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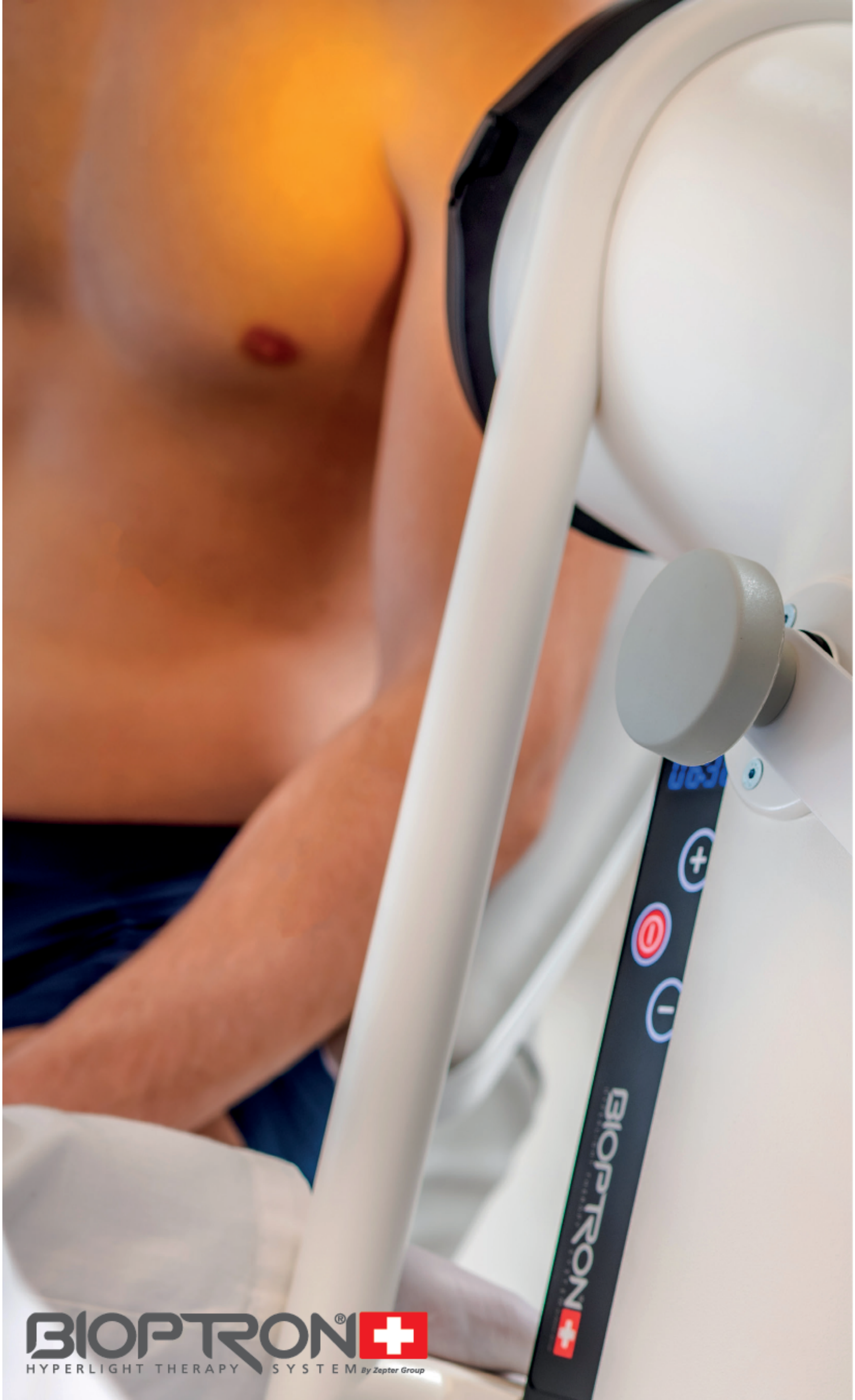

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fizjoterapia polska
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Lung Boost Training Effect on Ventilatory Functions in Choral Singers: A Randomized Controlled Trial

Wpływ treningu Lung Boost na funkcje oddechowe u śpiewaków chóralnych: randomizowane badanie kontrolowane

