



Inspiratory muscle training versus Aerobic training: Improvement on pulmonary function, exercise capacity and cardiorespiratory fitness in females with hypothyroidism

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ABSTRACT

The effect of hypothyroidism on the respiratory system is proven in various studies. The study is aimed to compare Inspiratory muscle training and Aerobic training on lung functions, exercise capacity & cardiorespiratory fitness in females having hypothyroidism. This comparative study was executed on 66 subjects based on the criteria of the study, which were randomly divided into Group A & B. Subjects in Group A received Inspiratory Muscle Training. Still, subjects in Group B received Aerobic Training for four weeks. Spirometry assessed pulmonary functions, exercise capacity was evaluated by the 6-Minute Walk Test, and cardiorespiratory fitness was assessed by Step Harvard test. All measurements were taken at the baseline, on the last day of 2nd week and final day of 4th week. Independent t-test and Analysis of Variance (ANOVA) were used to analyze the data. More significant improvement in terms of pulmonary functions, exercise capacity and Cardiorespiratory fitness was observed, in group B who received Aerobic training in contrast to group A that received Inspiratory muscle training. Results of this study showed Aerobic training to be more effective and beneficial in improving pulmonary functions, exercise capacity and cardiorespiratory fitness than Inspiratory Muscle Training.



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INTRODUCTION

Hypothyroidism is a clinical condition which results from inappropriate secretion of thyroid hormones. In hypothyroidism, the TSH level is increased,

whereas levels of T3 and T4 are decreased. It is a common worldwide disease (Maiti *et al.*, 2015). The prevalence of hypothyroidism is 11% in India as compared to 4.6% in the United States of America and 2% in the United Kingdom (Iyer *et al.*, 2017). Its prevalence rate in women is ten times more than in men (Sadek *et al.*, 2017). Age, pregnancy, postpartum period, and menopause are the risk factors of developing hypothyroidism in women (Dunn, 2016). Subjects with hypothyroidism present with symptoms of swelling of extremities, weight gain, fatigue, dyspnea, weakness, dryness, cold intolerance, bradycardia, depression and inattentiveness. Loss of memory, constipation and menorrhagia, paresthesia, delay in relaxation of tendon reflexes, hearing disorder & diffuse alopecia are also common complaints by the hypothyroidism patients (Swami *et al.*, 2010).

Hypothyroidism affects the strength of respiratory muscles which is directly related to the levels of thyroid hormone (Swami *et al.*, 2010). A study by Cakmak *et al.* has shown a significant reduction in the values of FEV1, FVC, DLco and FEF25%-75% in subjects with subclinical hypothyroidism as compared to euthyroid subjects (Cakmak *et al.*, 2007).

Treatment for hypothyroidism includes Pharmacological agents (hormonal replacement), exercises, complementary therapies, psychiatric symptoms & psychotherapy that can improve health-related quality of life (HRQoL) and cardiovascular health (Garces-Arteaga *et al.*, 2013). Thyroid function can be improved through exercises. One of the most potent natural therapies, i.e., exercise may help in alleviating depression which is one of the common symptoms of hypothyroidism (Bansal *et al.*, 2015).

Aerobic exercises are the exercise that helps in improving oxygen consumption by the body. Physical activities and aerobic exercises produce extended-lasting benefits in reducing depression and anxiety as well as also in improving physiological and psychological status by enhancing work and improving health (Nayek and Chatterjee, 2016). Andrea Garces-Arteaga *et al.* studied the effect of medium intensity exercise training given for three months in females with subclinical hypothyroidism. They reported improved quality of life-related to health and positive influence of the exercise program on the functional capacity and also effective in improving cardiorespiratory fitness (Garces-Arteaga *et al.*, 2013).

Inspiratory muscle training (IMT) exhibits an external resistance to the musculature of respiration (Ferreira *et al.*, 2013). In various conditions which involve impaired respiratory muscle strength like thoracic surgeries, asthma, chronic obstructive pulmonary disease, chronic heart failure and hypertension, respiratory muscle exercises are non-pharmacological strategy widely used to improve functional capacity (Feriani *et al.*, 2017). It has also been found that inspiratory Muscle Training along with Cycle Ergometer Training, is included as a key component in pulmonary rehabilitation of patients with COPD. Additional Inspiratory Muscle Training yielded increased strength and endurance of inspiratory muscle, enhanced maximum exercise capacity more than Cycle Ergometer Training given alone (Wanke *et al.*, 1994; Wang *et al.*, 2017). So, the purpose of the current study was to compare the effects of Inspiratory muscle training and aerobic training on pulmonary function, exercise capacity and cardiorespiratory fitness in females with

hypothyroidism.

