RESEARCH ARTICLE

EFFECTS OF INSPIRATORY MUSCLE TRAINING ON FUNCTIONAL CAPACITY AND QUALITY OF LIFE IN PULMONARY HYPERTENSIVE PATIENT

1. *Student, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University, Lahore. Pakistan*
2. *Senior Lecturer, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University, Lahore. Pakistan.*
3. *Clinical Physiotherapist Institute of Medical Rehabilitation Islamabad*
4. *Head of Department, National Institute of Rehabilitation Medicine, Islamabad*

Correspondence
Fareeha Kausar
Senior Lecturer, Faculty of Rehabilitation & Allied Health Sciences Riphah International University of Lahore Pakistan
E-mail: fareeha.kausar@riphah.edu.pk

Received on: *17-09-2021*
Revision on: *28-02-2022*
Published on: *31-03-2022*

Citation; Bano S,Kausar F, Amanat S, Shafique S, Muneeb HN, Mehmood Q Effects of inspiratory muscle training on functional capacity and quality of life in pulmonary hypertensive patient T Rehabili. J. 2021:06(01);275-279
soi: 21-2017/re-trjvol06iss01p275
doi: https://doi.org/10.52567/trj.v6i01.77

Shaher Bano[1]: Data collection, statistical analysis, article draft,
Fareeha Kausar[2]: Conception of idea, designing the methodology, revising it critically for important
Sumera Amanat[3]: Data Analysis and interpretation, revising it critically for important
Sidra Shafique[2]: Critical review, article writing
Hafiza Neelam Muneeb[2]: Critical review, revising it critically for important
Qamar Mehmood[4]: Critical review, revising it critically for important

ABSTRACT

Background: Exercise intolerance is present even in the early stages of pulmonary arterial hypertension (PAH) and is associated with poor prognosis. Respiratory muscle dysfunction is common and may contribute to exercise limitation. **Objective:** To determine the effects of inspiratory muscle training (IMT) in pulmonary hypertensive patient. **Methodology**: A randomized control trial was conducted at Services Hospital Lahore after approval from Medical Superintendent. A total of n=18 subjects were randomly allocated into two groups, both group received deep breathing exercise (DBE) and 2nd group received additionally Inspiratory muscle training (IMT) with pressure threshold Inspiratory muscle training device. All participants received 12 sessions in two weeks; the duration of each session was of 20 minutes. The outcome variables were functional capacity and quality of life (SF-36). In functional capacity, of the blood pressure (BP), heart rate (HR), partial pressure of oxygen (SpO_2), distance walk (6min walk test) and level of dyspnea were recorded The data was evaluated at baseline and after 12th session. **Results:** The mean age of patients was 58.11±7.11 years, with 9 male and 9 female. After 2 weeks, the general health, social activities and energy were significantly ($p<0.05$) improved in experimental group. But no significant difference ($p\geq0.05$) was observed between the group regarding activity limitation, physical and emotional health items of quality of life (SF-36). When comparing the Blood pressure and heart rate, no significant difference was observed between the groups, after 2 weeks of intervention ($p\geq0.05$). While SpO_2,6 MWT and dyspnea score was significantly ($p<0.05$) improved in experimental group as compare to control group. **Conclusion:** The Deep breathing and inspiratory muscle training both are equally effective with respect to improving the quality of life but IMT is more efficient as compared to Deep breathing for improving dyspnea and it also improves the pulmonary functional and exercise capacity.

Keywords: Breathing exercises, dyspnea, inspiratory muscle training, pulmonary hypertension, quality of life.

