

EFFECT OF FOUR-WEEK EXPIRATORY MUSCLE STRENGTHENING ON EXERCISE-INDUCED BREATHLESSNESS IN NORMAL ADULTS: PILOT STUDY

Akshata Ashok Changwani¹, Abhijit D. Diwate², Arijit K. Das³

¹Post Graduate student, ²HOD and Professor, ³Associate Professor,
Dept. of PT in Cardiovascular and Respiratory Science; DVVPF'S COPT, Ahmednagar, MUHS, Nashik.

ABSTRACT

Background: During exercise, the expiratory phase plays an equally important role in improving endurance as it helps in reducing the exercise-induced breathlessness. Therefore this study aims at specifically strengthening the expiratory muscles to study the effect of expiratory muscle strengthening on exercise-induced breathlessness. Aims and objectives: To evaluate the effect of 4 weeks of expiratory muscle strengthening on exercise-induced breathlessness in normal individuals. **Methodology:** Study was carried out on a total of 13 subjects ranging in the age group of 20-35yrs, where pre-intervention the Maximum Expiratory Pressure (MEP) and 1.5mile walk distance was calculated after which the subjects underwent a 4 week intervention protocol using Expiratory Muscle Strength Trainer 150 (EMST-150) where the subjects performed 25 training breaths in one session where there were a total of 5 sessions in a day, 5days/week for a total of 4 weeks. Post the intervention the MEP and 1.5mile walk values were recalculated and compared to check for the difference. **Result:** Data was analyzed in terms of the mean difference. Statistically significant change was seen in the MEP and 1.5 mile walk test values post-intervention, i.e at the end of 4 weeks, where the values obtained were, MEP : pre – 77.537 ±13.67 and post – 88.063 ±18.39 with a p-value of 0.0019 , 1.5 mile walk(vo2max.) : pre – 35.810 ±14.56 and post – 39.810 ±11.8 with a p-value of 0.0038 and RPE: pre – 3.80 ±0.5 and post – 1.7 ±0.5 with a p-value of 0.0057, thereby proving a statically significant improvement in the outcome measures. **Conclusion:** The study concludes that Expiratory muscle strengthening improves the maximum expiratory strength thereby reducing the exercise-induced breathlessness leading to an improvement in the endurance level.

Keywords: Expiratory muscle strength training; 1.5mile walk test; Exercise-induced breathlessness.

INTRODUCTION

In a country like India, with a population of 1.3 billion, India is ranked the second most populated country in the world [1]. But with this population rate, only a handful amount to a normal healthy population [2]. Even though considering them to be normal, at times even these healthy individuals complain of problems like headache, dizziness, anxiety, stress, nausea, breathlessness, general weakness etc. which in turn reflects the in general endurance of the individual [3,4]. Talking of endurance, it refers to the ability of an organism to exert and remain active for a long period of time, as well as its ability to resist, withstand, recover from and the immunity to trauma, wounds or fatigue in order to improve the endurance of an individual, he/she need to repeatedly perform that activity so as to allow the muscles to strengthen [4-10].

Exercise requires the perfect synchrony of the respiratory and cardiovascular system, in order to provide the muscle with the necessary supply of energy to be transformed into mechanical work on the part of the cardiovascular system thereby leading to increased supply of the arterial blood to the involved skeletal muscle and constant removal of metabolic waste [11-13].

In general, Respiratory muscle strength can be defined as a technique that aims at improving the function of the respiratory muscles through specific exercises. This is done by reducing the work of breathing, reducing muscle fatigue, improving the breathing pattern and improving the oxygen uptake, which generally get altered in normal individuals, when these individuals are subjected to any form of exercise/exercise training process, which leads to the development of exercise-induced breathlessness the physiology behind it being that there is expiratory flow limitation, which leads to breathing at higher volumes, leading to an increased inspiratory load which in turn leads to a mechanical disadvantage of the respiratory muscles [1, 7-9, 14, 15]. The expiratory phase as we saw in the previous physiology of breathlessness shows an alteration which in turn affect the inspiratory phase and the respiratory muscles [16- 19,20]. Therefore, if we aim at the strengthening of the expiratory phase, it would reverse the physiology, causing breathlessness. Also during the exercise, the expiratory phase plays an equally important role in improving the endurance by helping reduce the exercise-induced breathlessness, by correcting the physiology causing it, thereby helping to improve the activity level, functional capacity and exercise endurance of the individual [21, 22].

