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Case Report

Effect of inspiratory muscle training and breathing retraining technique on management of asthma: a case study

Ajay Agarwal[1], Jyoti Maan[2]*

[1] Clinical Physiotherapist, Mission Life Rehabilitation Center, Jaipur, Rajasthan, India
[2] Fit For Life Physiotherapy Clinic, Jaipur, Rajasthan, India

Corresponding author: Jyoti Maan, ✉ maanjyoti08@gmail.com, **Orcid Id**: https://orcid.org/0009-0005-3674-9042

Fit For Life Physiotherapy Clinic, Jaipur, Rajasthan, India

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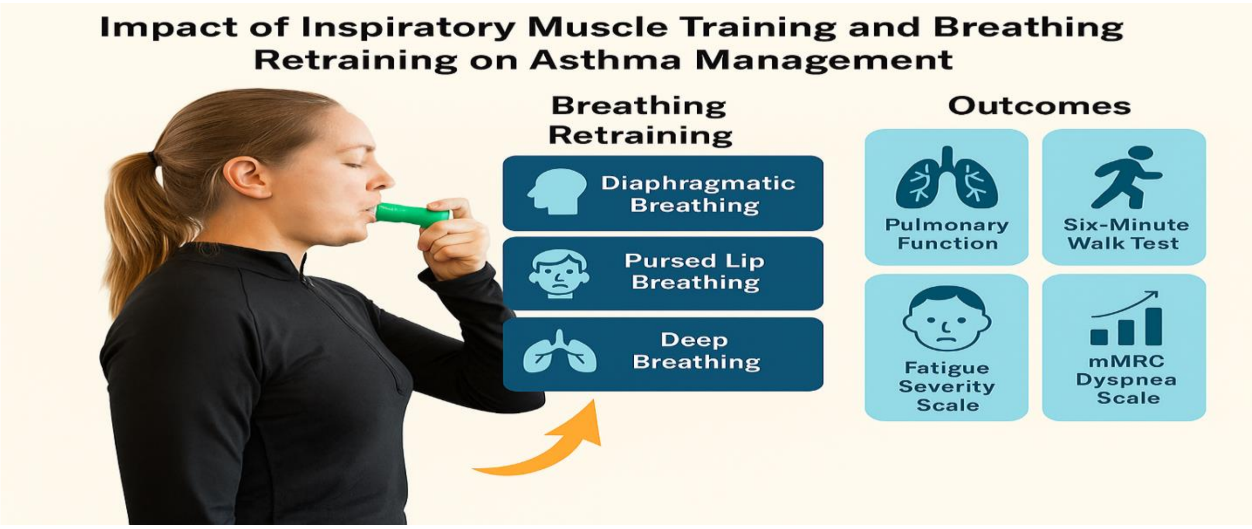
ABSTRACT

Asthma management poses persistent challenges despite advancements in pharmacological treatments. Non-pharmacological interventions, such as Inspiratory Muscle Training (IMT) and Breathing Retraining Techniques (BRT), offer promising avenues to enhance symptom control and quality of life for asthma patients. This case study explores the combined impact of IMT and BRT on asthma management in a single subject with persistent asthma. Over a structured intervention period, the subject engaged in IMT exercises twice daily using a specialized device, complemented by BRT techniques including diaphragmatic breathing, pursed lip breathing, and deep breathing exercises. Outcome measures included Pulmonary function tests, Fatigue severity scale, Six-minute Walk test and Modified medical research council scale. Results revealed significant changes in muscle strength, lung capacity, and reductions in symptoms, accompanied by decreased reliance on rescue medication. The synergistic effects of IMT and BRT underscore their potential as adjuncts to standard asthma care, addressing both respiratory muscle function and breathing patterns. This comprehensive approach holds promise for enhancing symptom management and improving overall quality of life in asthma patients. This work offers important insights into the effectiveness of non-pharmacological therapies in asthma therapy, but more investigation is necessary to confirm these results and clarify underlying mechanisms.



Keywords: Inspiratory Muscle Training, Breathing Retraining Technique, Asthma, Physiotherapy, Pulmonary rehabilitation.

INTRODUCTION

Chronic asthma is a respiratory disease that causes airway inflammation, bronchoconstriction, and hyper-responsiveness to different stimuli. These symptoms can include wheezing fits, dyspnea, tightness in the chest, and coughing fits on occasion. According to the World Health Organization, it affects an estimated 262 million people worldwide and significantly increases morbidity and healthcare expenditures [1].

Many patients still experience exacerbations and inadequate control despite advancements in pharmacological therapies, such as bronchodilators and inhaled corticosteroids. This emphasizes the necessity of using non-pharmacological adjunctive therapies to improve the condition's management [2]. There are about 25 million asthmatics in the United States. That works out to around 1 in 13 persons. In the United States, 20 million persons over the age of 18 suffer with asthma. In the US, adult Blacks have the highest prevalence of asthma. Adult females are more prone to asthma than adult males. 6.1% of adult males and 9.8% of adult females, respectively, have asthma [3,4]. Asthma, one of the most prevalent chronic conditions worldwide, affects 300 million people and contributes to 25,000 fatalities annually [4]. According to a national survey, roughly 2.38% of Indians have asthma. A prior survey in the Jaipur area of Rajasthan found that 0.96% of people had asthma [5]. It was significantly less than the 2.38% national average. At the time, it was hypothesised that this might be because Jaipur residents do not receive enough asthma diagnoses [5]. With a peak age of three years old, asthma can manifest at any age. Adults with asthma, even those whose symptoms started in maturity, actually go asymptomatic for life. Within a single patient, the severity of asthma does not vary much; mild asthmatics seldom develop into more severe cases, while severe asthmatics typically have severe disease from the start [6].

Asthma is a disease influenced by genetic and environmental factors. Allergens both indoors and outdoors, psychological strain, exercise, illnesses, specific medications, poor air quality, asthma, dyspnoea, and coughing are common triggers. Patients may experience difficulty breathing at night, tenacious mucus production, enhanced ventilation, and prodromal symptoms before an attack. It is important to distinguish between risk factors and triggers, which are environmental factors that worsen asthma in a patient with established asthma [7,8].