INTRODUCTION

Pulmonary hypertension (PH) is a progressive condition that is diagnosed as the mean pulmonary arterial pressure (PAP) is ≥25 mm Hg at rest.[1] PH represents with pathological changes in the lungs vasculature that lead to vasoconstriction and consequently the increase of pulmonary vascular resistance (PVR). This progressive vasoconstriction causes an increase in PAP, with the right ventricle (RV) overloading and resulting in right heart failure and eventually death.[2] The early stage of PH may remain asymptomatic; but major symptoms of its progression are fatigue, dyspnea, syncope and angina that may result in decreased exercise capacity and quality of life (QoL).[3]

Severe functional limitations in patients with PH, is due to dyspnea that make them unable to follow a physical exercise program and even their daily living activities (ADL).[4] As cardiopulmonary changes are marked as major contributor to these limitations, symptoms worsen gradually if the changes in respiratory muscles occur.[5] Several mechanisms responsible for peripheral and respiratory muscle changes include muscle disuse, inflammation, insulin resistance, decreased cardiac output, altered autonomic nervous system (ANS) response, and hypoxemia. Because of this there may be alterations of the type of fibre, muscle atrophy, decreases capillary network and oxidative capacity of muscle along with reduced muscle excitability.[6] According to literature, as a result of changes in respiratory muscles, patients with PH demonstrate reduction in maximal expiratory pressure (MEP) and maximal inspiratory pressure (MIP) by 25%.[7] When compared with healthy individuals, there is 28% decrease of MIP if PH is associated with left heart disease.[4,8]

Along with the drug therapy to treat PH, several studies have evaluated the effects of physical exercises on PH.[9-13] James R et al in 2019 found that supervised exercise training is a prognostic

factor for survival and improved quality of life in patients with Pulmonary Hyper tension.[9] Lenna Waller et al in 2020 concluded that aerobic, anaerobic and respiratory muscle training improves functional capacity indicated by VO_2peak and 6 MWT.[10] Keusch S et al in 2017 provided the evidence that physical training improves the quality of life, maximal oxygen capacity (VO2peak) and benefits in exercise capacity.[11] In patients of chronic conditions such as chronic obstructive pulmonary disease (COPD) and heart failure (HF), Hoeper MM in 2013 and Mainguy V in 2010 concluded that the use of inspiratory muscle training (IMT) has markedly improved the strength of respiratory muscle and hence the functional capacity. [12, 13] Inspiratory muscle strength training (IMST) involves an exercise program which uses the diaphragm and accessory respiratory muscles to repeatedly inhale against resistance.[14]

Upto the researcher's knowledge, there was lack of integrating exercise program that focuses on light-intensity endurance, strength, and respiratory training for pulmonary hypertension. So the current study was performed to determine the effect of respiratory training with IMT device in treatment of pulmonary hypertension that may affect the strength of inspiratory muscles and functional capacity and to increase awareness for the use of pulmonary exercise and rehabilitation strategies in pulmonary hypertension in combination with medicines.

METHODOLOGY

This randomized control trail was conducted from January 2021 to April 2021 at Services Hospital Lahore (RCRS-RE-MS-PT/Fall 20/044). The sample size was n=18, collected through convenient sampling techniques. The clinically stable patients of both gender, with age between 40-70 years, diagnosed with Pulmonary Hypertension (PAPm ≥ 25mmHg and PAOP <15mmHg) were included in the study. While patients with COPD, left heart failure, severe ischemic heart disease, cor-pulmonale, and any associated orthopedic and cognitive disorders were excluded.

The n=18 participants were randomly allocated into group A, receiving deep breathing exercises (DBE) and group B, receiving additionally pressure threshold Inspiratory Muscle training via lottery method.(Figure 1). Both groups received a total of 12 sessions in two weeks. For deep breathing exercise, patients performed pursed lip and diaphragmatic breathing with 10 repetitions of each twice a day. During diaphragmatic breathing, they were instructed to inhale as deeply as they could while their abdomen expanded, and to exhale as slowly as they could while their abdomen contracted, in a self-paced rhythm. For pursed lip breathing, patients were instructed to inhale deeply and exhale the air with lips partially closed slowly.

Additional inspiratory muscle training to Experimental group was performed using a Threshold Inspiratory Muscle Training Device (Philips) at a resistance generating a pressure corresponding to 50% of the initial Maximum inspiratory pressure (PImax) for each session Two sets of 30 breaths with 5–10 min of rest between each set with a total session of 20 minutes 6 days in a week for 2 weeks using pressure threshold device that utilizes a spring- loaded one-way controller that places reliable struggle on the inspiratory muscles. Patients are instructed to emphasize the use of their diaphragm and to ensure that their abdomen "sticks out" during each inspiratory manoeuvre.