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Abstract

Background and Purpose. Despite the well-known benefits of Breathing Exercise on ventilatory functions in singers, none of the former studies had evaluated the impact of Lung Boost on ventilatory functions in choral singers. Therefore, the aim of this study was to conduct the effect of lung boost as a respiratory muscle trainer on selected ventilatory function in choral singers. Materials and Methods. Sixty subjects of both sexes 36 female and 24 male with age ranged from 10-20 years old participated in this study in two groups A and B chosen from Qasr Al-Thaqafa in Fayoum city, all of them received traditional exercise program which includes deep breathing exercise in form of diaphragmatic, nose breathing exercises and exercise with respiration using upper limbs; thirty subjects in group A received respiratory muscle training by Lung Boost plus the traditional exercise program for 10 weeks 3 sessions per week. Ventilatory functions were measured (Forced Expiratory Volume in one second (FEV1), Forced Expiratory Volume in six second (FEV6), ratio of FEV1/FEV6 and Maximal Voluntary Ventilation (MVV)) at the beginning of the study and after 10 weeks. Results. Comparing both groups percent of change revealed that there were statistically significant increases in FEV1, FEV6, FEV1/FEV6, MVV ($p < 0.05$) in favour of group (A). Conclusion. The conjugation of lung Boost with traditional chest physical therapy program improved the ventilatory functions in choral singers.

Key words:

Choral singers, Ventilatory functions, Lung Boost

Streszczenie

Informacje wprowadzające i cel. Pomimo dobrze znanych korzyści wynikających z wykonywania ćwiczeń oddechowych na funkcje oddechowe u śpiewaków, żadne z wcześniejszych badań nie oceniało wpływu Lung Boost na funkcje oddechowe u śpiewaków chóralnych. Dlatego celem tego badania było zbadanie wpływu Lung Boost jako trenera mięśni oddechowych na wybrane funkcje oddechowe u śpiewaków chóralnych. Materiały i metody. W badaniu wzięło udział 60 osób obojga płci - 36 kobiet i 24 mężczyzn w wieku 10-20 lat w dwóch grupach A i B wybranych z Qasr Al-Thaqafa w mieście Fajum; wszyscy zostali objęci tradycyjnym programem ćwiczeń obejmującym ćwiczenia głębokiego oddychania w formie ćwiczeń przeponowych, oddychania przez nos oraz ćwiczenia oddechowe z wykorzystaniem kończyn górnych; trzydzieści osób w grupie A zostało poddanych treningowi mięśni oddechowych metodą Lung Boost oraz tradycyjnemu programowi ćwiczeń przez 10 tygodni, 3 sesje w tygodniu. Na początku badania i po 10 tygodniach mierzono funkcje oddechowe (wymuszona objętość wydechowa w ciągu jednej sekundy (FEV1), wymuszona objętość wydechowa w ciągu sześciu sekund (FEV6), stosunek FEV1/FEV6 i maksymalna wentylacja dobrowolna (MVV). Wyniki. Porównanie odsetka zmian w obu grupach wykazało, że wystąpiły statystycznie istotne wzrosty w zakresie FEV1, FEV6, FEV1/FEV6, MVV ($p < 0{,}05$) na korzyść grupy (A). Wniosek. Stosowanie Lung Boost w połączeniu z tradycyjnym programem fizjoterapii klatki piersiowej poprawiło funkcje oddechowe u śpiewaków chóralnych.

Słowa kluczowe

Śpiewacy chóralni, funkcje oddechowe, Lung Boost

Introduction

Speech and singing have the same pattern of a shorter inhalation followed by a longer exhalation with vocalization. During the development of singing voice, training of the breath is one of the most important components [1]. Singing, the act of producing musical sounds with the voice, it is well known that respiration has a key role in generating the voice, and it is an essential factor for singing as well [2].

Singing is a complex sensory motor activity that requires coordinated interaction of organs of aural perception, phonation, respiration and articulation monitored by the musical right brain [3]. So singing process involves a fast and strong inspiration followed by prolonged and controlled expiration. People who sing are practicing a particular exercise which requires diaphragm contraction to do inspiration followed by prolonged contraction of respiratory muscles to vibrate the vocal folds [4].

Breathing patterns during speaking and singing can differ from that during quiet breathing by modification of respiratory kinematics (i.e. movements of rib cage and abdomen) in response to altered task demands [5]. Enhanced respiratory muscle strength and control as well as coordinated breathing mode can effectively improve the efficiency of respiratory and circulatory response and coordinate cardiopulmonary function, resulting in increase in vital capacity, forced vital capacity (FVC), Forced Expiratory Volume in one second (FEV1), Peak Expiratory Flow Rate (PEFR), and Heart Rate Variability [6].