Variable and intermittent airway obstruction symptoms are indicative of asthma, and these symptoms need to be verified by objective lung function tests. Spirometry is one test of lung function that can be used to confirm airflow limitation and assist medical professionals in treating patients. Asthma diagnosis may not be aided by hematologic testing, such as total serum IgE and specific IgE to inhaled allergens [9]. Skin prick tests to common inhaled allergens, lung shadowing, high-resolution CT, and chest roent-genography are not useful in diagnosing intrinsic asthma but are positive in allergic asthma. Asthma challenge tests can be used to determine whether exercise aggravates symptoms. Eosinophilic airway inflammation is now quantified using fractional exhaled nitric oxide (FENO). By reducing airway tightness, bronchodilators reduce asthma symptoms; however, they do not reduce underlying inflammation. The three primary kinds of β2-agonists that work well are theophylline, anti-cholinergic, and β2-agonists [10,11].

IMT involves the use of devices that provide resistance during inhalation, thereby strengthening the muscles involved in inspiration. Research have shown that IMT can significantly enhance an asthma patient's lung function, respiratory muscle strength, and general quality of life [12].

Breathing retraining techniques encompass various methods aimed at improving breathing efficiency and reducing dysfunctional breathing patterns commonly seen in asthma. These techniques include diaphragmatic breathing, Buteyko breathing, and the Papworth method, among others. While IMT focuses on enhancing the mechanical aspects of breathing by strengthening the inspiratory muscles, BRT addresses the behavioural components by optimizing breathing patterns [13].

The purpose of this study was to ascertain the effects of IMT and BMT on the respiratory strength of muscles, capacity for exercise, tiredness, and daily living activities of asthmatic patients. By examining the synergistic effects of IMT and breathing retraining, this study aims to provide insights into the efficacy of these non-pharmacological approaches in asthma management. The findings could pave the way for incorporating these techniques into standard asthma care protocols, offering a holistic and patient-centred approach to managing this chronic condition.

MATERIALS AND METHODS

Participant

Subject selected for this study was 22-year-old female patient already diagnosed with asthma for one year. Patient was a student and came to physiotherapy OPD of Jaipur National University, Jaipur (RAJ.) with short ness of breath during walking after a few minutes on level ground and inclined surface. Assessment with examination was done after taking consent form with values recorded before the intervention for PFT: - FEV1= 1.57, FVC= 1.98, FEV1/FVC= 79.29 and mMRC value of patient=grade2, six-minute walk test = 330 m and fatigue severity scale score=40. Ethical approval letter was obtained from Department of Physiotherapy, Jaipur National University, Jaipur.

Instruments

Pulmonary Function Test (PFT) was used to measure the capacity of lungs. Dyspnoea was measured through mMRC grading. Functional status was assessed by six-minute walk test and fatigue by Fatigue Severity Scale. The readings for all were baseline on first day and after intervention at 21st day.

Pulmonary function test

It is used for assessment of lung function non-invasively which monitors a person's capacity to breathe in and out at different rates, is usually part of the exam. Patient breathes into a mouthpiece attached to a spirometer and frequently inhale deeply before beginning the process, and then exhale into the device as strongly as completely as possible. Then the graph appears on the monitor through which flow and volume is measured. In order to see how the test affects lung function, bronchodilator administration may be used.

Dyspnea– mMRC scale.

Patients with respiratory disorders can have their dyspnoea evaluated using the Modified Medical Research Council (mMRC) Dyspnoea Scale and other instruments. It is categorized into four grades: 0 through 4, each of which corresponds to a certain activity that causes dyspnoea. The scale aids medical professionals in assessing how dyspnoea affects a patient's day-to-day functioning and in making treatment recommendations.

Fatigue severity scale

Patients score each of the nine statements, which represent how exhaustion impacts their activities, motivation, and lifestyle, on a scale from 1 (strongly disagree) to 7 (strongly agree). With a specific focus on fatigue's severity and impairment with everyday activities, the FSS aids in distinguishing it from depression and other illnesses. Higher scores indicate more severe exhaustion. The total score can vary from 9 to 63. Generally speaking, a normal range score of less than 36 is considered acceptable.

Six-minute Walk test

The functional exercise ability of a patient is determined using a straightforward, non-invasive evaluation. The patient is given instructions to walk as far as they can for six minutes along a straight, level corridor during the test. They are free to stop, slow down, and rest as needed. The total distance walked is recorded and serves as an indicator of aerobic capacity and endurance. The 6MWT is commonly used in patients with chronic respiratory diseases, heart failure, and other conditions affecting mobility. It helps clinicians evaluate the effectiveness of treatments, track disease progression, and predict outcomes, providing valuable insights into a patient's functional status and overall health.

Figure 1: Patient performing IMT

Table 1: Exercise Intervention

Exercise	Variables	Benefits	Description
Inspiratory Muscle Training	30 Breaths twice a day *4 min * 3 weeks	Strengthen the inspiratory muscles and stronger inspiratory muscle require less effort, thus reduces dyspnea	Put the nose piece on nose and insert the mouthpiece of it device in mouth and inhale through the device
Deep Breathing Exercise	5 Breaths twice a day *4 min * 3 week	Progressive muscle relaxation exercise, induces state of relaxation which can reduce stress, Anxiety level and loses the secretions.	Take 3-5 long, slow, deep breaths in, through breath out through pursed lip. Pause at the end of each breath in for 2-3 seconds, then breath out gently throughout your mouth.
Pursed Lip Breathing	5 breaths twice a day * 4min * 3 week	Decreases trapping of air in lungs	Relax your neck and shoulder muscles. Breathe in through your nose for 2 seconds while keeping your mouth closed. You don't need a deep breath; a normal breath will do. Pucker or purse your lips as if you were going to whistle or like you're gently blowing out a candle flame. Breathe out slowly through your pursed lips while counting down from.
Diaphragmatic breathing	10 Breaths Twice a Day * 3 Min * 3 week	Trains the diaphragm & other respiratory muscles and help in increasing the tidal volume	Position the patient in a relaxed crook- lying position. The therapist places hand on the patient's upper abdomen. Ask the patient inhale through nose, letting the patient's hand rise during inspiration. Then have the patient exhale through pursed-lips, while the therapist's hand presses inward on the abdomen. Have the patient perform this exercise with patient's hand on upper abdomen. Have patient repeat exercise until adequate expansion is achieved. The patient should relax upper chest and shoulders during this procedure

