ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Research Article *Araştırma Makalesi* DOI:10.62425/rses.1627727

Effect of Device Respiratory Muscle Exercises Combined with Step Aerobic Exercise on Respiratory Functions

Step Aerobik Egzersizi ile Kombinlenen Aletli Solunum Kası Egzersizlerinin Solunum Fonksiyonlarına Etkisi

Zeynep KUTLU[1]
[1]Niğde Ömer Halisdemir University, Faculty of Sports Sciences, Department of Physical and Sports Education, Niğde, Türkiye

Serkan İBİŞ[1]
[1]Niğde Ömer Halisdemir University, Faculty of Sports Sciences, Department of Physical and Sports Education, Niğde, Türkiye

Zait Burak AKTUĞ[1]
[1]Niğde Ömer Halisdemir University, Faculty of Sports Sciences, Department of Physical and Sports Education, Niğde, Türkiye

ABSTRACT

The aim of the study was to compare the effects of device respiratory muscle exercises applied at different times on pulmonary function in sedentary women performing step aerobic exercise. The study included 32 sedentary female volunteers aged 18-24. Participants were divided into 3 groups as the group that performed respiratory muscle exercise with a device during the rest between sets of step aerobic exercise (Exercise+RMEG) (n=10), the group that performed respiratory muscle exercise with a device at home in addition to step aerobic exercise (Home+RMEG) (n=10) and the control group that performed only step aerobic exercise (CG) (n=12). All groups performed the same step aerobic exercise program 3 days a week for 8 weeks, while Exercise+RMEG and Home+RMEG also performed respiratory muscle exercises with the device. Respiratory functions of the participants were measured using a spirometer. The results indicated that all groups showed statistically significant improvements in respiratory parameters from pre-test to post-test, with the Exercise+RMEG group demonstrating the greatest percentage increase. As a result, it was determined that step aerobic exercises are an effective method to increase respiratory functions. In addition, it can be said that respiratory muscle exercises with devices performed together with step aerobic exercises provide greater improvement in respiratory parameters. For this reason, it is thought that respiratory muscle exercises with devices performed together with exercise can be applied as an alternative method to increase respiratory parameters.

Keywords: Device respiratory muscle exercises, pulmonary function, step aerobics, sedentary

ÖZ

Yapılan çalışmanın amacı step aerobik egzersizi yapan sedanter kadınlara farklı zamanlarda uygulanan aletli solunum kası egzersizlerinin solunum fonksiyonlarına etkisinin karşılaştırılmasıdır. Çalışmaya 18-24 yaş arasında 32 sedanter kadın gönüllü olarak katılmıştır. Katılımcılar, step aerobik egzersizinin setler arası dinlenme esnasında aletli solunum kası egzersizi yapan grup (Egzersiz+SKEG) (n=10), step aerobik egzersizine ilaveten evde aletli solunum kası egzersizi yapan grup (Ev+SKEG) (n=10) ve sadece step aerobik egzersizi yapan kontrol grubu (KG) (n=12) olarak 3'e ayrılmıştır. Tüm gruplar 8 hafta boyunca haftanın 3 günü aynı step aerobik egzersiz programını uygularken, Egzersiz+SKEG ve Ev+SKEG'leri aynı zamanda aletli solunum kası egzersizleri de yapmışlardır. Katılımcıların solunum fonksiyonları spirometre cihazı ile ölçülmüştür. Çalışma sonucunda tüm grupların solunum parametrelerinin ön testten son teste istatistiksel olarak anlamlı şekilde geliştiği belirlenirken, bu gelişimin yüzdesel olarak en fazla Egzersiz+SKEG'de olduğu tespit edilmiştir. Sonuç olarak, step aerobik egzersizlerinin solunum fonksiyonlarını artırmada etkili bir yöntem olduğu belirlenmiştir. Ayrıca step aerobik egzersizleri ile birlikte uygulanan aletli solunum kası egzersizlerinin ise solunum parametrelerinde daha fazla gelişim sağladığı söylenebilir. Bu nedenle de egzersiz ile birlikte yapılan aletli solunum kası egzersizlerinin solunum parametrelerini artırmada alternatif bir yöntem olarak uygulanabileceği düşünülmektedir.

Anahtar Kelimeler: Aletli solunum kası egzersizleri, solunum fonksiyonları, step aerobik, sedanter

Geliş Tarihi/Received 27.01.2025
Kabul Tarihi/Accepted 13.05.2025
Yayın Tarihi/Publication Date 20.06.2025

Sorumlu Yazar/Corresponding author: Serkan İBİŞ
E-mail: serkanibis@gmail.com

Cite this article: Kutlu, Z., İbiş, S., & Aktuğ, Z.B. (2025). Effect of device respiratory muscle exercises combined with step aerobic exercise on respiratory functions. *Research in Sport Education and Sciences, 27*(2), 166-175.

Content of this journal is licensed under a Creative Commons Attribution-Noncommercial 4.0 International License.

Introduction

With the developing technology, sports science is in a state of constant progress. This progress has provided the opportunity to access information more easily with the contribution of technology and to reveal new approaches with new ideas. One of these approaches is respiratory muscle exercises with devices (Aktuğ et al. 2022; McConnell, 2011). Respiratory muscle exercises were first used to treat people suffering from asthma, chronic obstructive pulmonary disease (COPD) and airflow restrictions (Beckerman et al., 2005; Weiner et al., 2004), and then their effects on athletic performance were examined and respiratory muscle exercises were found to increase respiratory muscle strength, endurance and exercise performance of athletes (Bostancı et al., 2019; Kilding et al., 2010; McCarthy et al., 2015; Romer et al., 2002).