Therefore the study aims at studying the effect of 4 week expiratory muscle strengthening on exercise-induced breathlessness in normal adults.

MATERIALS AND METHODS

Study design: This pilot study is an experimental clinical trial study with a pre and post-test design.



DOI: 10.31878/ijcbr.2019.53.3

eISSN: 2395-0471

pISSN: 2521-0394

Correspondence: Akshata Ashok Changwani, Post Graduate student, Dept. of PT in Cardiovascular and Respiratory Science, DVVPF'S COPT, Ahmednagar, MUHS, Nashik. Contact email: akshatachangwani22@gmail.com

Ethics approval: The research was duly approved by the Institutional Ethical Committee and All the subjects willing to participate were made to sign an informed consent which gave information regarding the procedure, benefits, and possible complications associated with the study.

Study place: This was carried out in the DVVPF institutional hospital, Ahmednagar (MS).

Inclusion criteria: All the normal individuals in the age category of 18-35 years of age and BMI within the normal category as per the WHO guidelines [23] were screened before enrolling them for the study.

Exclusion criteria: Subject with a pre-diagnosed pathology, addiction to nicotine or an athlete was excluded from the study.

Sample size: 13 Eligible subjects were then enrolled for the study.

Procedure: This was followed by achieving a medical fitness report from the hospital before the conduction of the study. Pre-readings of the vitals, MEP(best of 3 trials), and the 1.5mile test was calculated post which the intervention was given, i.e. Expiratory Muscle Strength Trainer (EMST).

Intervention: Expiratory Muscle Strength Trainer 150 (EMST-150) [24]: It is an exercise tool consisting of a pexi-glass tube and a mouthpiece. Inside the trainer is a variable tension spring controlling a 'pop-off' valve that is calibrated in pressure(cmH₂O) which is adjustable (fig A). At first, the maximum expiratory strength was measured using the MEP. The subject was then instructed to take a deep inspiration against a preset threshold of 75% of muscle strength. Post which the subject's nose was clipped and the subject was asked to forcefully expirate maximum air into the device which shall last for a few seconds. This was followed by a rest period lasting for 15-20 seconds followed by performing 5 repetitions of the same followed by a break of 1minute and a total of 25 training breaths were performed each day for a span of 5days/week. At the end of every week, the threshold was increased by turning it one-quarter turn clockwise.



Fig A. EMSTFIGURE



Fig B. MEP

Maximum Expiratory Pressure [25]: It is a positive expiratory pressure gauge (fig. B) which has been previously used in studies for a similar purpose, i.e for calculating the expiratory muscle strength which has been validated and checked for reliability. In this study, the subject was tested in a sitting position with a considerable amount of back support and armrest. The subject was then asked to blow maximum air post a maximum inspiration, the value of which will be denoted on the device signifying the pressure level which can directly be correlated with the expiratory muscle strength, which was recorded pre and post the intervention. The value of the best of three trials was considered.

1.5 Mile test: The Rate of perceived exertion (modified Borg scale), was calculated by performing the 1.5mile walk test. In this test, all the subject were pre-instructed for all the do's and don'ts in relation to the exercise training. On the day of the exercise training, the subject's vitals were recorded, post which all the subject were made to walk a uniform distance of 1.5miles, where the subject had to purely walk, no initiation of jogging or running on an even cemented ground. In case the subject was tired midway, he could rest but mandatorily had to complete the 1.5mile distance. On completion of the test, the RPE(modified Borg scale) shall be calculated which would give us the value of exercise-induced breathlessness in the subject.

Statistical Analysis: Statistical analysis was carried out using GraphPad instat software. The data was passed through the Kolmogorov and Smirnov test of normality, post which the two-tailed paired t-test was used to analyse the pre and post results of MEP and 1.5-mile walk test results. There was no statistical difference noted in terms of demographic data in the pre-interventional period.