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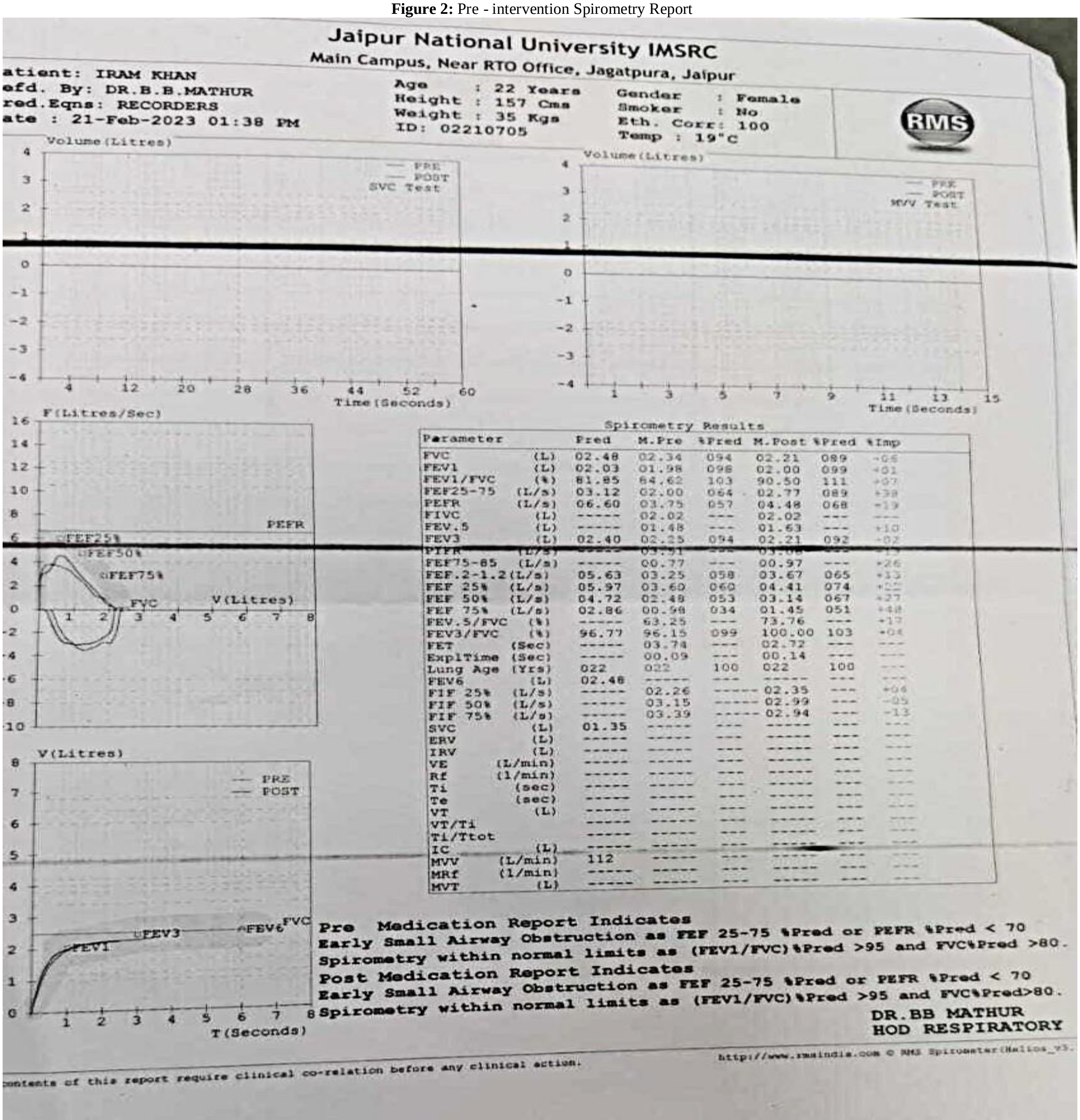
Procedure

The study procedure was structured into four distinct phases. Initially, in the first phase, patients were assessed, and tailored plans were formulated. The second phase focused on conducting preliminary tests. The third phase involved the implementation of a combined exercise regimen. Finally, in the fourth phase, follow-up tests were administered. The intervention included IMT Inspiratory Muscle Training) was applied around 4-5 minutes, twiceadayfor21days with intensity ranging from starting with 9 cm H2o and maximum up to 23 cmH2o. BRT (Breathing Retraining Technique) were performed at 3 sets, 10 repetitions, 60 seconds of interval between setsand3minutes rest between each exercise, twiceadayfor21 days. This included deep breathing and thoracic expansion exercises in which 3-5 long breaths with pause were included. Pursed lip and diaphragmatic breathing were also performed to achieve breath control. The results were assessed on 1st and 21st day. Table provides a detailed overview of the design of this rehabilitation exercise process.

