD. *Chest*, *128*(5), 3177-3182. https://doi.org/10.1378/chest.128.5.3177

Bostancı, Ö., Mayda, H., Yılmaz, C., Kabadayı, M., Yılmaz, A. K., & Özdal, M. (2019). Inspiratory muscle training improves pulmonary functions and respiratory muscle strength in healthy male smokers. *Respiratory Physiology & Neurobiology*, *264*, 28-32. https://doi.org/10.1016/j.resp.2019.04.001

Clotet, J., Gómez-Arbonés, X., Ciria, C., & Albalad, J. M. (2004). Spirometry is a good method for detecting and monitoring chronic obstructive pulmonary disease in high-risk smokers in primary health care. *Archivos de Bronconeumología (English Edition)*, *40*(4), 155-159. https://doi.org/10.1016/S1579-2129(06)60207-3

Culver, B. H., Graham, B. L., Coates, A. L., Wanger, J., Berry, C. E., Clarke, P. K., Hallstrand, T. S., Hankinson, J. L., Kaminsky, D. A., Macintyre, N. R., McCormack, M. C., Rosenfeld, M., Stanojevic, S., Weiner, D. J., & ATS Committee on Proficiency Standards for Pulmonary Function Laboratories (2017). Recommendations for a standardized pulmonary function report. An official American thoracic society technical statement. *American Journal of Respiratory and Critical Care Medicine*, *196*(11), 1463–1472. https://doi.org/10.1164/rccm.201710-1981ST

Dalack, G. W. Glasman, A. H. & Cavey L. S. (1993). *Nicotine use, current psychiatric therapy*, L Dunner (Ed), Philadelphia, WB Saunders Company.

Enright, S. J., Unnithan, V. B., Heward, C., Withnall, L., & 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. https://doi.org/10.1093/ptj/86.3.345

Feinberg, J. H., Ryan, M. A., Johns, M., Marvin, B. A., Reading, J. E., & White, M. R. (2015). Smoking cessation and improvement in physical performance among young men. *Military Medicine*, *180*(3), 343–349. https://doi.org/10.7205/MILMED-D-14-00370

Hill, K., Cecins, N. M., Eastwood, P. R., & Jenkins, S. C. (2010). Inspiratory muscle training for patients with chronic obstructive pulmonary disease: a practical guide for clinicians. *Archives of Physical Medicine and Rehabilitation*, *91*(9), 1466-1470. https://doi.org/10.1016/j.apmr.2010.06.010

Kanis, J. A., Johnell, O., Odén, A., Johansson, H., De Laet, C., Eisman, J. A., ... & Tenenhouse, A. (2005). Smoking and fracture risk: a meta-analysis. *Osteoporosis International*, *16*, 155-162. https://doi.org/10.1007/s00198-004-1640-3

Kilding, A. E., Brown, S., & McConnell, A. K. (2010). Inspiratory muscle training improves 100 and 200 m swimming performance. *European Journal of Applied Physiology*, *108*, 505-511. https://doi.org/10.1007/s00421-009-1228-x

Kim, J. S., & Lee, Y. S. (2012). Effects of a balloon-blowing exercise on lung function of young adult smokers. *Journal of Physical Therapy Science*, *24*(6), 531 534. https://doi.org/10.1589/jpts.24.531

Kok, M. O., Hoekstra, T., & Twisk, J. W. (2012). The longitudinal relation between smoking and muscle strength in healthy adults. *European Addiction Research*, *18*(2), 70-75. https://doi.org/10.1159/000333600

Kraemer, W. J., Adams, K., Cafarelli, E., Dudley, G. A., Dooly, C., Feigenbaum, M. S., Fleck, S. J., Franklin, B., Fry, A. C., Hoffman, J. R., Newton, R. U., Potteiger, J., Stone, M. H., Ratamess, N. A., Triplett-McBride, T., & American College of Sports Medicine (2002). American college of sports medicine position stand. Progression models in resistance training for healthy adults. *Medicine and Science in Sports and Exercise*, *34*(2), 364–380. https://doi.org/10.1097/00005768-200202000-00027

Krupski, W. C. (1991). The peripheral vascular consequences of smoking. *Annals of Vascular Surgery 5*, 291–304. https://doi.org/10.1007/BF02329389

Kutlu, Z. (2024). *Step aerobik egzersizi yapan sedanter kadınlarda aletli solunum kası egzersizlerinin solunum fonksiyonlarına etkisi* [Yayımlanmamış Doktora tezi], Niğde Ömer Halisdemir Üniversitesi.