METHODOLOGY

This experimental study was conducted in the Civil Dispensary, sector-14, Rohtak from April 2019 to February 2020. The sample size was calculated by G-Power software, using the power of study 0.95 and probability error 0.05. The calculated sample size was 66.

Inclusion and exclusion criteria

Pre-diagnosed females with hypothyroidism (TSH>6.0 μ IU/mL, FT₄≤0.8ng/dl), aged between 30-40 years who were on their regular medication of hypothyroidism for beyond three months were recruited for the study. Subjects who had a history of smoking, any presence of systemic, respiratory, cardiovascular diseases or any orthopaedic disease and subjects with any psychological disorder were excluded from the study (Sadek *et al.*, 2017).

Assessment parameters

Subjects underwent assessment for pulmonary function (Spirometry per American Thoracic Society guidelines), exercise capacity (Six-Minute Walk test by calculating the total distance walked in six minutes) and cardiorespiratory fitness (Step Harvard Test).

All measurements were taken at the baseline, on the last day of 2nd week and the last day of 4th week.

Method

The whole procedure was described to all subjects, and written informed consent was taken from them before the study. A total of 66 females were randomly allocated into two groups. Group A with 33 subjects in it received Inspiratory Muscle Training, and Group B with similar no. of subjects in it, i.e. 33 received Aerobic Training. Exercises were performed for four weeks in both groups. Regular medications for hypothyroidism were included along with the following protocol in both the groups.

Group A (Inspiratory Muscle Training)

Subjects attended an inspiratory muscle training session under researcher' using IMT threshold device at 50% pre-training PI_{max} for 15 minutes with a frequency of 5 days per week for four weeks. Each session was performed for 2 minutes and comprised of 7 sessions with a rest of 1-3 minutes in-between the session. Maximal static inspiratory pressure (PI_{max}) was kept at 50% as inspiratory load and adjusted weekly to maintain 50% of PI_{max} during all period of the protocol so that subjects were allowed to perform 30 breathing efforts. Dur-

ing the training period, subjects were asked to maintain diaphragmatic breathing at a rate of 6 to 10 breaths/min. The training was performed in a sitting position (Vasconcelos *et al.*, 2017).

Group B (Aerobic Training)

Aerobic exercise session consisted of stationary bicycle exercise training (using Body Gym Ez Magnetic Bike Agos II). Each session was of 15 minutes duration given for 5 days per week for four weeks. It included 10 minutes of warm-up then Bicycle exercise training for 15 minutes at 50-75% of maximum heart rate (MHR) and then 5 minutes of cool-down. The warm-up consisted of stretching exercises and gentle step-up exercise and cool down included simple brisk walking. Maximum heart rate was determined by using the formula: $HR_{max} = 220 - \text{Age}$ (Mostert and Kesselring, 2002).

Data Analysis

The data were analyzed by using the software package SPSS 21 for window version. Mean and standard deviation of all the parameters was taken. To compare the difference between the groups for variables (pulmonary function, cardiorespiratory fitness and exercise capacity) at baseline, last day of 2nd week and final day of 4th-week independent t-test was used. Differences within the groups for the variables (pulmonary function, cardiorespiratory fitness and exercise capacity) at baseline, last day of 2nd week and final day of 4th week were compared by One way ANOVA followed by posthoc test. The level of significance was 95% ($p \leq 0.05$).

At the beginning of the study on the pre-exercise comparison, groups were found to be homogenous for Age, height, weight, BMI and outcomes measured FVC, FEV1, 6 MWT and VO2 max.

Table 1 represents the difference between groups for variables at baseline, 2nd week and 4th week in Group A (IMT) and Group B (Aerobic training). The between Group analysis of the show that no significant differences were observed at baseline and 2nd week ($p > 0.05$) but there was a significant difference on 4th week ($p < 0.05$) concluding that significant improvement was found in the Aerobic Training Group when compared to IMT Group.

Table 2 & Table 3 show the comparison of difference within Group A & Group B. Significant improvement was found in both the groups (Aerobic training Group and IMT Group).