Figure 2: Pre - intervention Spirometry Report



Jaipur National University IMSRC
Main Campus, Near RTO Office, Jagatpura, Jaipur

Spirometry Results

Parameter		Pred	M.Pre	%Pred	M.Post	%Pred	%Imp
FVC	(L)	02.48	02.34	094	02.21	089	-06
FEV1	(L)	02.03	01.98	098	02.00	099	+01
FEV1/FVC	(%)	81.85	84.62	103	90.50	111	+07
FEF25-75	(L/s)	03.12	02.00	064	02.77	089	+38
PEFR	(L/s)	06.60	03.75	057	04.48	068	+19
FIVC	(L)	------	02.02	---	02.02	---	---
FEV.5	(L)	------	01.48	---	01.63	---	+10
FEV3	(L)	02.40	02.25	094	02.21	092	-02
PIFR	(L/s)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEF75-85	(L/s)	------	00.77	---	00.97	---	+26
FEF.2-1.2	(L/s)	05.63	03.25	058	03.67	065	+13
FEF 25%	(L/s)	05.97	03.60	060	04.41	074	[illegible]
FEF 50%	(L/s)	04.72	02.48	053	03.14	067	+27
FEF 75%	(L/s)	02.86	00.98	034	01.45	051	+48
FEV.5/FVC	(%)	------	63.25	---	73.76	---	+17
FEV3/FVC	(%)	96.77	96.15	099	100.00	103	[illegible]
FET	(Sec)	------	03.74	---	02.72	---	---
ExplTime	(Sec)	------	00.09	---	00.14	---	---
Lung Age	(Yrs)	022	022	100	022	100	---
FEV6	(L)	02.48	------	---	------	---	---
FIF 25%	(L/s)	------	02.26	------	02.35	---	+04
FIF 50%	(L/s)	------	03.15	------	02.99	---	-05
FIF 75%	(L/s)	------	03.39	------	02.94	---	-13
SVC	(L)	01.35	------	---	------	---	---
ERV	(L)	------	------	---	------	---	---
IRV	(L)	------	------	---	------	---	---
VE	(L/min)	------	------	---	------	---	---
Rf	(1/min)	------	------	---	------	---	---
Ti	(sec)	------	------	---	------	---	---
Te	(sec)	------	------	---	------	---	---
VT	(L)	------	------	---	------	---	---
VT/Ti		------	------	---	------	---	---
Ti/Ttot		------	------	---	------	---	---
IC	(L)	------	------	---	------	---	---
MVV	(L/min)	112	------	---	------	---	---
MRf	(1/min)	------	------	---	------	---	---
MVT	(L)	------	------	---	------	---	---

Pre Medication Report Indicates
Early Small Airway Obstruction as FEF 25-75 %Pred or PEFR %Pred < 70
Spirometry within normal limits as (FEV1/FVC)%Pred >95 and FVC%Pred >80.
Post Medication Report Indicates
Early Small Airway Obstruction as FEF 25-75 %Pred or PEFR %Pred < 70
Early Small Airway Obstruction as FEF 25-75 %Pred or PEFR %Pred < 70
Spirometry within normal limits as (FEV1/FVC)%Pred >95 and FVC%Pred>80.
DR.BB MATHUR
HOD RESPIRATORY

Contents of this report require clinical co-relation before any clinical action.

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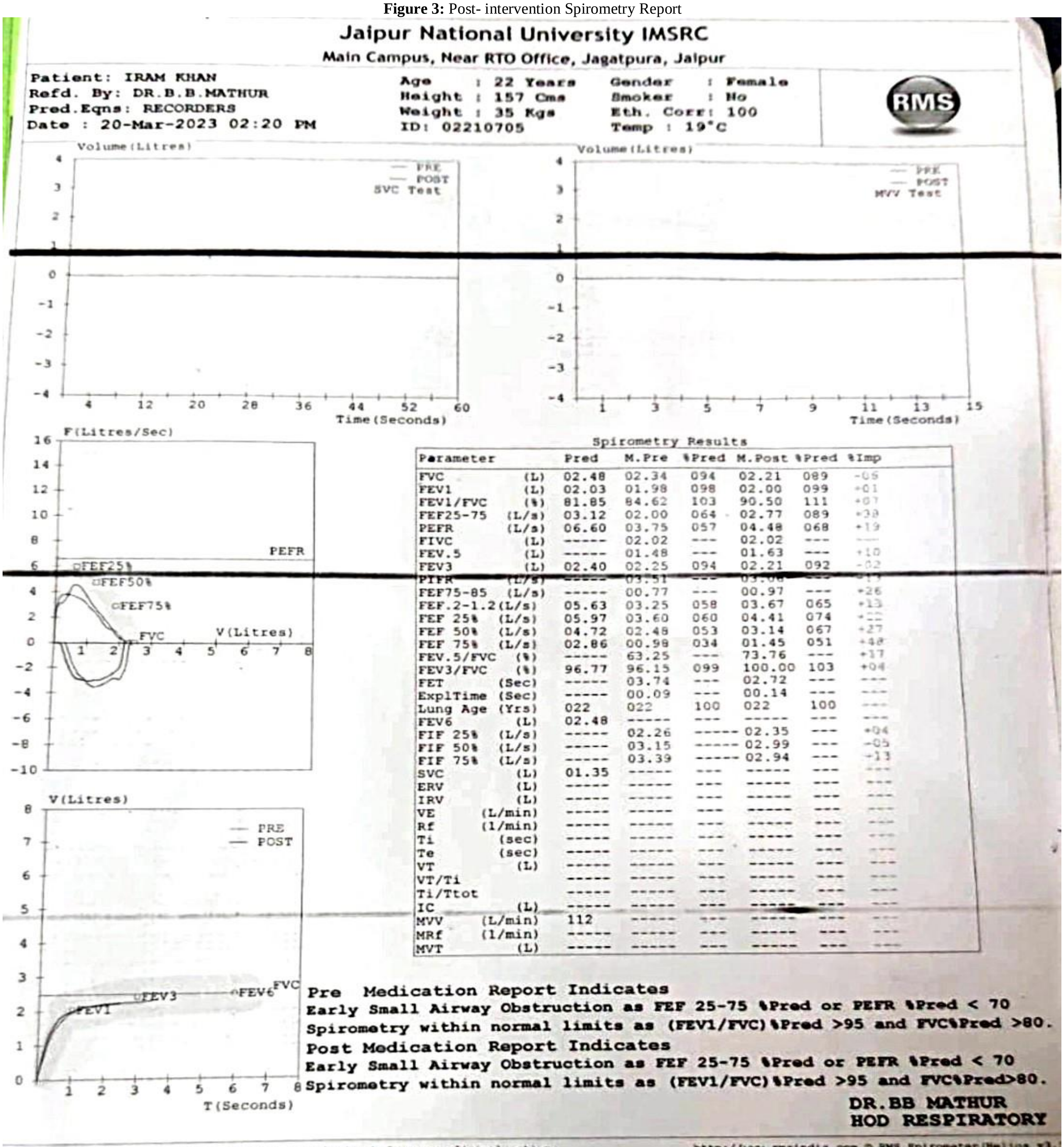
Figure 3: Post- intervention Spirometry Report