The respiratory system is mainly managed by the muscles between the diaphragm and ribs, and the functionality of this system directly depends on the strength of the respiratory muscles (Braman, 1995; Pişkin et. al., 2023; Tu et al., 2013). Weakness in respiratory muscles leads to both a decrease in respiratory capacity and impaired oxygen transport, negatively affecting the quality of life and physical fitness level of the individual (De Troyer, 2012; Schunemann et al., 2000). It is stated that especially sedentary individuals may have low respiratory function and respiratory muscle strength, which may negatively affect physical activity capacity and general health (Lötters et al., 2002; Martin, 1999). For this reason, it is said that respiratory muscle exercises can reduce the negative effects that may occur in respiratory functions and increase respiratory muscle strength (Verges et al., 2007). Respiratory functions develop with respiratory muscle exercises, the amount of O2 taken into the body increases with this development and the aerobic capacity of individuals improves (Olbrecht, 2000). It is also stated that aerobic exercises allow the body to get enough O2, develop the lungs and increase respiratory capacity (Sarıdede, 2019). In studies, it has been stated that step aerobic exercises, one of the aerobic exercise types, also improve respiratory functions (Kravitz et al., 1993; Milburn & Butts, 1983).

When the literature is examined, although it is known that there is an increase in the number of studies on strengthening the respiratory muscles (Bahçecioğlu & Yapıcıoğlu, 2024; Dinçer & Apaydın, 2023; Tsvetkova-Gaberska et al., 2023), it is seen that the studies on the effect of step aerobic exercises on respiratory parameters are limited (Esleman et al., 2022; Krishnamoorthi et al., 2021). In addition, when the studies were examined, it was determined that the sample groups were generally selected from patients with lung disease or athletes and these exercises were applied at home at rest (Arend et al., 2015; Hartz et al., 2018; Okrzymowska et al., 2019; Silva et al., 2013).

In the light of all this information, target to fill this gap in the literature; the aim of this study was to compare the effects of device respiratory muscle exercises applied at different times on respiratory functions in sedentary women doing step aerobic exercise. The hypothesis of the study was determined as “Among the step aerobic exercise sets, respiratory muscle exercises with devices are the most effective method to improve respiratory function.”

Methods

Participants

32 sedentary women between the ages of 18-24, who were studying at Niğde Ömer Halisdemir University Faculty of Sports Sciences, who had detailed health checks, participated in the study voluntarily (Table 1). Ethics committee approval for this study was obtained from Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee with the decision number 2022/37 dated April 14, 2022. Before the measurements, a detailed presentation about the study was made to the participants and an informed consent form was signed. This study was conducted in accordance with the Principles of the Declaration of Helsinki.

Research Design

Participants were selected by purposive sampling method and randomly divided into 3 groups as the group that performed respiratory muscle exercise with a device during rest between step aerobic exercise sets (Exercise+RMEG) (n=10), the group that performed respiratory muscle exercise with a device at home in addition to step aerobic exercise (Home+RMEG) (n=10) and the control group that performed only step aerobic exercise (CG) (n=12). Respiratory parameters of all participants were determined with a spirometer. The measurements were repeated twice, before the exercise protocol and 8 weeks after the first measurements. Before the step aerobic exercises, the respiratory muscle exercise loads of the participants in the Exercise+RMEG and Home+RMEG groups were determined by calculating 40% of the MIP measurements and each participant in these groups was given individualized respiratory muscle exercise devices.

Data Collection Tools

Pulmonary Function Test (PFT)

MIR brand SPIROLAB spirometer device was used to determine the lung volume and capacity of the participants. In order to obtain accurate results in the measurements, the participants were asked to rest for 5 minutes and to be in an upright position in a comfortable sitting position and clips were attached to their noses. Then, the mouthpiece of the device was placed between the teeth and the lips were placed tightly around the mouthpiece. Lung volumes and capacities including vital capacity (VC-lt), forced vital capacity (FVC-lt), forced expiratory volume in the first second (FEV1-lt), peak expiratory flow rate (PEF-lt/sec), mid forced expiratory flow rate (FEF25-75%), maximum voluntary ventilation (MVV) and FEV1/FVC were measured.

Maximum Inspiratory Pressure (MIP) Measurement

Powerbreathe K5 (HaB International Ltd, UK) device was used to measure the respiratory muscle strength of the participants and to determine the personalized exercise loads of the device to be used in respiratory muscle exercises. Intra-oral pressure was measured with the device and MIP measurement was performed to determine respiratory muscle strength. After entering the participant's gender, age, body weight and height information into the device, the participants were asked to sit comfortably and in an upright position in order to obtain accurate results in the measurements. The lips were placed firmly in contact with the mouthpiece of the Powerbreathe K5 device as if performing SFT, and after exhaling slowly and completely, the participant was instructed to inspire rapidly as if drawing a thick drink with a straw. The participant performed 30 ventilations on the S-Index (force index) and the best score was recorded.

Exercise Protocols

Step Aerobic Exercise Protocol

The reason why step aerobic exercises were preferred in this study is that the height of the platform used can be adjusted, the loads can be determined with regular music rhythms, and there are areas where the participants (Exercise + RMEG) can easily apply respiratory muscle exercises. A step aerobic exercise program was applied to all groups 3 days a week for 60 minutes a day for 8 weeks. The exercise was planned and implemented by the researcher in 3 phases as warm-up phase (5 min), main phase (50 min) and cool-down phase (5 min). All groups were subjected to the same exercise program.