DISCUSSION

The present study was executed to compare the effects of Inspiratory muscle training and Aerobic

training on lung function test, exercise capacity and cardiorespiratory fitness in females with hypothyroidism. Findings of this study revealed that both the training groups yielded significant improvement in pulmonary function test, exercise capacity and cardiopulmonary fitness.

Results of this study yielded that subjects in Group B which performed Aerobic exercises for four weeks showed a more clinically significant increase in FVC by 23.4 % & in FEV1 by 21.1 % than the subjects in Group A who performed Inspiratory muscle training showed a significant increase in FVC by 19% and in FEV1 by 16.2%. It has been proved that aerobic exercise leads to increased strength as well as endurance of the respiratory muscles. Aerobic training is also known to increase blood flow, improves muscle strength and decrease ventilatory demands for a given workload (Moazami and Farahati, 2013; Onsori and Galedari, 2015; Werneck *et al.*, 2018). Zeren *et al.* (2016) investigated the role of inspiratory muscle training in patients with atrial fibrillation, and they found that there was a significant improvement in the strength of respiratory muscles, pulmonary functions and distance walked in six minutes in the training group. This improvement can be explained based on the overload principle as respiratory muscles respond to training like any other skeletal muscle when an increasing amount of load is applied to it. Thus, the strength of respiratory muscles is increased with appropriate training technique and the study reported that IMT could be safely incorporated into the rehabilitation of patients with atrial fibrillation (Zeren *et al.*, 2016).

Jakes *et al.* (2002) reported beneficial effects of physical activity on FEV1 and stated regular physical activity improve the size and elasticity of airways. These effects of physical activity on respiratory function were mediated through an effect on body composition and also by enhancing the strength of ventilator muscles (Jakes *et al.*, 2002).

Result of this study showed more significant improvement in Group B, who received Aerobic training in exercise capacity by 17.3% as compared to the subjects in Group A who received Inspiratory muscle training by 14.8%. Similar effects were observed in a study done by Werneck *et al.* (2018). They evaluated the effects of 16 weeks aerobic training on functional capacity and quality of life in women having subclinical hypothyroidism. They found that women with subclinical hypothyroidism had lower values on functional capacity than the euthyroid one, comparatively. Training group yielded significant improvements in general health, emotional and mental aspects, functional capacity

Table 1: Comparison of FVC between the Group A & Group B

Variables	Baseline Comparison		t-value	p-value
	GROUP A (Mean ± SD)	GROUP B (Mean ± SD)		
FVC	2.36 ± 0.68	2.6 ± 0.55	-1.557	0.124 ^{NS}
FEV1	1.66 ± 0.44	1.84 ± 0.60	-1.398	0.167 ^{NS}
6 MWT	224.55 ± 41.54	236.97 ± 41.11	-1.221	0.227 ^{NS}
VO2 Max	49.09 ± 8.49	50.84 ± 7.94	-0.868	0.388 ^{NS}
Comparison at 2nd week				
FVC	2.6 ± 0.71	2.89 ± 0.58	-1.825	0.073 ^{NS}
FEV1	1.79±0.46	1.98±0.55	-1.514	0.135 ^{NS}
6 MWT	239.70±40.81	255.45±39.13	-1.601	0.114 ^{NS}
VO2 Max	51.60 ± 8.39	53.72 ± 7.85	-1.060	0.293 ^{NS}
Comparison at 4th week				
FVC	2.81 ± 0.63	3.21 ± 0.57	-2.661	0.010*
FEV1	1.93±0.41	2.23±0.52	-2.593	0.012*
6 MWT	257.88±41.59	278.18±39.48	-2.034	0.046*
VO2 Max	54.27 ± 8.44	58.30 ± 7.80	-2.014	0.048*

NS: Non-Significant (p>0.05); * Significant (p<0.05)

Table 2: Comparison of variables within Group A

Variables	Sum of square	Mean square	F-value	p-value
FVC	44.42	0.463	3.51	0.034*
FEV1	18.82	0.196	2.96	0.050*
6 MWT	1639.66	1706.94	5.38	0.006*
VO2 Max	6841.15	71.262	3.10	0.049*

* Significant (p<0.05)

Table 3: Comparison of variables within Group B

Variables	Sum of square	Mean square	F-value	p-value
FVC	31.41	0.327	9.12	0.000**
FEV1	30.18	0.314	3.95	0.022*
6 MWT	1530.06	1593.81	8.82	0.000**
VO2 Max	5943.75	61.91	7.53	0.001**

** Highly Significant (p<0.001) * Significant (p<0.05)

and physical component of health-related quality of life. In contrast, the control group showed no significant changes. They concluded that improvement in the functional capacity, as well as the quality of life of subclinical hypothyroid patients, was due to enhanced physical activity, improved physical fitness and decreased signs and symptoms (Werneck *et al.*, 2018).