Jaipur National University IMSRC
Main Campus, Near RTO Office, Jagatpura, Jaipur

Patient: IRAM KHAN
Refd. By: DR.B.B.MATHUR
Pred.Eqns: RECORDERS
Date : 20-Mar-2023 02:20 PM

Age : 22 Years
Height : 157 Cms
Weight : 35 Kgs
ID: 02210705

Gender : Female
Smoker : No
Eth. Corr: 100
Temp : 19°C

Spirometry Results

Parameter		Pred	M.Pre	%Pred	M.Post	%Pred	%Imp
FVC	(L)	02.48	02.34	094	02.21	089	-05
FEV1	(L)	02.03	01.98	098	02.00	099	+01
FEV1/FVC	(%)	81.85	84.62	103	90.50	111	+07
FEF25-75	(L/s)	03.12	02.00	064	02.77	089	+38
PEFR	(L/s)	06.60	03.75	057	04.48	068	+19
FIVC	(L)	------	02.02	---	02.02	---	---
FEV.5	(L)	------	01.48	---	01.63	---	+10
FEV3	(L)	02.40	02.25	094	02.21	092	-02
PIFR	(L/s)	------	03.51	---	[illegible]	---	[illegible]
FEF75-85	(L/s)	------	00.77	---	00.97	---	+26
FEF.2-1.2	(L/s)	05.63	03.25	058	03.67	065	+13
FEF 25%	(L/s)	05.97	03.60	060	04.41	074	+22
FEF 50%	(L/s)	04.72	02.48	053	03.14	067	+27
FEF 75%	(L/s)	02.86	00.98	034	01.45	051	+48
FEV.5/FVC	(%)	------	63.25	---	73.76	---	+17
FEV3/FVC	(%)	96.77	96.15	099	100.00	103	+04
FET	(Sec)	------	03.74	---	02.72	---	---
ExplTime	(Sec)	------	00.09	---	00.14	---	---
Lung Age	(Yrs)	022	022	100	022	100	---
FEV6	(L)	02.48	------	---	------	---	---
FIF 25%	(L/s)	------	02.26	------	02.35	---	+04
FIF 50%	(L/s)	------	03.15	------	02.99	---	-05
FIF 75%	(L/s)	------	03.39	------	02.94	---	-13
SVC	(L)	01.35	------	---	------	---	---
ERV	(L)	------	------	---	------	---	---
IRV	(L)	------	------	---	------	---	---
VE	(L/min)	------	------	---	------	---	---
Rf	(1/min)	------	------	---	------	---	---
Ti	(sec)	------	------	---	------	---	---
Te	(sec)	------	------	---	------	---	---
VT	(L)	------	------	---	------	---	---
VT/Ti		------	------	---	------	---	---
Ti/Ttot		------	------	---	------	---	---
IC	(L)	------	------	---	------	---	---
MVV	(L/min)	112	------	---	------	---	---
MRf	(1/min)	------	------	---	------	---	---
MVT	(L)	------	------	---	------	---	---

Pre Medication Report Indicates
Early Small Airway Obstruction as FEF 25-75 %Pred or PEFR %Pred < 70
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Post Medication Report Indicates
Early Small Airway Obstruction as FEF 25-75 %Pred or PEFR %Pred < 70
Spirometry within normal limits as (FEV1/FVC)%Pred >95 and FVC%Pred>80.
DR.BB MATHUR
HOD RESPIRATORY

contents of this report require clinical co-relation before any clinical action.
http://www.rmsindia.com © RMS Spirometer(Helios_v3.

Data analysis

The test's data were gathered and visibly displayed for examination. The data before and after the intervention for all outcome measures were plotted using MS Office Excel 2013. All measurements were taken at day 0 and day 21 to obtain the result.