Respiratory Muscle Exercise Protocol

Participants performed respiratory muscle exercises using a mechanically adjustable Powerbreathe Plus (blue) respiratory muscle exerciser (PowerBreathe, HaB International Ltd, UK) with progressive pressure and load adjustment between 10-250 cmH2O. Powerbreathe K5 MIP measuring device was used to determine the individualized exercise load before the respiratory muscle exercises. After determining the MIP of the participants by performing 30 ventilations, a personalized exercise load was set with 40% of this pressure and then each participant was given a Powerbreathe respiratory muscle exerciser specially adjusted according to the exercise load. In the literature, it was reported that respiratory muscle exercises performed with 15% of MIP were placebo, and the ideal load should be performed at 40% of MIP (Lorca-Santiago et al., 2020).

Group Performing Respiratory Muscle Exercise During Rest Between Sets of Step Aerobic Exercise (Exercise+RMEG)

Participants regularly participated in step aerobic exercises three days a week. In the first part of the main phase of the step aerobic exercises, the participants were exercised for 20 min. and then 30 respiratory muscle exercises were performed 30 times in the 5 min. rest interval. In the 2nd part of the main phase, 20 minutes of exercise was performed again and then respiratory muscle exercises were performed 30 times in the 5 min. rest interval. The participants performed a total of 60 respiratory muscle exercises until the end of the step aerobic exercise.

Group Performing Respiratory Muscle Exercises at Home (Home+RMEG)

The participants regularly participated in step aerobic exercises 3 days a week and performed a total of 60 respiratory muscle exercises, 30 times each in the morning and evening of the day they exercised. In Powerbreathe laboratory studies, it was recommended to perform respiratory muscle exercises with Powerbreathe 30 times twice a day in order to improve respiratory muscles. It was also stated that there should be at least 6 hours between the two exercises in order for the respiratory muscles to recover after 30 respiratory muscle exercises. For this reason, it was reported that the exercises to be performed should be done 30 times in the morning and 30 times in the evening (PowerBreathe, 2024).

Control Group (CG)

They participated in step aerobic exercises regularly as in the other groups. However, this group did not perform respiratory muscle exercise.

Statistical Analysis

In this study, the assumption of normal distribution of quantitative variables was examined visually (histograms and probability graphs) and analytically (Shapiro-Wilk Test). Since the quantitative variables were normally distributed, they were expressed as mean and standard deviation. Repeated measures two-way ANOVA test was used to examine the results of different protocols (Exercise+RMEG, Home+RMEG, CG), pre- and post-test measurements and protocol*time interaction effect. Mauchly's test of sphericity was used to test the homogeneity of variances and Greenhouse-Geisser correction was applied when necessary. Partial eta squares ($\eta p2$) were calculated for the magnitude of the effect between groups. In this study, significance level was accepted as $p<.05$.

Results

Table 1.
Demographic variables of the participants

	Exercise+RMEG	**Home+RMEG**	**CG**
	X̄±Sd	X̄±Sd	X̄±Sd
Age (year)	20.50±1.26	20.80±1.39	21.16±1.69
Height (cm)	163.80±3.67	166.60±3.97	162.08±5.76
Body weight (kg)	57.53±8.74	59.04±9.74	56.34±11.79
	Exercise+RMEG	Home+RMEG	CG

Table 2. ***Intragroup and intergroup comparison of lung volumes and capacities***