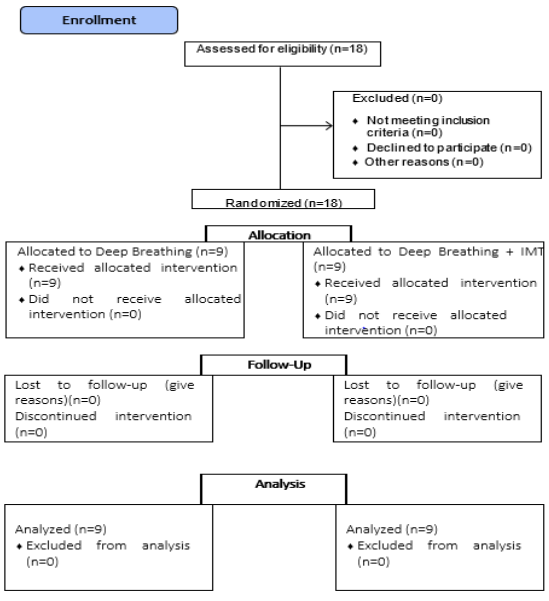

Figure 1: CONSORT diagram

After taking the consent from patients, Quality of life and functional capacity of the patients were evaluated with SF 36 (r=0.778) [15] and 6MWT(r=0.94)[16] respectively before and after 2

weeks of intervention. Data was analysed using SPSS 21.0.

After checking the normality of data with Shapiro-Wilk test, parametric tests were used for analysis with paired sample t-test for within group analysis and independent sample t-test for between group analyses, as the data was normally distributed. The level of significance was set at p<0.05.

RESULTS

The mean age of patients was 58.11±7.11 with 9 male and 9 female. The mean age of n=6 males and n=3 females patients in control group was 52.67±6.764. While the mean age of 3 males and 6 females patients in Experimental group was 58.22±11.56.

For within group analysis of SF-36 for control group and experimental groups, the results shows that there were statistically significant changes in all the sections of SF36, 6 MWT, systolic BP and dyspnea score before and after treatment (p<0.05). While no change in BP Diastolic after 2 weeks of intervention in both groups (p≥0.05). The Heart rate (HR) was statistically improved in control group (p<0.001), while no significant change in experimental group (p=0.073). While the SpO_2 was significantly improved in experimental group (p<0.001), but no significant change in control group (p=0169) after 2 weeks (Table 1)

Table 1: Within group analysis for quality of life and functional Capacity

		Group A (DBE)		Group B (DBE+IMT)	
		Mean±SD	Sig	Mean±SD	Sig
Quality of Life					
General Health	Pre	37.52±12.041	.000***	31.72±5.52	.000***
	Post	51.66±13.29		65.08±9.47	
Limitation of Activities	Pre	38.27±5.77	.000***	30.22±4.71	.000***
	Post	51.33±7.38		59±14.28	
Physical health	Pre	31.38±10.05	.000***	31.05±7.01	.000***
	Post	51.97±9.14		57.3±7.20	
Emotional health	Pre	37.22±7.77	.041*	31.66±4.52	.000***
	Post	69.63±37.91		58.61±12.26	
Social activities	Pre	25.05±7.37	.003**	25.88±6.91	.000***
	Post	43.67±10.22		58.08±11.15	
Energy and emotions	Pre	33.11±7.70	.000***	29.33±6.69	.007**
	Post	44.41±8.67		43.83±10.94	
Functional Capacity					
BP Systolic	Pre	137.22±6.55	0.03*	140.33±8.48	.000***
	Post	147±7.87		147±7.87	
BP Diastolic	Pre	75.66±5.33	.362	75±6.18	.325
	Post	77.33±6.12		77.33±6.12	
HR	Pre	109.22±4.40	.000***	112.55±6.24	.073
	Post	118.33±3.60		116.88±4.67	
SpO2	Pre	78.77±2.27	.169	77±2.91	.000***
	Post	80.33±3.39		85.66±2.64	
Distance Walked	Pre	362.22±62.85	.000***	393.33±63.24	.000***
	Post	410.77±53.85		515±68.55	
Dyspnea	Pre	6.11±1.69	.001**	6.33±1.93	.000***
	Post	4.44±1.13		3±1.65	