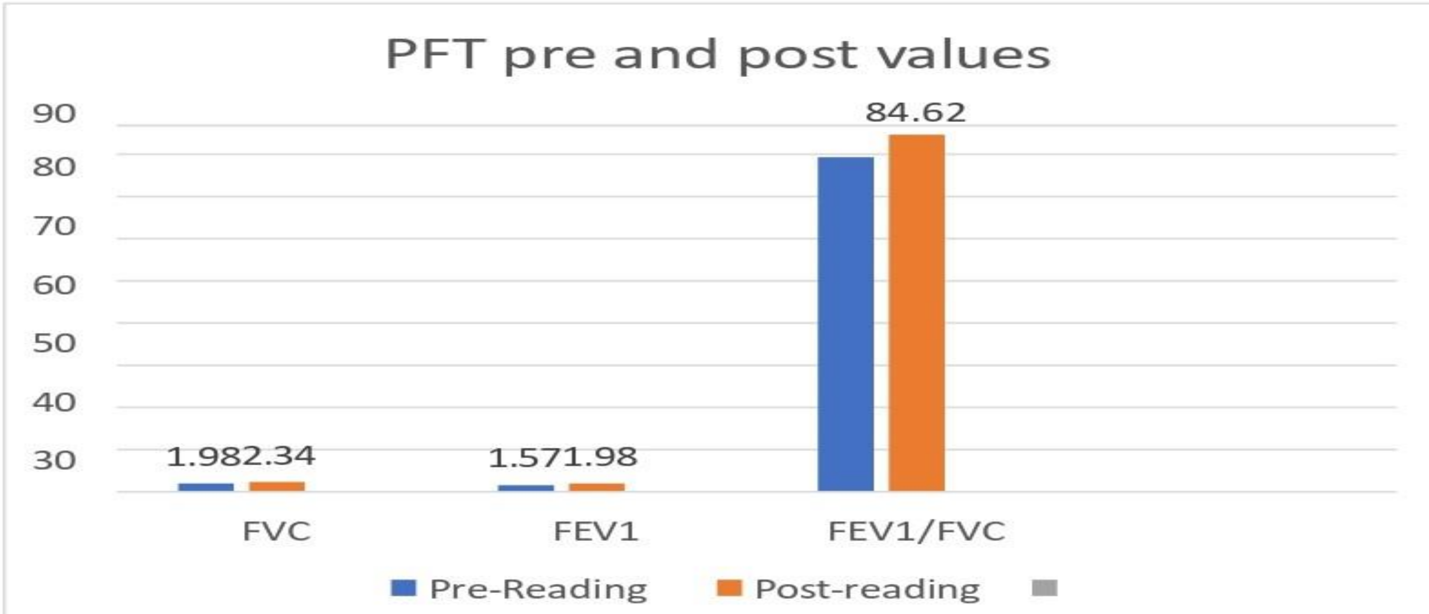
RESULTS

PFT, mMRC scale, Fatigue severity scale and Six-minute Walk test, were used to measure the exercise capacity, strength, dyspnea a comparison was made between pre-test value sand post-test values all these parameters.

Results of PFT

Before the intervention potential obstructive airway limitation is indicated by a FEV1/FVC ratio of 79.29%, which is somewhat below the normal range of 80%. Following an intervention the improvement in airway function, approaching the normal range, is indicated by the increase to a FEV1/FVC ratio of 84.62%. This improvement shows that improved airway patency and respiratory efficiency have been mostly attributed to the IMT and BRT. The patient's capacity to breathe more easily and the symptoms related to obstructive airway issues are likely being reduced as a result of the training's positive effects on lung function.

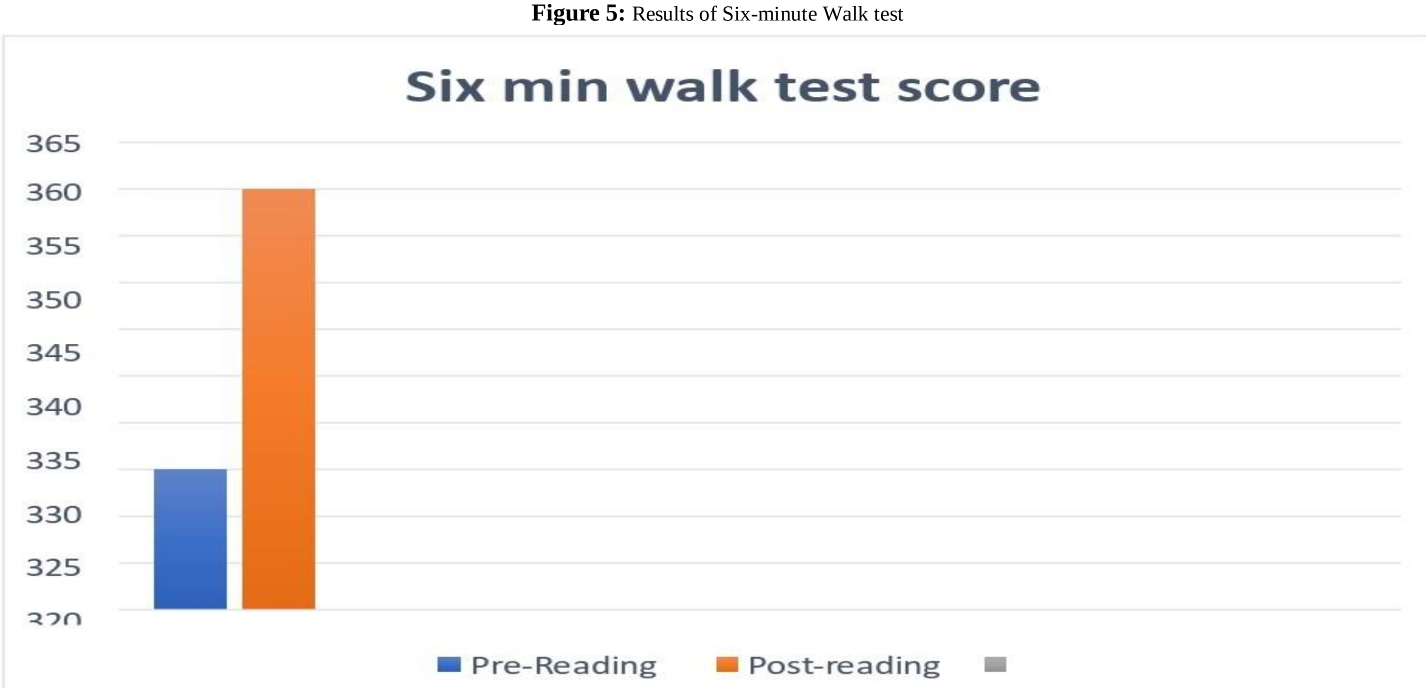
Figure 4: Results of PFT



Results of Six-minute Walk test

The initial distance of 330 meters walked indicates the patient's baseline functional capacity. A shorter distance suggests limited endurance and potentially compromised physical performance. The increase to 360 meters reflects improved endurance and physical performance following IMT and BRT. This improvement suggests that the interventions have effectively enhanced the patient's functional exercise capacity, translating to improved mobility and potentially better overall cardiovascular and respiratory fitness.