RESULTS & DISCUSSION

The results of this study suggest that expiratory muscle training with a threshold trainer increase the strength of

Table 1. Comparison of MEP pre and post-intervention results using the paired t-test.

	Pre intervention	Post intervention	P Value	T Value
MEP (in cmH ₂ O)	77.537± 13.67	88.063± 18.39	0.0019	18.23
1.5mile test (vo ₂ peak in ml/kg/min)	35.810 ± 14.56	39.837± 11.83	0.0038	13.847
RPE (Modified Borg Scale)	3.810 ± 0.56	1.737± 0.53	0.0057	

the expiratory muscles thereby improving the endurance by reducing the breathlessness induced as a result of exercising.

The efficiency of expiratory training at low load has been previously reported in individuals with COPD. But there was no such study conducted on the normal adults to check the effect of expiratory muscle strengthening on exercise-induced breathlessness. Our study proves that expiratory muscle strengthening improves the expiratory muscle strength as the pre MEP values so obtained were 77.53 and post values so obtained were 88.06 with a p-value of 0.0019 thereby proving the results to be statistically significant.

Similar results were obtained by Illi et.al [26] studied the Effect of respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis

They were able to provide evidence of improved strength and reduced sensation of respiratory effort and improved endurance post the treatment regimen.

Another study was conducted by Susana Mota et.al [27] who conducted a study on Clinical outcomes of expiratory muscle strengthening in severe COPD patients, and found positive results for increased muscle strength and lung volumes and found a significant reduction in the levels of dyspnoea along with a significant improvement in quality of life scores, the results of which are similar to those obtained in this study thereby supporting the positive effect of expiratory muscle strengthening on MEP (maximum expiratory pressure).

Ernesto Crisafulli [28] also conducted a study on Respiratory Muscle Training in Patients Recovering Recent Open Cardiothoracic Surgery: A Randomized-Controlled Trial and concluded that an additional expiratory training helped in faster recovery of subjects undergoing open cardiothoracic surgeries by improving the expiratory muscle strength thereby reducing the chances of associated lung pathologies and complication.

The increase of the maximum expiratory muscle strength can be explained according to Leith and Bradley [29] who studied Ventilatory muscle strength and endurance training and demonstrated that ventilatory muscle training increased ventilatory muscle strength by the cardio-respiratory adaptation to training intensity, which promotes the recruitment and better function of oxidative muscle fibers, unlike the statement by Lacasse et al [30] who claimed that physical activity improves peripheral and respiratory muscles without specific training of the muscles, although the literature is emphatic on the need for standardizing physical training.

Our study also found an increment in the level of 1.5 mile walk test along with a reduction in the level of the perceived exertion which was measured using the Modified Borg Scale, thereby indicating an improvement in the endurance level where the pre-intervention value for 1.5 mile walk test (vo₂ peak) was 35.81 with an RPE of 3.810 and post-intervention the values obtained were 39.83 for vo₂ peak and 1.71 for RPE, with a p-value of 0.0038 and 0.0057

respectively, thereby proving it to be statistically significant.

Similar results were obtained by Illi et al. [26] studied the Effect on respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis They were able to provide evidence of improved strength and reduced sensation of respiratory effort and improved endurance post the treatment regimen.

We are thereby concluding that expiratory muscle strengthening improves the maximum expiratory strength along with reducing the exercise-induced breathlessness leading to an improvement in the endurance level as well.

CONCLUSION

Therefore the study concludes that Expiratory muscle strengthening improves the maximum expiratory strength along with reducing the exercise-induced breathlessness leading to an improvement in the endurance level as well.

Limitations: Intermittent non-adherence to intervention

Future scope: A similar study can be conducted on a larger sample size to generalize the results of the intervention

This training protocol can then be administered to the sports population to see further increment in performance by reducing the exercise-induced breathlessness.