n=32	Pre-Test	Post- Test	Δ	%	Two-Way Repeated ANOVA			
Variables	X±SS	X±SS	T_{pre}-T_{post}	T_{pre}-T_{post}	Time	Group	Time*Group	Tukey
				VC				
Exercise+RMEG (10)	3.62±.31	4.08±.36*	.46±5	%12.70	F=53.87	F=.04	F=3.12	
Home+RMEG (10)	3.69±.36	3.96±.42*	.27±6	%7.31	$p < .000$	$p < .961$	$p < .059$	
CG (12)	3.76±.42	3.97±.43*	.21±1	%5.58	$\eta_p^2 = .65$	$\eta_p^2 = .00$	$\eta_p^2 = .17$	
				FVC				
Exercise+RMEG (10)	3.39±.52	3.85±.43*	.46±.09	%13.56	F = 36.71	F = .23	F = 1.49	
Home+RMEG (10)	3.63±.49	3.91±.49*	.55±00	%7.71	$p < .000$	$p < .790$	$p < .242$	
CG (12)	3.52±.64	3.76±.69*	.24±.05	%6.81	$\eta_p^2 = .55$	$\eta_p^2 = .01$	$\eta_p^2 = .09$	
				FEV1				
Exercise+RMEG (10)	3.12±.51	3.37±.44*	.25±.07	%8.01	F = 35.56	F = .28	F = .76	
Home+RMEG (10)	3.13±.43	3.35±.35*	.22±.08	%7.02	$p < .000$	$p < .972$	$p < .475$	
CG (12)	3.12±.63	3.28±.60*	.16±.03	%5.12	$\eta_p^2 = .55$	$\eta_p^2 = .00$	$\eta_p^2 = .05$	
				FEV1/FVC				
Exercise+RMEG (10)	85.18±4.41	90.04±5.44*	4.86±1.03	%5.70	F = 52.18	F = .29	F = 1.87	
Home+RMEG (10)	87.66±6.12	90.93±5.47*	3.27±.65	%3.73	$p < .000$	$p < .744$	$p < .172$	
CG (12)	87.55±4.62	90.13±5.37*	2.58±.75	%2.94	$\eta_p^2 = .64$	$\eta_p^2 = .02$	$\eta_p^2 = .11$	
				PEF				
Exercise+RMEG (10)	6.49±1.15	6.88±1.15*	.39±.00	%6.00	F = 48.18	F = 2.01	F = 1.77	
Home+RMEG (10)	6.42±.73	6.63±.74*	.21±.01	%3.27	$p < .000$	$p < .151$	$p < .187$	
CG (12)	5.76±1.13	6.00±1.04*	.24±.09	%4.16	$\eta_p^2 = .62$	$\eta_p^2 = .12$	$\eta_p^2 = .10$	
				FEF25-75%				
Exercise+RMEG (10)	3.88±.41	4.21±.51*	.33±.10	%8.50	F = 33.37	F = 2.44	F = 2.86	
Home+RMEG (10)	4.40±.51	4.57±.57*	.17±.06	%3.86	$p < .000$	$p < .105$	$p < .073$	
CG (12)	4.27±.38	4.40±.37*	.13±.01	%3.04	$\eta_p^2 = .53$	$\eta_p^2 = .14$	$\eta_p^2 = .16$	
				MVV				
Exercise+RMEG (10)	108.93±16.16	121.79±21.03*	12.86±4.87	%11.80	F = 45.32	F = .77	F = 1.36	
Home+RMEG (10)	113.90±13.02	122.43±14.64*	8.53±1.62	%7.48	$p < .000$	$p < .471$	$p < .272$	
CG (12)	105.23±20.11	112.62±22.19*	7.39±2.08	%7.02	$\eta_p^2 = .61$	$\eta_p^2 = .05$	$\eta_p^2 = .08$	
				MIP				
Exercise+RMEG (10)	83.20±5.69	89.33±7.32*	6.13±1.63	%7.36	F = 100.82	F = 6.76	F = 1.99	Exercise
Home+RMEG (10)	81.18±5.66	85.76±5.57*	4.58±.09	%5.64	$p < .000$	$p < .004$	$p < .154$	+RMEG>
CG (12)	76.29±3.91	80.12±4.12*	3.83±.21	%5.02	$\eta_p^2 = .77$	$\eta_p^2 = .31$	$\eta_p^2 = .12$	CG

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.

When Table 2 is analyzed, VC (F=53.87; *p*=.000, eta=.65), FVC (F=36.71; *p*=.000, eta=.55), FEV1 (F=35.56; *p*=.000, eta=.55), FEV1/FVC (F=52.18; *p*=.000, eta=0.64), PEF (F=48.18; *p*=.000, eta=.62), FEF25-75 (F=33. 37; *p*=.000, eta=.53), MVV (F=45.32; *p*=.000, eta=.61) and MIP (F=100.82; *p*=.000, eta=.77) parameters from pretest to posttest in all groups. There was a statistically significant difference between the groups only in the MIP parameter between Exercise+RMEG and CG in favor of Exercise+RMEG (F=6.76; *p*=.004; eta=.31). There was no statistical difference in the group*time interaction. When the development levels in percentage (%) are analyzed, it is seen that the highest development in all parameters was in Exercise+RMEG.

Discussion

The main function of the respiratory system is the exchange of O2 and carbon dioxide (CO2) gases in order to maintain an optimal O2 level in the arterial blood. Thus, the metabolic requirements of the body can be met during activity (Braman, 1995). In order for the amount of O2 inhaled to be more efficient, the muscles that help breathing must be strong and function properly. Increasing the muscle strength of breathing helps to improve the muscle structure and relaxation relationship of these muscles and increase the amount of O2 exhaled (Gosselink et al., 2000; Harver et al., 1989; Santos et al., 2012).

There are many different respiratory muscle exercises for improving the respiratory muscles. The aim of these exercises is to improve lung function, reduce shortness of breath, improve athletic performance and quality of life. It is known that respiratory muscle exercises are first used for rehabilitation and then to improve athletes' sportive performance (Aktuğ et. Al, 2024; Boutellier et al., 1992; Dowman et al., 2021; Figueiredo et al., 2020; Kurnianto et al., 2022; Volianitis et al., 2001). Especially in the national literature, it was determined that the studies on respiratory muscle exercises with devices were carried out in the field of rehabilitation and sports sciences. In the majority of these studies, it is seen that the training protocols are generally the same and the sample groups are selected from patients with lung disease or athletes.

In our study, the hypothesis "device respiratory muscle exercises applied between step aerobic exercise sets are the most effective method to improve respiratory functions" was confirmed. When Table 2 is examined, as a result of 8-week step aerobic and device respiratory muscle exercises, VC, FVC, FEV1, FEV1/FVC, PEF, FEF25-75, MVV and MIP parameters improved in favor of the post-test in all groups (Exercise+RMEG, Home+RMEG and CG).

When the literature was reviewed, the fact that there was no study similar to this study design in studies on respiratory muscle exercises revealed the originality of our study, but limited our discussion.