Figure 5: Results of Six-minute Walk test



Results of FSS

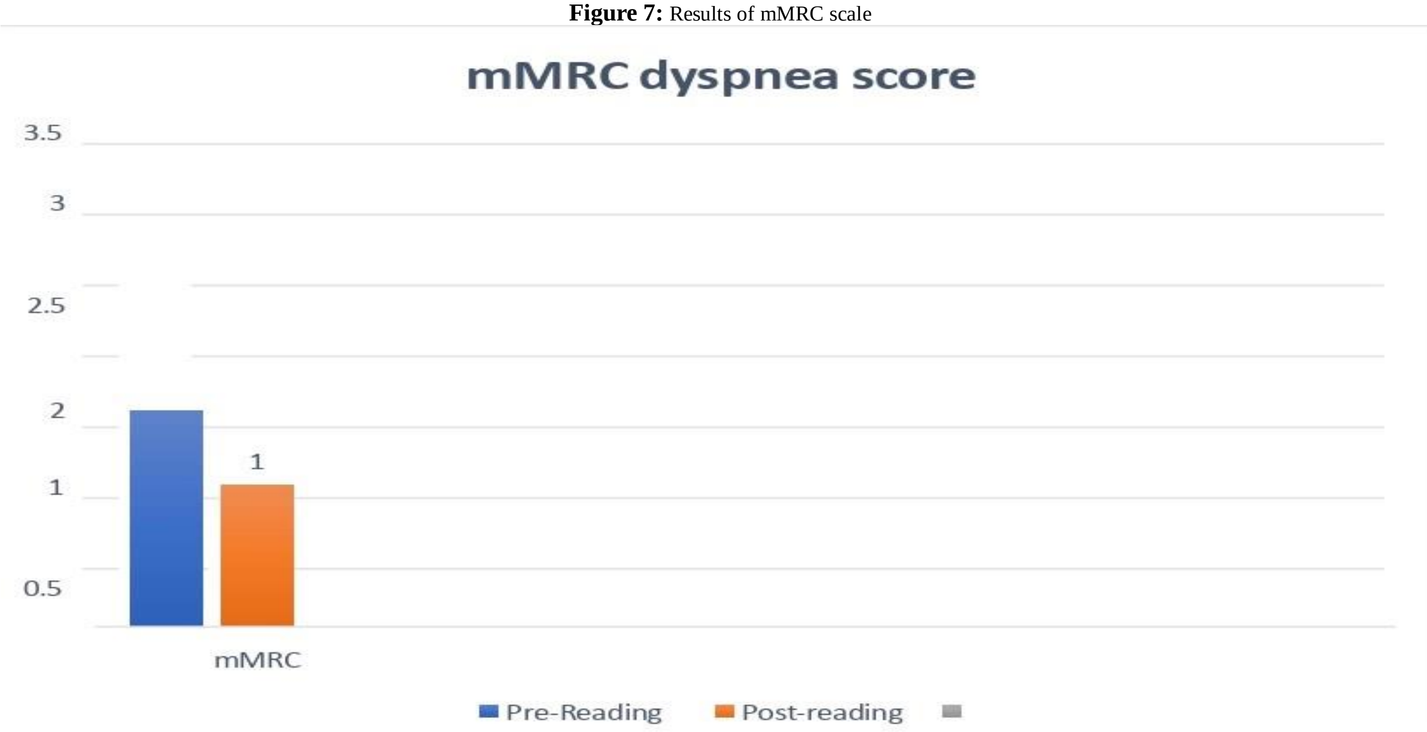
Pre-Training value of 40 indicates a moderate to severe tiredness score has a substantial influence on daily activities and general quality of life. Post-Training it reduced to 36. Although the decrease indicates that some of the fatigue symptoms may have been mitigated by IMT and BRT, the fatigue range is still present. This improvement, taken together, indicates that the patient's fatigue severity has decreased as a result of the IMT and BRT therapies. As a result of these therapeutic approaches, there may be an improvement in general functioning.

Figure 6: Results of FSS

Results of mMRC scale

This suggests that the patient's dyspnea has improved. At first, the patient had a grade of 2, meaning that they were so out of breath that they had to walk at a slower rate when walking at their own pace or slower than persons their own age on flat ground. After the training, with a grade of 1, the patient now only experiences breathlessness when hurrying on level ground or walking up a slight hill. This progression signifies a notable enhancement in the patient's respiratory function and their ability to perform physical activities with less discomfort.

Figure 7: Results of mMRC scale



DISCUSSION

Asthma yet remains a complex challenge despite of the advancements and treatment options available in which exercise rehabilitation plays a crucial role. This case study was investigated with aim to evaluate the effectiveness of IMT and BRT in combination as this can be prescribed as home protocol also for the patient. The study employed a structured protocol where the subject underwent IMT sessions and BRT for 21 days.

Previous literatures were reviewed and studies supported each technique individually. According to a study by Neslihan Duruturk et al. (2018), dyspnea and inspiratory muscle strength are positively impacted by respiratory muscle exercise. In this study, the impact of an IMT program on asthmatic patients' inspiratory muscle strength, capability to exercise, dyspnea, tiredness, activities of daily living, and health status were examined.

Weiner et al. (2003) demonstrated significant increases in maximal inspiratory pressure following IMT, indicating enhanced respiratory muscle performance [14]. Similarly, BRT techniques, including diaphragmatic breathing and pursed lip breathing, have been shown to improve respiratory muscle coordination and efficiency, contributing to better control of asthma symptoms [15].

Meta-analysis by Ramirez-Venegas et al. (2019) indicated that IMT significantly increased FEV1 and peak expiratory flow rates in patients with chronic respiratory conditions, including asthma which are consistent with results in our case study [16].

Lista-Paz A et al. (2023) combined data from clinical studies in a comprehensive review and meta-analysis, showing a significant improvement in respiratory muscle strength, dyspnea degree of severity, and exercise capacity in asthma patients receiving IMT. This review highlights how IMT can improve breathing and lessen the severity of symptoms, and it recommends incorporating it into all-encompassing asthma treatment plans [17].

Breathing retraining techniques aim to address dysfunctional breathing patterns commonly seen in asthma patients. These methods focus on controlled breathing, diaphragmatic breathing, and slow, deep breaths to mitigate hyperventilation and enhance oxygenation. Furthermore, breathing retraining can help alleviate anxiety linked to asthma, potentially reducing the frequency and severity of asthma attacks [18].