REFERENCES

- [1] India population live(2018) worldometer. India: c2018[updated 2018 February]; Available from: <http://www.worldometer.info/>
- [2] National family health survey, India: c2016 [updated 2016 December]; Available from: <http://www.rchiips.org/>
- [3] Filipkowski KB. Do healthy people worry? Modern health worries, subjective health complaints, perceived health and health care utilization. *Int. J Behave Med.* 2010;17(3):182-8
- [4] Endurance. c2018[updated 2018 February]; Available from : <http://en.m.wikipedia.org/>
- [5] MoriciG. Endurancetraining: Is it bad for you? . *Breathe (Sheff).* 2016;12(2):140-7
- [6] Kubukeli ZN.Ttraining technique to improve endurance exercise performance. *Sports Med.* 2002;32(8):489-509
- [7] Bouaziz W. Effect of aerobic training on peak oxygen uptake among senior aged 70 or older: A Meta-Analysis of RCT. *Rejuvenation Res* 2018 Jan.
- [8] Keens TG. Ventilatory muscle endurance training in normal subjects and patients with cystic fibrosis. *Am Rev Respir. Dis.* 1977;116(5):853-60

- [9] Menezes KK. Respiratory muscle training increases respiratory muscle strength and reduces respiratory complications after stroke: A Systemic Review. *J Physiotherapy*.2016 ;62(3):138-44
- [10] Noppawan C. Inspiratory muscle training protocol for patients with COPD: A Multicentre RCT. *BMJ Open* 2013 Aug 5;3(8)
- [11] William Mc Ardle. Exercise physiology Chapter 15: Lippincott; 7th edition.
- [12] Jack Willmore. Physiology of sports and exercise Chapter 10 and 15: W Larry Kenny; 5th edition.
- [13] ACSM guidelines for exercise testing and prescription: Wolters Kluwer; 9th edition
- [14] Donna Frownfelter. Cardiovascular and pulmonary physical therapy; 4th edition
- [15] Anand S. Effect of training frequency on maximum expiratory pressure. *Am J Speech Lang Pathol*. 2012;21(4):380-6
- [16] Florian JP. Breathing 100% oxygen during water immersion improves post immersion cardiovascular response to orthostatic stress. *Physiol. Rep*. 2016;4(23).
- [17] Comparing the density of air to water. Available from: <http://the weather prediction.com/>
- [18] Elkins. Inspiratory muscle training facilitates weaning from mechanical ventilation among patients in the ICU : a systemic review. *J Physiotherapy*. 2015;61:125-134
- [19] Xiao Y. Inspiratory muscle training for the recovery of function after stroke. *Cochrane Database Systemic Review*.2012;16:CD009360
- [20] Puente M. Hyperinflation and its management in COPD. *Int Journal Chron Obstruct Pulmon Dis*. 2016
- [21] ACSM resource manual for guidelines for exercise testing and prescription.-7th edition
- [22] Arijit D., Narasimman S. Effect of Routine Physiotherapy Vs early mobilization in preventing postoperative pulmonary complications in subjects with specific risk factors: A Randomized Controlled Study. *Physiotherapy and Occupational Therapy Journal* 2010;3(3).
- [23] WHO/EUROPE Nutrition-Body Mass Index , Available from : <http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index>.
- [24] O Neill Healthcare- EMST 150 user guide , Available from : <https://onhealthcare.ie/wp-content/uploads/2017/01/EMST-150-User-Guide-Download.pdf>.
- [25] Katherine A. Expiratory Muscle Strength Training Evaluated With Simultaneous High Resolution Manometry and Electromyography. *Laryngoscope* . 2017 April ; 127(4): 797–804.
- [26] Illi SK. Effect of respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis. *Sports Medicine*, 42(8):707-724.
- [27] Susana Mota. Clinical outcomes of expiratory muscle strengthening in severe COPD patients. *Respiratory Medicine* (2007) 101, 516–524.
- [28] Ernesto Crisafulli. Respiratory Muscle Training in Patients Recovering Recent Open Cardiothoracic Surgery: A Randomized-Controlled Trial. *BioMed Research International* Volume 2013.
- [29] Leith DE, Bradley M. Ventilatory muscle strength and endurance training. *Appl Physiol* 1976;41:508-16.
- [30] Lacasse Y. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev*. 2015.