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Effects of Inspiratory Muscle Training and Incentive Spirometer on Fatigue and Quality of Life in Asthma Patients: A Comparative Study

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ABSTRACT

Introduction: Asthma is a chronic respiratory condition that often leads to fatigue and a reduced quality of life due to airway obstruction and respiratory muscle weakness. Inspiratory muscle training (IMT) and incentive spirometry (IS) are non-pharmacological interventions that may improve respiratory function and overall well-being in asthma patients. However, limited studies have compared their effectiveness when combined with structured exercise training. This study aimed to compare the effects of a 6-week exercise training program with IMT and IS on fatigue levels and quality of life in asthma patients.

Materials & Methods: 70 Stable asthmatic patients were enrolled in study after obtaining consent and were randomly divided into two groups (group A and group B) by using chit method. GROUP A (n=35) received incentive spirometer along with conventional therapy (Breathing Exercise) and GROUP B (n=35) received inspiratory muscle training along with conventional therapy, for three session a week for 6 weeks. Fatigue levels were assessed using the Modified Borg scale and quality of life was measured using the SF-36 questionnaire. Heart rate and oxygen saturation were also recorded before and after the intervention.

Results: Both groups showed significant improvement ($p < 0.05$) in fatigue score and quality of life score after 6-week intervention. However, between group analysis IMT groups demonstrated a greater reduction in general health and social activity in term of Quality-of-Life scores as compared to the IS group. However, heart rate and oxygen saturation showed no significant difference in both groups.

Conclusion: A 6-week exercise training program combined with IMT or IS significantly improves fatigue and quality of life in asthma patients, with IMT demonstrating superior benefits to improve quality of life. These findings suggest that incorporating IMT into pulmonary rehabilitation programs may be a valuable strategy for enhancing respiratory function and well-being in individuals with asthma.

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Introduction

Asthma is a chronic airway disease marked by recurrent wheezing, breathlessness, cough, and chest tightness, often worsened at night or triggered by allergens, exercise, or infections. Asthma is a major noncommunicable disease, affecting both children and adults, and is the most common chronic disease among children[1]. As per the 2011 census projections, the Indian population aged ≥15 years and ≥35 years is estimated at respectively 845 million and 415 million. Corresponding to 2.04% population prevalence, nearly 17.23 million people aged ≥15 years have asthma[2]. Diagnosis combines clinical history, physical examination, and objective lung function tests. Spirometry is the gold standard, showing reversible airflow obstruction with an FEV_1 increase of ≥12% and ≥200 mL after bronchodilator use. Peak expiratory flow (PEF) variability (>10%) and bronchial provocation tests help when spirometry is inconclusive[3]. Bronchodilators like short-acting β2-agonists (SABAs) provide quick relief, while long-acting β2-agonists (LABAs) and inhaled corticosteroids (ICS) help with long-term control. Combination therapy with ICS and LABAs is commonly used, while leukotriene receptor antagonists (LTRAs) like montelukast assist in managing allergic and exercise-induced asthma. Severe cases may require oral corticosteroids or biologic therapies like omalizumab[1,4]. non-pharmacological strategies include avoiding triggers such as allergens and smoke, practicing breathing techniques like inspiratory muscle training, and maintaining a healthy lifestyle with regular exercise and a balanced diet. Breathing exercises and inspiratory muscle training are widely used, cost-effective, easy to perform, and effective non-pharmacological interventions for improving asthma control[1]. Breathing exercises like diaphragmatic and pursed-lip breathing help optimize lung function and reduce dyspnea. Inspiratory muscle training strengthens respiratory muscles, enhancing endurance and reducing breathlessness[6]. Airway clearance techniques, including postural drainage and chest physiotherapy, aid in mucus clearance, preventing airway obstruction[7]. Additionally, aerobic and resistance exercises enhance cardiovascular fitness and lung capacity, reducing asthma severity. Education on proper inhaler techniques, posture correction, and relaxation techniques further supports to control symptoms.