The results of this case study indicate that combining breathing retraining strategies with inspiratory muscle training (IMT) may be a promising way to improve asthma management. The subject, who underwent a structured program incorporating both interventions, demonstrated notable improvements in various parameters.

Pulmonary function tests revealed enhancements in respiratory muscle strength and efficiency, as evidenced by increased maximal inspiratory pressure and improved lung function parameters. Additionally, the subject reported a reduction in asthma symptoms, including dyspnea and wheezing, along with decreased reliance on rescue medication.

CONCLUSION

The holistic nature of the combined intervention, addressing both respiratory muscle function and breathing patterns, likely contributed to the observed benefits. By strengthening inspiratory muscles through IMT and promoting more efficient breathing through retraining techniques, the subject experienced improved respiratory function and reduced symptom burden.

These findings underscore the potential of non-pharmacological interventions as adjuncts to standard asthma care. Incorporating IMT and breathing retraining into asthma management protocols could offer a comprehensive approach to addressing the multifaceted nature of the condition, ultimately leading to enhanced symptom control and improved quality of life for patients.

Limitations for this study majorly were single case study very small sample size and limited days of study, it should be conducted for longer period of time along with follow up. To confirm these results and clarify the processes underlying the synergistic benefits of IMT and breathing retraining, more studies with bigger sample sizes and longer follow-up times are necessary. Nevertheless, this study provides valuable insights into the efficacy of these interventions and highlights their potential as integral components of asthma management strategies.

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CONFLICT OF INTEREST

There are no financial or personal relationships that could have influenced the conduct or reporting of this research.

REFERENCES

1. GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020; 396(10258):1204–22. doi:10.1016/S0140-6736(20)30925-9

2. Nelson HS, 2021. The evolution of allergy immunotherapy. Ann Allergy Asthma Immunol. 126(4), Pages 357–66. Doi: 10.1016/j.anai.2020.11.011.

3. Arik V, 2022. National Center for Health Statistics. 2022 NHIS Adult Summary Health Statistics. U.S. Department of Health and Human Services.

4. Gupta PR, Bansal A, Singh A, 2016. Resurvey of symptomatics of the Jaipur district population and suggestion for alternative diagnostic criteria of asthma for epidemiological surveys. Lung India. 33, Pages 32–35. Doi:10.4103/0970-2113.173053.

5. Usmani OS, Roche N, Jenkins M, et al, 2021. Consistent pulmonary drug delivery with whole lung deposition using the Aerosphere inhaler: a review of the evidence. Int J Chron Obstruct Pulmon Dis. 16, Pages 113–124. Doi:10.2147/COPD.S274846.

6. Loscalzo J, Fauci A, Kasper D, et al, 2022. editors. Harrison's Principles of Internal Medicine. 20th ed. New York: McGraw-Hill Education, 1.

7. Van der Meer AN, de Jong K, Hoekstra-Kuik A, 2019. Dynamic hyperinflation impairs daily life activity in asthma. Eur Respir J. 53, Pages 1801500. Doi: 10.1183/13993003.01500-2018.

8. Dominguez-Ortega J, Plaza V, Nieto A, et al, 2023. The ATLAS ASMA Study: assessing the impact of asthma on patients' life – the Spanish patients' perspective. J Asthma Allergy. 16, Pages 461–71. Doi: 10.2147/JAA.S403148.

9. Van der Molen T, Fletcher M, Price D, 2017. Identifying patient attitudinal clusters associated with asthma control: the European REALISE survey. J Allergy Clin Immunol Pract. 6, Pages 962–71. Doi: 10.1016/j.jaip.2017.10.003.

10. Chaves GS, Freitas DA, Santino TA, et al, 2019. Chest physiotherapy for pneumonia in children. Cochrane Database Syst Rev. Pages 1:CD010277. Doi: 10.1002/14651858.CD010277.pub2.

11. Shei RJ, Paris HL, Wilhite DP, et al, 2016. The role of inspiratory muscle training in the management of asthma and exercise-induced bronchoconstriction. Phys Sports med. 44(4), Pages 327–334. Doi:10.1080/00913847.2016.1224211.

12. Duruturk N, Acar M, Doğrul MI, 2018. Effect of inspiratory muscle training in the management of patients with asthma: a randomized controlled trial. J Cardio pulm Rehabil Prev. 38(4), Pages 198–203. Doi:10.1097/HCR.0000000000000329.

13. Weiner P, Magadle R, Beckerman M, et al, 2003. Comparison of specific expiratory, inspiratory, and combined muscle training programs in COPD. Chest. 124(4), Pages 1357–1364. Doi: 10.1378/chest.124.4.1357.

14. Santino TA, Chaves GS, Freitas DA, et al, 2020. Breathing exercises for adults with asthma. Cochrane Database Syst Rev. 3, Page CD001277. Doi: 10.1002/14651858.CD001277.pub2.

15. Ramírez-Venegas A, Torres-Duque C, Guzmán-Bouilloud N, et al, 2019. Small airway disease in COPD associated to biomass exposure. Rev Invest Clin. 71, Pages 163–170. Doi: 10.24875/RIC.18002652.

16. Lista-Paz A, Bouza Cousillas L, Jácome C, et al, 2023. Effect of respiratory muscle training in asthma: a systematic review and meta-analysis. Ann Phys Rehabil Med. 66, Page 101691. Doi: 10.1016/j.rehab.2023.101691.

17. Thomas M, McKinley RK, Freeman E, et al, 2003. Breathing retraining for asthma: a randomised controlled trial. Thorax. 58(2), Pages 110–115. Doi:10.1136/thorax.58.2.110.

18. Bruton A, Thomas M, 2011. Breathing training for dysfunctional breathing in asthma: a randomized controlled trial. Thorax. 66(1), Pages 101–107. Doi:10.1136/thx.2010.136497.