In the literature, there are studies in which respiratory muscle exercise is applied during exercise or at rest between exercise sets, which have a similar design, although not identical to this study. In one of these studies, Tan et. al (2024) investigated the effect of combined core and device respiratory muscle exercises on pulmonary function in 40 basketball players aged 13-14 years. In the study, 4 groups were formed as core exercise group, device respiratory muscle exercise group, combined exercise group and control group. All groups exercised 3 days a week during the study period and also continued their basketball training regularly. The core exercise group performed 20 minutes of core exercises just before basketball training, while the device respiratory muscle exercise group performed device respiratory muscle exercises 30 times each in the morning and evening (with 40% of MIP). The combined exercise group performed the core exercises performed by the core exercise group with the Powerbreathe respiratory muscle exerciser in their mouths (with 40% of the MIP) for 15 seconds each movement just before the basketball training, and after the movements, they released the Powerbreathe respiratory muscle exerciser and took a passive rest for 30 seconds. No exercise protocol was applied to the control group. As a result, statistically significant differences were found in FVC and FEV1 parameters in all exercise groups, while no difference was found in the control group. A significant difference was found in favor of the combined exercise group in FEV1/FVC and FEF25-75 parameters, while no difference was found in the other groups. PEF, VC and MIP parameters were significantly different in all groups. Since the most important muscle of respiration is the diaphragm muscle in the core region, it has been reported that core exercises also improve the diaphragm muscle and as a result, respiratory parameters increase. In addition, it has been reported by the researcher that the combination of core exercises and device respiratory muscle exercises is effective in the development of respiratory functions.

In another study, it was aimed to investigate the effects of respiratory muscle exercises on MIP and swimming performance with the participation of 8 elite swimmers aged 17-24 years. In the study, a high-volume device respiratory muscle exercise group and a low-volume device respiratory muscle exercise group were formed. All participants performed device respiratory muscle exercises 30 times (10x3) in the morning 6 days a week for 6 weeks. The high-volume device respiratory muscle exercise group performed device respiratory muscle exercises in the afternoon in addition to the device respiratory muscle exercises performed in the morning. The low-volume device respiratory muscle exercise group participated in the core exercises performed in the afternoon but did not perform device respiratory muscle exercise during this time. As a result, it was found that there was an improvement in the MIP values of the swimmers in both groups, but there was no statistically significant difference between the groups, while there was no improvement in swimming performance and lactate removal rates in both groups. Researchers have reported that respiratory muscle exercises performed with device increase inspiratory muscle strength in elite swimmers (Gómez-Albareda et al. 2023).

Mustafaoğlu et al. (2019) aimed to examine the effects of core exercises and respiratory muscle exercises on respiratory function, respiratory muscle strength, and functional capacity in 49 individuals with substance use disorder aged 15-18 years. An exercise group and a control group were formed in the study. All participants walked and jogged for 30 minutes a day for 6 weeks and also participated in activities such as table tennis, basketball and soccer for 30 minutes 3 days a week. In addition to all these exercises, the exercise group performed core exercises combined with deep breathing exercises for 45-60 minutes 2 days a week for 6 weeks. In addition to the exercises, the control group participated in activities such as table tennis and basketball accompanied by a trainer for 45-60 minutes 2 days a week for 6 weeks. As a result, it was found that respiratory function (FVC, FEV1, PEF and FEF 25%-75%, FEV1/FVC) respiratory muscle strength (MIP, MEP) and functional capacity (6 DYT) parameters of the participants improved between pre-test and post-test in both groups, and when the groups were compared, it was found that all parameters except FEV1/FVC improved more in the exercise group. According to these findings, respiratory exercises combined with core exercises improved respiratory function, respiratory muscle strength and functional capacity of individuals with substance use disorder.

In the above studies, respiratory muscle exercises were performed in combination with different exercises. The results of the studies suggest that respiratory muscle exercises during exercise are effective in improving respiratory function. In the studies examined, it was observed that respiratory muscle exercises improved VC, FVC, FEV1, PEF, FEV1/FVC and MIP parameters among the respiratory functions of the participants. The findings are similar to our study. The common features of the studies are that respiratory muscle exercises were performed without rest after exercise. This is a direct result of the respiratory muscles encountering a new load before exercise fatigue has passed. All respiratory muscles, especially the diaphragm muscle, develop thanks to the respiratory muscle exercises with the device performed before the fatigue of the exercise passes. This development is thought to further enhance respiratory function.

In our study, step aerobic and device respiratory muscle exercises were applied to the participants for 8 weeks and statistically significant differences were determined in respiratory parameters (VC, FVC, FEV1, FEV1/FVC, PEF, FEF25-75, MVV and MIP) from pretest to posttest in all groups (Exercise+RMEG, Home+RMEG and CG). When the difference between the groups was examined, a statistical difference was found only in the MIP parameter between Exercise+RMEG and CG in favor of Exercise+RMEG. The fact that there was a difference only in the MIP parameter between Exercise+SKEG and CG and in favor of Exercise+RMEG confirms that the strength of the diaphragm muscle increased. MIP primarily determines the strength of the diaphragm, the respiratory muscle (De Jesús Mora-Romero et al., 2014). In the literature, it is reported that significant improvements were achieved in the MIP values of individuals performing Powerbrathe respiratory muscle exercise. This, in turn, has been reported to increase the oxidative capacity of the diaphragm (Powers et al., 1990), leading to an increase in strength that provides greater resistance to fatigue (HajGhanbari et al., 2013).