Significance Level: p<0.05, p<0.01**, p<0.001****

Table 2: Between Group comparison of Quality of Life & Functional Capacity

	Group A (DBE)	Group B (DBE+IMT)	
	Mean±SD	Mean±SD	Sig
Quality of Life			
General Health	51.66±13.293	65.08±9.47	0.025*
Limitation of Activities	51.33±7.38	59±14.28	0.172
Physical health	51.97±9.14	57.3±7.2	0.188
Emotional health	69.63±37.91	58.61±12.26	0.419
Social activities	43.67±10.22	58.08±11.15	0.000***
Energy and emotions	44.41±8.67	43.83±10.94	0.046*
Functional Capacity			
BP (systolic)	147±7.87	147±7.87	1
BP (diastolic)	77.33±6.12	77.33±6.12	1
Heart rate (HR)	118.33±3.60	116.88±4.67	0.474
SpO_2	80.33±3.39	85.66±2.64	0.002**
6MWT	410.77±53.85	515±68.55	0.002**
Level of dyspnea	4.444±1.130	3.000±1.658	0.046*

Significance Level: p<0.05, p<0.01**, p<0.001****

While comparing the both groups after 2 weeks, the general health (p=0.025), social activities (p<0.001) and energy (p=0.046) were significantly improved in experimental group. But no significant difference was observed between the group regarding activity limitation, physical and emotional health items of quality of life (SF-36). When comparing the Blood pressure and heart rate, no significant difference was observed between the groups, after 2 weeks of intervention (p≥0.05). While SpO_2 (p=0.002), 6MWT(p=0.002) and dyspnea score (p=0.046) was significantly improved in experimental group as compare to control group. (table 2).

DISCUSSION

The purpose of current study was to determine the effects if inspiratory muscle training to improve functional capacity and quality of life in patients of pulmonary hypertension. The patients were treated for 2 weeks and were assessed before and after the intervention with respect to 6 MWT and SF 36. The null hypothesis was rejected; IMT showed an improvement in characteristics of inspiratory muscle resulting in improvement in total distance walked, dyspnea and HRQoL in Pulmonary Hypertension (PH) patients.

The current study showed significant improvement in functional capacity and 6MWT in patient receiving IMT, similar results were proposed by Derek Tran B App Sc et al [17] in 2021 and concluded that the IMT group improved maximum inspiratory pressure (PImax) and 6-minute walk distance as compared to control group but no change in peak oxygen uptake between-groups was observed. Lena Waller et al in 2020 confirmed that combination of both the aerobic and anaerobic; along with the respiratory muscle training induces the strongest improvement in functional capacity and increases the quality of life. [10] Results of these both studies favor the findings of current study in which the group receiving IMT improved in functional capacity along with SpO_2 and dyspnea as compared to the group which was receiving deep breathing exercises measured on 6-minute distance

André Luiz Lisboa Cordeiro in 2016 evaluated the effectiveness if IMT in patients undergoing cardiac surgery and revealed the similar results like current study inspiratory muscle training is beneficial in the field of increasing inspiratory muscle strength and overall functional capacity.[18] Melda Saglam et al. in 2015 also found the comparable results that IMT decrease the level of hyperventilation in patients, improve the respiratory muscle power and enhances the functional capability in patients having pulmonary arterial hypertension.[19] Derliz Mereles et al in 2006 endorsed the results of current study and concluded that low-dose exercise and respiratory muscle training are promising adjunct to medical treatment in patients with severe PH.[5]

Ferreira JB et al [20] in 2013 said that IMT validated beneficial outcomes on systolic and diastolic blood pressures. Claire M et al[21] in 2017 studied the effect of daily inspiratory muscle training in lowering blood pressure and vascular resistance with the treatment duration of 6 weeks and concluded that there is reduction of blood pressure and vascular resistance but no change in heart rate was observed. Similar results were observed in current study for heart rate but for blood pressure, no significant improvement was observed in systolic and diastolic blood pressures as the duration of treatment was not long enough to produce significant change. So Inspiratory muscle training is safe for patients and feasible and improves key prognostic outcomes that relate to improve the survival rate. As there was time constraint and patients were discharged from hospital as soon as they were stable, long-term follow up was not possible to observe long term changes and to evaluate its impact on improving the other parameters and quality of life.