Bosnak-Guclu *et al.* (2011) investigated the effects of IMT on functional status, the strength of peripheral and respiratory muscles, dyspnea, fatigue, pulmonary function and psychological status in heart failure patients. All parameters significantly

improved, suggesting that Inspiratory Muscle Training should be a part of pulmonary rehabilitation programs (Bosnak-Guclu *et al.*, 2011).

Results of this study showed more significant improvement on cardiorespiratory fitness in Group B (Aerobic Training) by 14.6% as compared to Group A (Inspiratory muscle training) showed considerable improvement by 10.5% on cardiorespiratory fitness. A study by Andrea Garces-Arteaga *et al.* showed similar results in which they examined the effects of the 3-month program of medium intensity exercises in females with subclinical hypothyroidism. Results showed a higher VO2max (28%)

and suggested that there was a positive influence of the exercise program on the functional capacity and also effective in improving cardiorespiratory fitness (Garces-Arteaga *et al.*, 2013).

Dall'Ago *et al.* (2006) evaluated the effects of 12-weeks inspiratory muscle training in patients with chronic heart failure and found that inspiratory muscle strength, peak VO₂ and exercise capacity were significantly increased. The peak VO₂ showed a 9.2% improvement from baseline (Dall'Ago *et al.*, 2006).

Limitations

This study did not include male subjects with hypothyroidism, age group other than 30-40 years was not considered, and follow-up was not done to assess the sustained effects of both interventions.

Future recommendation of study

Effects of inspiratory muscle training and aerobic training on other physiological parameters such as vital capacity, DLCO, FEV₁/FVC ratio, in patients with hypothyroidism.

CONCLUSION

In conclusion, both training programs yielded a clinically significant improvement in pulmonary function, exercise capacity and cardiorespiratory fitness. These findings are clinically relevant, thereby supporting the use of Inspiratory muscle training and aerobic training as an adjunct to pulmonary rehabilitation protocol in the management of females with hypothyroidism.

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Conflict of interest

The authors declare that they have no conflict of interest for this study.

REFERENCES

Bansal, A., Kaushik, A., Singh, C. M., Sharma, V., Singh, H. 2015. The effect of regular physical exercise on the thyroid function of treated hypothyroid patients: An interventional study at a tertiary

care center in Bastar region of India. *Archives of Medicine and Health Sciences*, 3(2):244.

Bosnak-Guclu, M., Arikan, H., Savci, S., Inal-Ince, D., Tulumen, E., Aytemir, K., Tokgözoğlu, L. 2011. Effects of inspiratory muscle training in patients with heart failure. *Respiratory Medicine*, 105(11):1671-1681.

Cakmak, G., Saler, T., Saglam, Z. A., Yenigen, M., Demir, T. 2007. Spirometry in patients with clinical and subclinical hypothyroidism. *Tuberk Toraks*, 55(3):266-270.

Dall'Ago, P., Chiappa, G. R., Guths, H., Stein, R., Ribeiro, J. P. 2006. Inspiratory Muscle Training in Patients With Heart Failure and Inspiratory Muscle Weakness. *Journal of the American College of Cardiology*, 47(4):757-763.

Dunn, D. 2016. Hypothyroidism in Women. *Elsevier Masson SAS*, pages 93-98.

Feriani, D. J., Coelho-Júnior, H. J., Scapini, K. B., de Moraes, O. A., Mostarda, C., Ruberti, O. M., Uchida, M. C., Érico Chagas Caperuto, Irigoyen, M. C., Rodrigues, B. 2017. Effects of inspiratory muscle exercise in the pulmonary function, autonomic modulation, and hemodynamic variables in older women with metabolic syndrome. *Journal of Exercise Rehabilitation*, 13(2):218-226.