Pulmonary function tests (PFT) have been evolved from tools that are widely used in assessing the respiratory status by providing objective information about the status of an individual's respiratory system. Hence, voice researchers are interested in exploring various aspects of the pulmonary function of professional singers. Previous studies reported that vocal function exercises improved the phonation system of singers, while phonatory ability or efficiency largely depended on pulmonary efficiency that was evaluated by PFTs [7]. Thus, this study aimed to conduct the effect of lung boost on ventilatory functions in choral singers. This study may increase the body knowledge of physical therapist in field of breathing exercises in choral singers.

Materials and Methods

Study Design

The study was designed as a prospective, pre–posttest design. Ethical approval was obtained from the institutional review board at the Faculty of Physical Therapy, Cairo University before study commencement [No: P.T. REC/012/002392]. It was conducted between July to December. 2020.

Participants

A convenient sample of sixty choral singers of both sexes 36 female and 24 males was recruited from Qasr al Thaqafa in Fyoum City. They were enrolled and assessed for their eligibility to participate in the study. Accordingly, all selected subjects were informed with the training program. The Body Mass index was less than 24 kg/m^2. Some participants were excluded from the study if they showed any epistaxis (nose bleeding), malignant disease, acute infection, recent acute cardiac event (6 weeks) or congestive cardiac failure, any significant musculoskeletal disorders (Kyphosis –Scoliosis) or recent positive Covied-19.

Randomization

A written form of informed consent was taken before participation of the singers in this study, in a way that ensures their confidentiality. Informed consent was obtained from each participant after explaining the study's nature, purpose and benefits, informing them of their right to refuse or withdraw at any time, and about the confidentiality of any obtained information. Anonymity was assured through coding of all data. The choral singers were randomly divided into 2 groups (control and study) using computer generated random numbers. Distribution was hidden in sequentially numbered opaque envelopes [8].

Outcome measures

Ventilatory Functions: The choral singers included in the study were subjected to assessment of ventilatory functions by vital graph spirometry, measuring (Forced Expiratory Volume in one second (FEV1), Forced Expiratory Volume in six second (FEV6), ratio of FEV1/FEV6)

While Maximal Voluntary Ventilation (MVV) measured (by the equation FEV1 multiplied 37.5) [9].

by the following steps:

1) Both height and weight for each singer were measured before starting the ventilator functions assessment.
2) The singer sits comfortably and upright while putting nose clip and relax.
3) Every singer has his/her privet mouthpiece
4) The singer was asked to inhale as deeply as possible, holding the breath, then inserted the mouthpiece carefully into the mouth.
5) The singer held the mouthpiece tightly between lips and kept his/her tongue down.
6) The singer was asked to exhale for as long as possible and blow for at least 6 seconds.
7) The singer was asked to inhale as deeply as possible while holding mouthpiece.
8) The singer exhaled for as long as possible.
9) The singer repeated blowing three times to obtain good test quality.

Intervention

All participants were trained by traditional exercise program (Diaphragmatic breathing, Nose breathing exercise and exercise with respiration using upper limbs).

• Diaphragmatic breathing (The singer was asked to sit on the chair and placed one hand on his belly below the ribcage and the other hand on his chest, then he was asked to inhale deeply through the nose for a count of 3, then he was asked to tight the stomach muscles and exhale for a count of 6 through slightly puckered lips and his hands on his chest should remain still).

• Nose breathing (The singer was asked to site on the chair and placed his right thumb to close right nostril after full exhalation, then he inhaled slowly and completely through left nostril followed by opening right nostril and exhaled slow controlled and free from exertion through it while closing left nostril, the cycle was repeated by left nostril in the beginning).