When respiratory parameters of Home+RMEG and CG were compared, it was observed that there was more improvement in Home+RMEG. The reason for this is thought to be that in device respiratory muscle exercises, the individual inspires against a certain resistance (at a load of 40% of the MIP) and as a result, respiratory muscles and respiratory functions develop. As a matter of fact, targeting the diaphragm muscle in respiratory muscle exercises and exposing this muscle directly to external load for a while may have led to the development of both the diaphragm, the main muscle of respiration, and indirectly other auxiliary respiratory muscles. It can also be said that direct targeting of the respiratory muscles leads to an improvement in the oxidative capacity of the diaphragm muscle (Dempsey, 2006). It is known that respiratory muscle fatigue leads to a decrease in inspiratory muscle strength, and the efficiency of respiratory parameters depends on the delay of respiratory muscle fatigue (Gupta & Sawane, 2012). Therefore, this finding may explain the improvement in respiratory parameters and performance as a result of increased oxidative capacity of the diaphragm muscle, the major muscle in respiration (Weiner et al., 2003).

It is noteworthy that the respiratory parameters of the other participants of this study, Exercise+RMEG, showed a higher improvement compared to Home+RMEG. It is thought that this may be related to the fact that all respiratory muscles, especially the diaphragm muscle, develop more as a result of the fact that the respiratory muscles are directly confronted with a new load before recovery after the step aerobic exercise. In a study, it was reported that the contractions that occur during the application of respiratory muscle exercises create favorable conditions for the development of O2 delivery and muscle microvascular utilization profiles, and as a result of the combined effect, respiratory parameters are improved due to the prolongation of fatigue time due to the strengthening of respiratory muscles (Gupta & Sawane, 2012; Poole & Jones, 2012). In this study, it is thought that the respiratory muscle exercises performed during the fatigue that occurred while the participants were practicing step aerobic exercises may have improved the aerobic capacity of the respiratory muscles in the participants more than the other groups. As a matter of fact, studies have shown that variables such as the frequency, number of repetitions, duration and time of the exercises are important in the development of respiratory muscles (Saicaors, 1987).

Conclusion and Recommendation

As a result, it was determined that step aerobic exercises applied to sedentary individuals were an effective method to improve the respiratory parameters of sedentary individuals. It has been observed that respiratory muscle exercises with devices applied together with step aerobic exercises lead to more improvement in respiratory parameters. Therefore, respiratory muscle exercises with devices applied together with exercise can be applied as an alternative method to increase respiratory parameters. When we look at the studies in the literature, it is seen that respiratory muscle exercises with the device are usually applied when the person is in the resting phase and not doing any activity. In our study, unlike the literature, respiratory muscle exercises with the device were performed between sets of exercise without resting the individuals. In addition, with the comprehensive evaluation of the device respiratory muscle exercises (Exercise+RMEG, Home+RMEG) that we performed with the inclusion of different groups in this study, it was determined which of the 2 methods improved respiratory functions more. Considering this development, it is thought that device respiratory muscle exercises applied between exercise sets will be the most beneficial way of use. In future studies, it may be recommended to examine the effect of device respiratory muscle exercises applied with different MIP pressures on respiratory functions.

Etik Komite Onayı: Bu çalışma için etik komite onayı Niğde Ömer Halisdemir Üniversitesi'nden (Tarih: 14 Nisan 2022, Karar No: 2022/37 ile alınmıştır.

Hasta Onamı: Çalışmaya katılan tüm katılımcılardan yazılı onam alınmıştır.

Hakem Değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir- S.İ.; Tasarım- S.İ., Z.K.; Denetleme- Z.B.A., S.İ., Z.K.; Kaynaklar- Z.B.A., Z.K.; Veri Toplanması ve/veya İşlemesi* S.İ. Z.K. Analiz ve/ veya Yorum- Z.B.A.; Literatür Taraması- Z.B.A., Z.K.; Yazıyı Yazan- Z.K., Z.B.A., S.İ.; Eleştirel İnceleme-Z.B.A.

Çıkar Çatışması: Yazarlar, çıkar çatışması olmadığını beyan etmiştir.

Finansal Destek: Bu araştırma, Niğde Ömer Halisdemir Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon Birimi tarafından desteklenmiştir (Proje Numarası: SPT 2022/1-BAGEP, 2022).

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Niğde Ömer Halisdemir University (Date: 14 April 2022, Decision Number: 2022/37

Informed Consent: Written consent was obtained from all the participants.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept- S.İ.; Design- S.İ., Z.K.; Supervision- Z.B.A., S.İ., Z.K.; Resources- Z.B.A., Z.K.; Data Collection and/or Processing- S.İ., Z.K.; Analysis and/or Interpretation- Z.B.A.; Literature Search- Z.B.A., Z.K.; Writing Manuscript- Z.K., Z.B.A., S.İ.; Critical Review-Z.B.A.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: This research has been supported by the Scientific Research Projects Coordination Unit of Nigde Omer Halisdemir University (Project Number: SPT 2022/1-BAGEP, 2022).