CONCLUSION

The Deep breathing exercises along with inspiratory muscle training gives more promising results in increased exercise capacity and better quality of life. It is recommended as a safe and potential adjunct therapy in pulmonary hypertensive patients with improved survival outcomes. It is further needed to evaluate the effect of IMT on diaphragmatic function and in acute and chronic PH separately so an integrated programme may develop that focuses on light-intensity respiratory training.

Acknowledgement

I am thankful to my Creator Allah Subhana-Watala to have guided me throughout this work at every step and for every new thought which you setup in my mind to improve it.

REFERENCES

1. Hoeper MM, Bogaard HJ, Condliffe R, Frantz R, Khanna D, Kurzyna M, et al. Definitions and diagnosis of pulmonary hypertension. J Am Coll Cardiol. 2013;62(25 Suppl):D42-50. doi:10.1016/j.jacc.2013.10.032.
2. Fowler RM, Gain KR, Gabbay E. Exercise intolerance in pulmonary arterial hypertension. Pulm Med. 2012;2012:359204. doi:10.1155/2012/359204.
3. Malenfant S, Lebret M, Breton-Gagnon É, Potus F, Paulin R, Bonnet S, Provencher S. Exercise intolerance in pulmonary arterial hypertension: insight into central and peripheral pathophysiological mechanisms. Eur Respir Rev. 2021 Apr 13;30(160):200284. doi: 10.1183/16000617.0284-2020.
4. Galiè N, Simonneau G. The Fifth World Symposium on Pulmonary Hypertension. J Am Coll Cardiol. 2013 Dec 24;62(25 Suppl):D1-3. doi: 10.1016/j.jacc.2013.10.030.
5. Mereles D, Ehlken N, Kreuscher S, Ghofrani S, Hoeper MM, Halank M, Meyer FJ, Karger G, Buss J, Juenger J, Holzapfel N, Opitz C, Winkler J, Herth FF, Wilkens H, Katus HA, Olschewski H, Grünig E. Exercise and respiratory training improve exercise capacity and quality of life in patients with severe chronic pulmonary hypertension. Circulation. 2006 ;114(14):1482-9. doi: 10.1161/CIRCULATIONAHA.106.618397.
6. Fowler RM, Gain KR, Gabbay E. Exercise intolerance in pulmonary arterial hypertension. Pulm Med. 2012;2012:359204. doi: 10.1155/2012/359204.
7. Kim D, George MP. Pulmonary hypertension. Med Clin North Am. 2019;103(3):413-23. doi:10.1016/j.mcna.2018.12.002.
8. Galiè N, Humbert M, Vachiery JL, Gibbs S, Lang I, Torbicki A, Simonneau G, Peacock A, Vonk Noordegraaf A, Beghetti M, Ghofrani A, Gomez Sanchez MA, Hansmann G, Klepetko W, Lancellotti P, Matucci M, McDonagh T, Pierard LA, Trindade PT, Zompatori M, Hoeper M; ESC Scientific Document Group. 2015 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension: The Joint Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS): Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC), International Society for Heart and Lung Transplantation (ISHLT). Eur Heart J. 2016 ;37(1):67-119. doi: 10.1093/eurheartj/ehv317.
9. JamesR.VallerandPhDaJasonWeatheraldMDbcd1PierantonioLavenezianaMD P. Pulmonary hypertension and exercise. doi:https://doi.org/10.1016/j.ccm.2019.02.003.
10. Waller L, Krüger K, Conrad K, Weiss A, Alack K. Effects of Different Types of Exercise Training on Pulmonary Arterial Hypertension: A Systematic Review. J Clin Med. 2020 Jun 2;9(6):1689. doi: 10.3390/jcm9061689.