• Respiration using upper limbs (The singer was asked to site on the chair and started shoulder flexion from 0 to 180 degree (upper limbs elevation) during inspiratory time and returned to initial position during expiratory time (shoulder extension 180 to 0

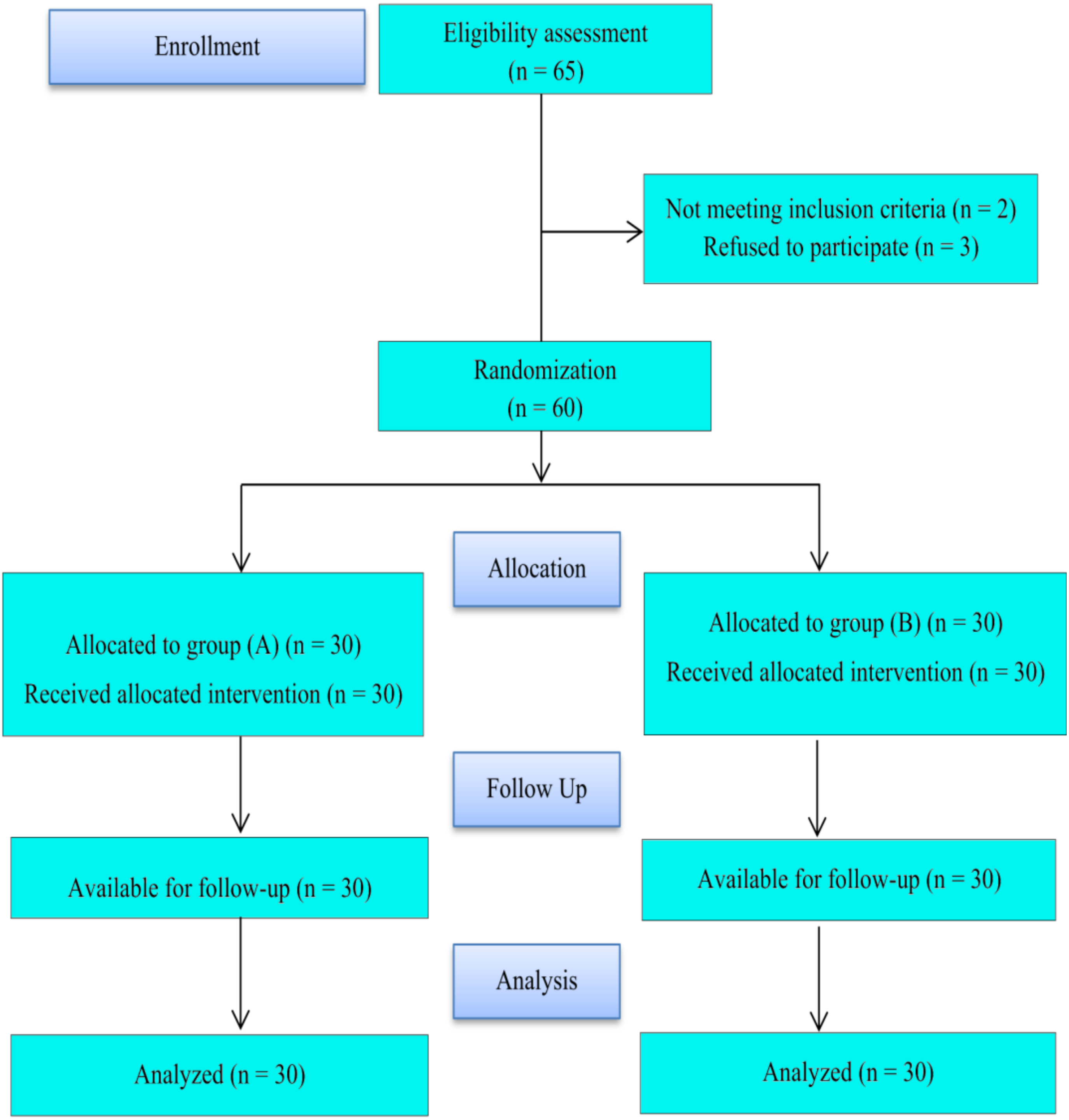

Figure 1. Flow chart of the study

degree) and (shoulder horizontal abduction) initial position (shoulder flexion 90 degree) during inspiratory time and returned to initial position during expiratory time (shoulder horizontal adduction) after 5 minutes of warming up in the form of stretching exercises (for the upper limb and accessory muscles of respiration). Each exercise was repeated for 10 repetitions for 6 sets for a total time for the session 45 min. Only group A was trained by Lung Boost beside the traditional exercise program. This program was performed 3 times per a week for 10 successive weeks.

Lung Boost respiratory trainer

Starting by choosing strength mode of the device for respiratory muscles training with measuring tube inhale or exhale by the mouthpiece. The effort had been vary depending on the volume of air that displaced. By raising the difficulty level one step at a time, the duration of breathing exercise was allowed for 15 minutes, made up to 45 counts for 5 minutes, repeatedly. After every inhale/exhale exercise, singer started to rest for 15 seconds that to prevent hyperventilation or muscle fatigue.