References

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

Aktuğ, Z. B., Yavuz, G., Kutlu, Z., & Akçar, M. (2024). Sağlıklı bireylerde farklı solunum kası egzersizlerinin solunum fonksiyonları, fonksiyonel kapasite ve yaşam kalitesi üzerine etkisinin karşılaştırılması. *SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi, 22*(4), 84-95. https://doi.org/10.33689/spormetre.1477159

Arend, M., Mäestu, J., Kivastik, J., Rämson, R., & Jürimäe, J. (2015). Effect of inspiratory muscle warm-up on submaximal rowing performance. *The Journal of Strength & Conditioning Research, 29*(1), 213-218. https://doi.org/10.1519/JSC.0000000000000618

Bahçecioğlu, H. & Yapıcıoğlu, B. (2024). Milli bocce sporcularında dört haftalık solunum kası antrenmanının solunum kas kuvveti, fonksiyonları ve performansa etkisi. *Spor Bilimleri Araştırmaları Dergisi, 9*(1), 34-49. https://doi.org/10.25307/jssr.1398493

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: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

Boutellier, U., Büchel, R., Kundert, A., & Spengler, C. (1992). The respiratory system as an exercise limiting factor in normal trained subjects. *European Journal of Applied Physiology and Occupational Physiology, 65*(4), 347-353. https://doi.org/10.1007/BF00868139

Braman, S. S. (1995). The regulation of normal lung function. *In Allergy and Asthma Proceedings, Ocean Side Publications. 16*(5), 225-6. https://doi.org/10.2500/108854195778702602

De-Jesús Mora-Romero, U., Gochicoa-Rangel, L., Guerrero-Zúñiga, S., CidJuárez, S., Silva-Cerón, M., Salas-Escamilla, I., & Torre Bouscoulet, L. (2014). Maximal inspiratory and expiratory pressures: Recommendations and procedure. *NCT Neumol. y Cirugía Tórax,73*, 247–253. https://dx.doi.org/10.35366/55380

Dempsey, J.A. (2006). Challenges for future research in exercise physiology as applied to the respiratory system. *Exerc Sport Sci Rev., 34*(3), 92-8.

De Troyer, A. (2012). Respiratory effect of the lower rib displacement produced by the diaphragm. *Journal of Applied Physiology, 112*(4), 529-534. https://doi.org/10.1152/japplphysiol.01067.2011

Dinçer, Ö. & Apaydın, C. (2023). Voleybolcularda uygulanan crosfitt tabata protokolünün anaerobik güç, kapasite ve solunum fonksiyonları üzerine etkisi. *Spor ve Rekreasyon Araştırmaları Dergisi, 5*(2), 125-137. https://doi.org/10.52272/srad.1393480

Dowman, L., Hill, C. J., May, A., & Holland, A. E. (2021). Pulmonary rehabilitation for interstitial lung disease. *Cochrane Database of Systematic Reviews*, (2). https://doi.org/10.1002/14651858

Esleman, A., Geberemariam, B. Y., & Aychiluhim, W. (2022). Effects of twelve week aerobic exercise on selected health-related physical fitness variables on Gonji preparatory school male students. *East African Journal of Biophysical and Computational Sciences, 3*(1), 9-16. https://dx.doi.org/10.4314/eajbcs.v3i1.2S

Figueiredo, R. I., Azambuja, A. M., Cureau, F. V., & Sbruzzi, G. (2020). Inspiratory muscle training in COPD. *Respiratory Care, 65*(8), 1189-1201. https://doi.org/10.4187/respcare.07098

Gosselink, R., Kovacs, L., Ketelaer, P., Carton, H., & Decramer, M. (2000). Respiratory muscle weakness and respiratory muscle training in severely disabled multiple sclerosis patients. *Archives of Physical Medicine and Rehabilitation, 81*(6), 747-751. https://doi.org/10.1016/S0003-9993(00)90105-9

Gupta, S.S. & Sawane, M.V. (2012). A comparative study of the effects of yoga and swimming on pulmonary functions in sedentary subjects. *Int J Yoga, 5*(2), 128-33. https://dx.doi.org/10.4103/0973-6131.98232

Gómez-Albareda, E., Viscor, G., & García, I. (2023). Inspiratory muscle training improves maximal inspiratory pressure without increasing performance in elite swimmers. *International Journal of Sports Physiology and Performance, 18*(3), 320- 325. https://doi.org/10.1123/ijspp.2022-0238

HajGhanbari, B., Yamabayashi, C., Buna, T. R., Coelho, J. D., Freedman, K. D., Morton, T. A., Palmer, S. A., Toy, M. A., Walsh, C., Sheel, A. W., & Reid, W. D. (2013). Effects of respiratory muscle training on performance in athletes: a systematic review with meta-analyses. *The Journal of Strength & Conditioning Research, 27*(6), 1643-1663. https://doi.org/10.1519/JSC.0b013e318269f73f

Harver, A., Mahler, D. A., & Daubenspeck, J. A. (1989). Targeted inspiratory muscle training improves respiratory muscle function and reduces dyspnea in patients with chronic obstructive pulmonary disease. *Annals of Internal Medicine, 111*(2), 117 124. https://doi.org/10.7326/0003-4819-111-2-117

Hartz, C. S., Sindorf, M. A., Lopes, C. R., Batista, J., & Moreno, M. A. (2018). Effect of inspiratory muscle training on performance of handball athletes. *Journal of Human Kinetics, 6*3, 43. https://doi.org/10.2478/hukin-2018-0005

Kilding, A. E., Brown, S. & McConnell, A. K. (2010). Inspiratory muscle training improves 100 and 200 m swimming performance. *Eur J Appl Physiol 108*, 505–511. https://doi.org/10.1007/s00421-009-1228-x

Kravitz, L., Cisar, C. J., Christensen, C. L., & Setterlund, S. S. (1993). The physiological effects of step training with and without handweights. *The Journal of Sports Medicine and Physical Fitness, 33*(4), 348–358.

Krishnamoorthi, K., Kumaran, S., & Halik, A. (2021). Effect of aerobic dance training on body composition and cardio respiratory endurance among obese. *International Journal of Yogic, Human Movement and Sports Sciences, 6,* 143- 145.