Lee, S. C., Jung, C. H., Lee, E. S., Lee, H. H., Joung, Y. H., Chae, H. J., Choi, J. A., Chul, L. H., Oh, S. B., & Son, K. H. (2011). Changes of respiratory ability according to respiratory muscle exercises for smokers and non-smokers in their twenties. *Journal of Korean Physical Therapy Science*, *18*(3), 9-16.

McCarthy, B., Casey, D., Devane, D., Murphy, K., Murphy, E., and Lacasse, Y. (2015). Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database of Systematic Reviews, 23*(2), CD003793. https://doi.org/10.1002/14651858.CD003793.pub3

Olbrecht, J. (2000). The science of winning: Planning, periodizing and optimizing swimming training. Belgium: IJS.

Pardy, R. L., Reid, W. D., & Belman, M. J. (1988). Respiratory muscle training. *Clinics in Chest Medicine. 9*(2), 287-296. https://doi.org/10.1016/S0272-5231(21)00505-0

Pişkin, N. E., Kutlu, Z., Yavuz, G., Aktuğ, Z. B., İbiş, S., & Aka, H. (2023). The effect of deviced respiratory muscle exercises applied to smokers and non-smokers on respiratory functions. *Journal of Education & Recreation Patterns (JERP),* 4(1). https://doi.org/10.53016/jerp.v4i1.99

Romer, L. M., Mcconnell, A., & Jones, D. A. (2002). Effects of inspiratory muscle training on time-trial performance in trained cyclists. *Journal of Sports Sciences, 20*(7), 547-590. https://doi.org/10.1080/026404102760000053

Santos, M. L. D. M. D., Rosa, B. D., Ferreira, C. D. R., Medeiros, A. D. A., & Batiston, A. P. (2012). Maximal respiratory pressures in healthy boys who practice swimming or indoor soccer and in healthy sedentary boys. *Physiotherapy Theory and Practice, 28*(1), 26-31. https://doi.org/10.3109/09593985.2011.560239

Schunemann, H. J., Dorn, J., Grant, B. J. W., Winkelstein, J. R., & Trevisan, M. (2000). Pulmonary function is a long-term predictor of mortality in the general population: 29-year follow-up of the Buffalo Health Study. *Chest, 118*(3), 656-664. https://doi.org/10.1378/chest.118.3.656

Tchissambou, B. P., Massamba, A., Babela, J. R., Mouanou, J. K., Mboussa, J., & Senga, P. (2004). The effects of smoking and the degree of nicotine dependence on aerobic capacity in sportsmen. *Revue des Maladies Respiratoires, 21*(1), 59-66. https://doi.org/10.1016/s0761-8425(04)71236-x

Verges, S., Flore, P., Nantermoz, G., Lafaix, P. A., & Wuyam, B. (2009). Respiratory muscle training in athletes with spinal cord injury. *International Journal of Sports Medicine, 30*(07), 526-532. https://doi.org/10.1055/s-0029-1202336

Yıldız, A., Çanakçı, R., Rüştü, İ. E., & Sarıhan, İ. A. (2024). Amatör sporculardaki sigara kullanımının egzersiz kapasitesi ve fiziksel aktivite üzerine etkileri. *Celal Bayar Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi, 11*(4), 640-647. https://doi.org/10.34087/cbusbed.1503995

Weiner, P., Magadle, R., Berar-Yanay, N., & Pelled, B. (1999). The effect of specific inspiratory muscle training on the sensation of dyspnea and exercise tolerance in patients with congestive heart failure. *Clinical Cardiology, 22*(11), 727-732. https://doi.org/10.1002/clc.4960221110

Weiner, P., Magadle, R., Beckerman, M., Weiner, M., & Berar-Yanay, N. (2004). Maintenance of inspiratory muscle training in COPD patients: one year follow-up. *European Respiratory Journal, 23*(1), 61-65. https://doi.org/10.1183/09031936.03.00059503

World Health Organization. (2018, February 21). Tobacco. https://www.who.int/mediacentre/factsheets/fs339/en/