Statistical analysis

Results are expressed as mean ± standard deviation (SD) for normally distributed data and median and interquartile range (IQR) for non-normally distributed data. Comparison of percent of change of different variables between groups was performed using Mann Whitney U test as non-normally distributed data. Pair-wise comparison (pre- versus post-assessment) within the same group for all variables was performed using paired t-test as normally distributed data. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value ≤ 0.05 was considered significant and < 0.01 was considered highly significant.

Results

Comparing the general characteristics of the participants between both groups revealed that there were no statistical significant differences in the mean age, weight, height and BMI ($p > 0.05$) (Table 1).

Paired t test was used to compare the mean values of FEV1, FEV6, FEVI/FEV6 and MVV measured at post-treatment in the two groups on controlling their baseline values measured at pre- treatment. So, a highly significant increase of FEV1, FEVI/FEV6 and MVV in post-intervention compared to pre-intervention ($P < 0.05$) at both groups. In addition, it showed a significant increase of FEV6 in post-intervention compared to pre-intervention ($P < 0.05$) at group (A) only (table 2). Mann Whitney U test was used to compare the percent of change of FEV1, FEV6, FEVI/FEV6 and MVV between both groups. So, a highly significant improvement of FEV1, FEVI/FEV6 and MVV in group (A) compared to group (B) ($P < 0.05$) (table 3).

Table 1. Baseline characteristics of participants in both groups

	Group [A] [n = 30]	Group [B] [n = 30]	P value*
Age [yrs.]	17.77 ± 1.96	17.27 ± 2.43	0.384^{NS}
Weight [kg]	63.63 ± 9.94	62.10 ± 9.38	0.541^{NS}
Height [cm]	1.64 ± 0.11	1.63 ± 0.10	0.839^{NS}
BMI [kg/m^2]	23.28 ± 1.27	22.95 ± 1.38	0.344^{NS}

^{NS} = P > 0.05 = non-significant, P = Probability

Table 2. Descriptive and Inferential Statistics of the Dependent Variables in the Experimental and Control Groups Pre and Post the Eight-Week Study Period

Within groups		Group [A] [n = 15]	Group [B] [n = 15]
FEV1	Pre training	3.87 ± 0.76	4.15 ± 0.61
	Post training	4.12 ± 0.82	4.20 ± 0.62
	P value**	0.001^{S}	0.001^{S}
FEV6	Pre training	4.22 ± 0.86	4.53 ± 0.60
	Post training	4.36 ± 0.85	4.54 ± 0.59
	P value**	0.039^{S}	0.595^{NS}
FEV1/FVC	Pre training	91.30 ± 3.26	90.90 ± 4.18
	Post training	94.21 ± 3.15	91.90 ± 4.05
	P value**	0.007^{S}	0.023^{S}
MVV	Pre training	145.06 ± 28.52	155.51 ± 22.94
	Post training	154.32 ± 30.74	157.34 ± 23.06
	P value**	0.001^{S}	0.001^{S}

Data expressed by mean and standard Deviation (SD), ^{NS} P > 0.05 = non-significant, ^{S} P < 0.05 = significant, P = Probability, FEV1: forced expiratory volume in one second, FEV6: forced expiratory volume in six second, MVV: Maximal Voluntary Ventilation

Table 3. The percent of change of The ventilatory functions for both groups

		Group [A] [n = 15]	Group [B] [n = 15]	
FEV1	% of change	3.24 (7.2)	0.88 (1.4)	0.0001[S]
FEV6	% of change	0.6 (4.62)	0 (0.88)	0.046[S]
FEV1/FEV6	% of change	3.14 (7.2)	0.87 (1.41)	0.0001[S]
MVV	% of change	3.2 (3.6)	1.06 (2.07)	0.0001[S]

Data expressed by median and interquartile range (IQR), [NS] P > 0.05 = non-significant, [S] P < 0.05 = significant, P = Probability, FEV1: forced expiratory volume in one second, FEV6: forced expiratory volume in six second, MVV: Maximal Voluntary Ventilation

Discussion

Respiratory and vocal exercises are important steps for a singer to improve his/her respiratory coordination. As a consequence, they are considered essential parts of the learning singing process. Therefore, singing not only improves social bonding and enjoyment during practice but, because breathing exercise is also an irreplaceable part of singing, it also enhances physical achievement [6]. So, the present study was conducted to find out the effect of (Lung Boost) on selected ventilatory functions testing in choral singers. There was a significant effect on some ventilatory functions FEV1 by 6.46%, FEV1/FEV6 by 3.19%, FEV6 3.32% and increased MVV by 6.38%.