Kurnianto, S., Astuti, A., Sulistyono, R. E., & Putri, M. C. (2022). Changes in respiratory function in asthma patients using respiratory inspiration muscle exercise: literature review. *Nursing and Health Sciences Journal (NHSJ), 2*(2), 179-182.

Lorca-Santiago, J., Jiménez, S. L., Pareja-Galeano, H., & Lorenzo, A. (2020). Inspiratory muscle training in intermittent sports modalities: a systematic review. *International Journal of Environmental Research and Public Health, 17*(12), 4448. https://doi.org/10.3390/ijerph17124448

Lötters, F., van Tol, B., Kwakkel, G., & Gosselink, R. (2002). Effects of controlled inspiratory muscle training in patients with COPD: a meta-analysis. *The European Respiratory Journal, 20*(3), 570–576. https://doi.org/10.1183/09031936.02.00237402

Martin, L. (1999). Methods of assessing exercise capacity. Rehabilitation of the patient with respiratory disease. McGraw Hill/editors NS Cherniack, MD Altose, I. Homma.

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

McConnell, A. (2011). Breathe strong perform better. (1th Edition). USA: Human Kinetics.

Milburn, S., & Butts, N. K. (1983). A comparison of the training responses to aerobic dance and jogging in college females. *Medicine and Science in Sports and Exercise, 15*(6), 510-513.

Mustafaoğlu, R., Demir, R., Demirci, A. C. & Yigit, Z. (2019). Effects of core stabilization exercises on pulmonary function, respiratory muscle strength, and functional capacity in adolescents with substance use disorder: Randomized controlled trial. *Pediatric Pulmonology, 54*(7), 1002-1011. https://doi.org/10.1002/ppul.24330

Olbrecht, J. (2000). The sicence of winning: planning periodizingand optimizing swim training. *Kersen bomenlaan, Belgium: IJS. Published, 335*(4): 281-283.

Okrzymowska, P., Kurzaj, M., Seidel, W., & Rozek-Piechura, K. (2019). Eight weeks of ınspiratory muscle training improves pulmonary function in disabled swimmers a randomized trial. *International Journal of Environmental Research and Public Health, 16*(10), 1747. https://doi.org/10.3390/ijerph16101747

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 and Recreation Patterns (JERP),4*(1),87-98. https://doi.org/10.53016/jerp.v4i1.99

PowerBreathe. (2024). How the POWERbreathe IMT device Works, Web: https://www.powerbreathe.com/how-the-powerbreathe-imt-device-works/, 20 Mayıs 2024'te alınmıştır.

Powers, S.K., Lawler, J., Criswell, D., Dodd, S., Grinton, S., Bagby, G., & Silverman, H. (1990). Endurance-training-induced cellular adaptations in respiratory muscles. *J. Appl. Physiol. 68,* 2114–2118. https://doi.org/10.1152/jappl.1990.68.5.2114

Poole, D.C. & Jones, A.M. (2012). Oxygen uptake kinetics. *Compr. Physiol, 2*(2), 933-996.

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

Saicaors, M. (1987). Comporison of responses to weight training in pubescent boys and men. *J Sport Med Phys Fitness, 27*(1):30-37.

Sarıdede, C. Ö. (2019). *Pilates egzersizinin sedanter insanlar üzerindeki etkileri*. Yayımlanmamış Yüksek Lisans Tezi, İstanbul Gelişim Üniversitesi, Sağlık Bilimleri Enstitüsü, İstanbul.

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

Silva, I. S., Fregonezi, G. A., Dias, F. A., Ribeiro, C. T., Guerra, R. O., & Ferreira, G. M. (2013). Inspiratory muscle training for asthma. Cochrane Database of Systematic Reviews, (9). https://doi.org/10.1002/14651858.CD003792.pub2

Tan, M., Aktuğ, Z. B., Yavuz, G., & İbiş, S. (2024). Basketbolcularda kombine olarak uygulanan kor ve solunum kası egzersizlerinin solunum fonksiyonlarına etkisi: Deneysel çalışma. *Türkiye Klinikleri Journal of Sports Sciences*, 16(3).

Tsvetkova-Gaberska, M., Kozhuharov, M., Ganeva, M., Markova, P., & Pencheva, N. (2023). The effect of respiratory muscle training on young track-and-field athletes. *Journal of Physical Education and Sport, 23*(3), 730-737. https://doi.org/10.7752/jpes.2023.03090

Tu, J., Inthavong, K., & Ahmadi, G. (2013). Computational fluid and particle dynamics in the human respiratory system. *Dordrecht: Springer Netherlands.* https://doi.org/10.1007/978-94-007-4488-2

Verges, S., Lenherr, O., Haner, A.C., Schulz, C., & Spengler, C.M. (2007). Increased fatigue resistance of respiratory muscles during exercise after respiratory muscle endurance training. *Am J Physiol Regul Integr Comp Physiol, 292*(3):1246- 1253. https://doi.org/10.1152/ajpregu.00409.2006

Volianitis, S., McConnell, A. K., Koutedakis, Y., McNaughton, L., Backx, K., & Jones, D. A. (2001). Inspiratory muscle training improves rowing performance. *Medicine and Science in Sports and Exercise, 33*(5), 803 809.

Weiner, P., Magadle, R., Beckerman, M., Weiner, M., & Berar-Yanay, N. (2003). Comparison of specific expiratory, inspiratory, and combined muscle training programs in COPD. *Chest, 124*(4), 1357-1364. https://doi.org/10.1378/chest.124.4.1357

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:10.1183/09031936.03.00059503