Materials and methods

Ethical clearance for the study was obtained from the Institutional Ethical Committee of Pt. B.D. Sharma University of Health Sciences, Rohtak, concerning letter No. BREC/23/TH-Physiotherapy/40 dated 20.07.2023. Seventy stable asthmatic patients, aged 30–50 years, who had been diagnosed with asthma for at least six months, were enrolled in the study from the Pulmonary OPD of Pt. B.D. Sharma, PGIMS. Patients with chronic obstructive pulmonary disease (COPD), unstable asthma, or any psychological, neurological, or musculoskeletal illness were excluded from the study. Subjects were randomly assigned to two groups (Group A and Group B) using the chit method. Group A (n=35) received incentive spirometry along with conventional therapy, while Group B (n=35) underwent inspiratory muscle training along with conventional therapy, including breathing exercises, for three sessions a week over six weeks. Fatigue levels were assessed using the Modified Borg Scale, and quality of life was measured using the SF-36 questionnaire. Heart rate and oxygen saturation were also recorded before and after the intervention in both groups. Conventional therapy includes breathing control exercises, deep breathing or thoracic expansion exercises, and pursed-lip breathing[9].

Incentive Spirometer

The therapeutic tool was sterilized with alcohol before each session, and the mouthpiece was checked for proper attachment. Patients were seated comfortably, ensuring all breathing was performed through the mouth with lips sealed around the mouthpiece. They were instructed to exhale fully before inhaling slowly until maximal inspiration was reached, preventing discomfort from sudden pressure changes. Patients aimed to lift as many balls as possible in the spirometer and held their breath for 2–3 seconds before exhaling slowly. This process was repeated 10 times over 10–15 minutes, with 30-second rest intervals. Conventional therapy included breathing control, pursed-lip breathing, diaphragmatic breathing, and thoracic expansion exercises. The study consisted of 18 sessions, conducted three times per week over six weeks[10].

Inspiratory muscle training

The threshold device was sterilized before each session, and the control knob was set to 39 cm H_2O. The mouthpiece was attached, and the patient was seated comfortably with a nose clip to ensure mouth breathing. After determining the maximum training load, patients performed 10 breaths at their highest tolerable resistance. Training began at low intensity, progressing gradually under supervision. Patients took a deep maximal inspiration followed by a slow, prolonged exhalation, continuing this pattern for 10–20 breaths. Conventional therapy included breathing control, pursed-lip breathing, diaphragmatic breathing, and thoracic expansion exercises session, conducting three times per week over six weeks.[9,10]

Fig.1.1. Inspiratory Muscle Training threshold device

Figure 1.2 Incentive Spirometer

Data analysis

Data were analysed using SPSS software version 21.0. Categorical variables were expressed as frequency and percentage, while continuous variables were presented as mean ± SD. Within-group analysis was conducted using repeated measures ANOVA with post hoc Tukey's test to assess treatment effects. Between-group analysis was performed using an independent t-test, with a p-value < 0.05 considered statistically significant

Result

The age range of 70 participants in both the inspiratory muscle training and incentive spirometer groups was 30 to 50 years. The mean age in the inspiratory muscle training group was 40 ± 8.42 years, while in the incentive spirometer group, it was 40±9.04years. There was no significant difference in the mean age between the two groups.

Table 1.1. shows Turkey's post hoc analysis for multiple comparison of Fatigue in terms of General, Physical and Mental Fatigue, reduced activity and motivation, and Spo2, heart rate and Quality of life parameter within group in both the groups at baseline and 6 weeks.

Variable	**Group A (Mean ± SD)**		**Mean difference**	**p-value**	**Group B (Mean ± SD)**		**Mean difference**	**p-value**
General fatigue	0 weeks 11.82±1.822	6 weeks 13.42±1.98	1.600	0.000**	0 weeks 11.60± 1.37	6 weeks 13.54± 1.70	1.94	0.000**
Physical fatigue	0 weeks 12.25±2.04	6 weeks 11.60±2.29	0.657	0.031*	0 weeks 12.05± 1.92	6 weeks 11.51± 2.18	.54	0.048*
Mental fatigue	0 weeks 10.91±3.	6 weeks 10.17±3.	0.743	0.043*	0 weeks 10.62±1.9	6 weeks 10.54±1.8	.08	0.707^{NS}