In study by Nam et al. [10] who disagreed with our results he stated that little differences were found in pulmonary functions before and after using Respiratory muscle training (RMT) (Ultrabreath) with singers. This can be beneficial to singers aiming to improve their voice production and might serve as a model for similar training or an additional training program to be added to the other approaches. These values of FVC and FEV1 were found to be statistically similar before and after respiratory training, which opposed with results of the present study. While, differences in findings may be due to various factors such as the equipment's adequacy used for respiratory muscle training, differences in training methods, differences in application of the load (volume and intensity), heterogeneity, and a small number of participants.

In line with Menzes et al. [11] stated that there were fourteen respiratory training devices available in the market and were reported by published studies. However, 3 devices were not described in details, due to lack of information. Amongst the eleven evaluated devices, all of them showed positive aspects and limitations that should be considered. Although some devices appear to be more advantageous than others, it is not possible to choose the best one, based only upon their technical information and clinical utility. To select the most appropriate one, it is also necessary to consider the specific health condition, the nature of the impairments, and the purpose of the training.

In addition to, Imam et al. [12] reported that increasing in metabolic activities during physical activity would improve pulmonary function by increasing pulmonary capacity as the strength of respiratory muscles are increased. Their results showed that both singers and athletes had a better lung function than the sedentary group. This is an evident in the significantly higher FEV1and FVC than that for sedentary group. Also, Mackała et al. [13] reported that the application of an additional IMT program significantly increased the inspiratory and expiratory muscle strengths and improved aerobic tolerance. In addition, in case of recreational runners, respiratory muscle training could also change the mechanics of breathing and improved oxygen consumption, ventilation, HR, blood lactate concentration, and perceptual response during continuous training load.

Lung Boost is a device which assists its user in strengthening their respiratory muscles while inspiration and expiration, this device uses dual purpose training low intensity endurance aerobic training(endurance mood)and high intensity anaerobic interval training(strength mood) it provide 6 resistance level each resistance level can be adjusted to 5 positions and this agreed with Roa, [9] who found that respiratory muscle training devices were developed to increase strength and endurance of the respiratory muscles, they also have been shown to be effective in improving other clinical outcomes, such as pulmonary function (forced vital capacity, forced expiratory volume in the first second, peak expiratory flow, maximum voluntary ventilation, forced expiratory flow between 25% and 75% of vital capacity, vital capacity, tidal volume, expiratory reserve volume, inspiratory reserve volume, and inspiratory capacity), dysphagia, perceived exertion, cough, swallow, diaphragm thickness, chest expansion, respiratory complications, and levels of activity and participation. Such findings demonstrate the importance of respiratory muscle training for various health conditions and clinical outcomes. Thus, respiratory muscle training could influence not only strength and endurance measures, but also other clinical outcomes.

Parallel to, Bausek et al. [14] who reported that Respiratory Muscle Training (RMT) is equivalent to that of peripheral muscle strength and/or endurance training. In order to improve muscle strength, short sessions (bouts) of muscle utilization with high intensity are applied, akin to a few moves at near maximal power during weight lifting or bouldering. Alternatively muscle endurance is improved by repetitious exercise at low intensity, such as long distance running or low grade, long range alpine climbing. As in skeletal muscles, respiratory muscles will predominantly show type II fiber growth in response to strength training and type I fiber growth after endurance training. RMT schemes may improve both respiratory muscle strength and endurance. Although the present study demonstrated that respiratory muscle training by Lung Boost plus traditional exercise program does not have any adverse effect on ventilator function, its short duration represents a major limitation. Therefore, longitudinal studies are necessary to explore the long-term effect of respiratory muscle training by Lung Boost plus traditional exercise program on ventilator functions in choral singers.

Conclusion

This study concluded that respiratory muscle training by Lung Boost plus traditional exercise program which includes deep breathing exercise in form of diaphragmatic, nose breathing exercises and exercise with respiration using upper limbs for 10 weeks has a significant effect on some ventilator functions in choral singers.

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