11. Keusch S, Turk A, Saxer S, Ehlken N, Grunig E, Ulrich S, On Behalf Of The Swiss Society Of Pulmonary Hypertension. Rehabilitation in patients with pulmonary arterial hypertension. Swiss Med Wkly. 2017;147:w14462. doi: 10.4414/smw.2017.14462.
12. Hoeper MM, Bogaard HJ, Condliffe R, Frantz R, Khanna D, Kurzyna M, Langleben D, Manes A, Satoh T, Torres F, Wilkins MR, Badesch DB. Definitions and diagnosis of pulmonary hypertension. J Am Coll Cardiol. 2013;62(25 Suppl):D42-50. doi: 10.1016/j.jacc.2013.10.032.
13. Mainguy V, Maltais F, Saey D, Gagnon P, Martel S, Simon M, Provencher S. Peripheral muscle dysfunction in idiopathic pulmonary arterial hypertension. Thorax. 2010;65(2):113-7. doi: 10.1136/thx.2009.117168.
14. Craighead DH, Heinbockel TC, Freeberg KA, Rossman MJ, Jackman RA, Jankowski LR, Hamilton MN, Ziemba BP, Reisz JA, D'Alessandro A, Brewster LM, DeSouza CA, You Z, Chonchol M, Bailey EF, Seals DR. Time-Efficient Inspiratory Muscle Strength Training Lowers Blood Pressure and Improves Endothelial Function, NO Bioavailability, and Oxidative Stress in Midlife/Older Adults With Above-Normal Blood Pressure. J Am Heart Assoc. 2021;10(13):e020980. doi: 10.1161/JAHA.121.020980.
15. Zhang Y, Qu B, Lun SS, Guo Y, Liu J. The 36-item short form health survey: reliability and validity in Chinese medical students. Int J Med Sci. 2012;9(7):521-6. doi: 10.7150/ijms.4503.
16. Rikli RE, Jones CJ. The reliability and validity of a 6-minute walk test as a measure of physical endurance in older adults. J Aging Phys Act. 1998;6(4):363-75 doi:10.1123/japa.6.4.363.
17. Tran D, Munoz P, Lau EMT, Alison JA, Brown M, Zheng Y, et al. Inspiratory muscle training improves inspiratory muscle strength and functional exercise capacity in pulmonary arterial hypertension and chronic thromboembolic pulmonary hypertension: A pilot randomised controlled study. Heart Lung Circ. 2021;30(3):388-395. doi: 10.1016/j.hlc.2020.06.006.
18. Cordeiro AL, de Melo TA, Neves D, Luna J, Esquivel MS, Guimarães AR, Borges DL, Petto J. Inspiratory Muscle Training and Functional Capacity in Patients Undergoing Cardiac Surgery. Braz J Cardiovasc Surg. 2016;31(2):140-4. doi: 10.5935/1678-9741.20160035.
19. Laoutaris ID, Dritsas A, Kariofyllis P, Manginas A. Benefits of inspiratory muscle training in patients with pulmonary hypertension: A pilot study. Hellenic J Cardiol. 2016 20:S1109-9666(16)30155-5.doi: 10.1016/j.hjc.2016.05.008.
20. Ferreira JB, Plentz RD, Stein C, Casali KR, Arena R, Lago PD. Inspiratory muscle training reduces blood pressure and sympathetic activity in hypertensive patients: a randomized controlled trial. Int J Cardiol. 2013 ;166(1):61-7. doi: 10.1016/j.ijcard.2011.09.069.
21. DeLucia CM, De Asis RM, Bailey EF. Daily inspiratory muscle training lowers blood pressure and vascular resistance in healthy men and women. Exp Physiol. 2018;103(2):201-211. doi: 10.1113/EP086641.

Disclaimer: None to declare.
Conflict of Interest: None to declare.
Funding Sources: None to declare.