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Reduced Activity	0 weeks 11.74±1.86	6 weeks 11.40±2.30	0.34	0.088 NS	0 weeks 13.65± 2.11	6 weeks 13.22± 2.43	0.43	0.230NS
Reduced Motivation	0 weeks 12.65±2.90	6 weeks 12.20±2.31	0.45	0.165 NS	0 weeks 11.54± 1.52	6 weeks 11.82± 1.88	0.32	0.143NS
Spo2	0 weeks 97.14±1.35	6 weeks 97.11±1.32	0.03	0.353 NS	0 weeks 96.74± .610	6 weeks 96.54± 1.24	0.20	1.356NS
Heart rate	0 weeks 90.48±13.53	6 weeks 89.25±10.61	1.23	0.297 NS	0 weeks 87.82±11.63	6 weeks 85.71±4.74	2.11	0.084NS
General Health	0 weeks 45.71±14.85	6 weeks 60.82±21.88	15.114	0.000**	0 weeks 44.85± 13.95	6 weeks 50.31± 9.44	5.457	0.044*
Limitation of Activities	0 weeks 92.42±18.95	6 weeks 95.57±13.49	3.15	0.401 NS	0 weeks 92.14±17.95	6 weeks 100.0±.000	7.857	0.042**
Physical Health Problems	0 weeks 94.09±17.00	6 weeks 97.14±12.02	3.05	0.135 NS	0 weeks 97.14± 12.45	6 weeks 100.00± .000	2.76	0.184NS
Emotiona	0 weeks	6 weeks	4.47	0.095	0 weeks	6 weeks	2.457	0.001*

l Health Problems	54.11±11.15	49.64±11.47		NS	51.82±11.33	54.28±10.47		*
Social Activities	0 weeks 45.34±12.50	6 weeks 50.74±16.46	5.386	0.000**	0 weeks 40.57±12.11	6 weeks 44.14±7.99	3.571	0.000**
Pain	0 weeks 58.27±17.25	6 weeks 60.61±15.42	2.34	0.098 NS	0 weeks 58.21±14.22	6 weeks 62.22±14.01	4.014	0.093 NS
Energy and Emotions	0 weeks 49.64±11.47	6 weeks 57.28±13.46	7.643	0.000**	0 weeks 53.30±15.91	6 weeks 56.30±14.76	0.30	1.000^{NS}
NS-Non significant, * Highly significant**								

Table 1.2. shows comparison of Fatigue, Spo2, Heart rate and Quality of life variable between incentive spirometer and inspiratory muscle training by using independent t-test.

Variable	**Duration**	**Group A (Mean ± SD)**	**Group B (Mean ± SD)**	**t-value**	**p-value**
General fatigue	0 weeks	11.82± 1.82	11.60± 1.37	.592	0.556^{NS}
	6 weeks	13.42±1.98	13.54 ± 1.70	.258	0.797^{NS}
Physical fatigue	0 weeks	12.25± 2.04	12.05± 1.92	.049	0.675^{NS}
	6 weeks	11.60±2.29	11.51 ± 2.18	.406	0.873^{NS}
Mental fatigue	0 weeks	10.91± 3.05	10.62± 1.92	3.687	0.641^{NS}
	6 weeks	10.17±3.08	10.54 ± 1.88	7.473	0.545^{NS}
Reduced Activity	0 weeks	12.65± 2.90	13.65± 2.11	2.463	0.105^{NS}

	6 weeks	12.20±2.31	13.22± 2.43	.653	0.075^{NS}
Reduced Motivation	0 weeks	11.74± 1.86	11.54± 1.52	.491	0.625^{NS}
	6 weeks	11.40±2.30	11.82± 1.88	-.852	0.397^{NS}
Spo2	0 weeks	97.14 ± 1.35	96.74±.610	1.594	0.116^{NS}
	6 weeks	97.11 ± 1.32	96.54 ± 1.24	1.861	0.067^{NS}
Heart rate	0 weeks	90.48 ± 13.53	87.82±.11.65	.880	0.382^{NS}
	6 weeks	89.25 ± 10.61	85.71 ± 4.74	1.803	0.076^{NS}
General Health	0 weeks	45.71 ± 14.85	44.85 ± 13.95	.249	0.804^{NS}
	6 weeks	60.82 ± 21.88	50.31 ± 9.44	2.610	0.011*
Limitation of Activities	0 weeks	92.42 ± 18.95	92.14 ± 17.95	.065	0.949^{NS}
	6 weeks	95.57 ± 13.49	100.0 ± .000	1.942	0.05*
Physical Health Problems	0 weeks	94.09 ± 17.00	97.14 ± 12.45	.856	0.395^{NS}
	6 weeks	97.14 ± 12.02	100.0 ± .000	1.406	0.164^{NS}
Emotional Health Problems	0 weeks	54.11 ± 11.1	51.82 ± 11.33	1.406	0.398^{NS}
	6 weeks	49.64 ± 11.47	54.28 ± 10.47	1.768	0.082^{NS}