Ferreira, J. B., Plentz, R. D. M., Stein, C., Casali, K. R., Arena, R., Lago, P. D. 2013. Inspiratory muscle training reduces blood pressure and sympathetic activity in hypertensive patients: A randomized controlled trial. *International Journal of Cardiology*, 166(1):61-67.

Garces-Arteaga, A., Nieto-Garcia, N., Suarez-Sanchez, F., Triana-Reina, H. R., Ramírez-Vélez, R. 2013. Influence of a Medium-Impact Exercise Program on Health-Related Quality of Life and Cardiorespiratory Fitness in Females with Subclinical Hypothyroidism: An Open-Label Pilot Study. *Journal of Thyroid Research*, 2013:1-5.

Iyer, S. K., Menon, S. K., Bahuleyan, B. 2017. An analysis of dynamic pulmonary functions of hypothyroid patients. *Journal of clinical and diagnostic research: JCDR*, 11(3):10-12.

Jakes, R. W., Day, N. E., Patel, B., Khaw, K. T., Oakes, S., Luben, R., Wareham, N. J. 2002. Physical inactivity is associated with lower forced expiratory volume in 1 second: European Prospective Investigation into Cancer-Norfolk Prospective Population Study. *American journal of epidemiology*, 156(2):139-147.

Maiti, S. R., Maiti, A., Bose, I., Chakraborti, D., Ghosh, P., Dutta, A. K. 2015. Study of pulmonary function tests in patients of primary hypothy-

- roidism. *Indian Journal of Basic and Applied Medical Research*, 5(1):121-148.
- Moazami, M., Farahati, S. 2013. The effects of aerobic training on pulmonary function in postmenopausal women. *Int J Sport Std*, 3(2):169-74.
- Mostert, S., Kesselring, J. 2002. Effects of a short-term exercise training program on aerobic fitness, fatigue, health perception and activity level of subjects with multiple sclerosis. *Multiple Sclerosis Journal*, 8(2):161-168.
- Nayek, B., Chatterjee, D. K. 2016. Effect of 6-weeks yoga and aerobic exercise on muscular strength and flexibility of pre-adolescence students. *International Journal of Yogic, Human Movement and Sports Sciences*, 1(1):12-16.
- Onsori, M., Galedari, M. 2015. Effects of 12 weeks aerobic exercise on plasma level of TSH and thyroid hormones in sedentary women. *European Journal of Sports and Exercise Science*, 4(1):45-54.
- Sadek, S. H., Khalifa, W., Azoz, A. 2017. Pulmonary consequences of hypothyroidism. *Annals of Thoracic Medicine*, 12(3):204.
- Swami, G., Singh, S., Singh, K. P., Gupta, M. 2010. Effect of yoga on pulmonary function tests of hypothyroid patients. *Indian J Physiol Pharmacol*, 54(1):51-57.
- Vasconcelos, T., Hall, A., Viana, R. 2017. The influence of inspiratory muscle training on lung function in female basketball players - a randomized controlled trial. *Porto Biomedical Journal*, 2(3):86-89.
- Wang, K., Zeng, G. Q., Li, R., Luo, Y. W., Wang, M., Hu, Y. H., Chen, X. 2017. Cycle ergometer and inspiratory muscle training offer modest benefit compared with cycle ergometer alone: a comprehensive assessment in stable COPD patients. *International Journal of Chronic Obstructive Pulmonary Disease*, 12:2655-2668.
- Wanke, T., Formanek, D., Lahrman, H., Brath, H., Wild, M., Wagner, C., Zwick, H. 1994. Effects of combined inspiratory muscle and cycle ergometer training on exercise performance in patients with COPD. *European Respiratory Journal*, 7(12):2205-2211.
- Werneck, F. Z., Coelho, E. F., Almas, S. P., Garcia, M., Bonfante, H. L. M., Lima, J., Vaisman, M. 2018. Exercise training improves quality of life in women with subclinical hypothyroidism: a randomized clinical trial. *Archives of endocrinology and metabolism*, 62(5):530-536.
- Zeren, M., Demir, R., Yigit, Z., Gurses, H. N. 2016. Effects of inspiratory muscle training on pulmonary function, respiratory muscle strength and functional capacity in patients with atrial fibrillation: a randomized controlled trial. *Clinical Rehabilitation*, 30(12):1165-1174.