Social Activities	0 weeks	45.35 ± 12.54	40.57 ± 12.11	1.624	0.109^{NS}
	6 weeks	50.74 ± 16.46	44.14 ± 7.99	2.133	0.037*
Pain	0 weeks	58.27 ± 17.25	58.21 ± 14.22	.015	0.988^{NS}
	6 weeks	60.61 ± 15.42	66.22 ± 14.O1	.458	0.648^{NS}
Energy and Emotions	0 weeks	49.64 ± 11.47	53.22 ± 15.91	1.081	0.284^{NS}
	6 weeks	57.28 ± 13.46	56.30 ± 14.76	.292	0.771^{NS}

Discussion

Asthma is a chronic respiratory disease characterized by inflammation, airway obstruction, and respiratory muscle weakness. Inspiratory muscle training and incentive spirometer are two commonly used interventions to improve lung function and respiratory muscle strength in asthmatic patients[3]. The current study aimed to analyze the effect of 6 weeks inspiratory muscle training and incentive spirometer in asthmatic Patients. Inspiratory muscle training shows significant benefits in asthmatic patients. IMT's shows positive impact on fatigue indicates improved respiratory muscle strength and endurance. Fatigue was assessed by Multidimensional fatigue inventory scale[11]. There were no significant differences in GF, PF, MF, RM and RA at baseline and significant difference observed at 6 weeks in both groups.

Between group analysis revealed that there was no significant difference observed in GF, PF, MF, RM and RA, at 6 weeks. Spo2 and Heart Rate was assessed by Pulse Oximeter. Within group analysis Spo2 and Heart Rate reflected that there were no significant differences in Group A and Group B. Quilty of Life was assessed by SF-36 Questionnaire[12]. Between group analysis revealed that there were no significant differences observed GH, LOA, PHP, EHP, SA, Pain, EHE and SA, at baseline and also significant difference were observed in GH, LOA at 6 weeks in IMT groups.

Inspiratory Muscle Training (IMT) and Incentive Spirometry (IS) improve fatigue and quality of life in asthma patients by enhancing respiratory muscle strength, lung function, and oxygenation. IMT strengthens the diaphragm and inspiratory muscles, reducing the effort required for breathing and decreasing fatigue, while IS encourages deep breathing, preventing respiratory muscle deconditioning[12]. Both techniques improve lung expansion, increase tidal volume, and reduce air trapping, leading to better oxygen exchange and reduced breathlessness. Strengthening the inspiratory muscles lowers the work of breathing, reducing respiratory fatigue and improving exercise tolerance[13]. Additionally, improved lung mechanics enhance oxygen delivery to tissues, reducing systemic fatigue and promoting overall energy levels[14]. These interventions also have psychological benefits by decreasing anxiety related to breathlessness, allowing patients to perform daily activities with greater ease, ultimately leading to an improved quality of life. Additionally, IMT induces neuromuscular adaptations that enhance respiratory muscle endurance, delaying fatigue and reducing episodes of rapid, shallow breathing[15,16]. Improved lung function enhances oxygen delivery to tissues, lowering systemic fatigue and increasing exercise capacity[17]. These interventions also offer psychological benefits by activating the parasympathetic nervous system, reducing anxiety, and improving breath control, which helps patients manage asthma symptoms more effectively[18,19]. By addressing both physiological and psychological aspects, IMT and IS serve as essential non-pharmacological interventions for improving overall well-being in asthma patients.

Conclusion

Inspiratory Muscle Training (IMT) and Incentive Spirometry (IS) are effective non-pharmacological interventions that significantly improve fatigue levels and quality of life in asthma patients. By strengthening respiratory muscles, enhancing lung function, and optimizing oxygen utilization, these techniques reduce the work of breathing and improve exercise tolerance. Additionally, their role in airway clearance, lung expansion, and autonomic regulation contributes to better asthma control and reduced respiratory distress. The psychological benefits, including reduced anxiety and improved breath control, further enhance patients' overall well-being. Given their safety, affordability, and ease of use, IMT and IS should be integrated into asthma management to complement conventional therapy, ultimately leading to better disease outcomes and improved daily functioning.

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