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The Effect of Inspiratory Muscle Training, Incentive Spirometer and Deep Breathing Exercise in Asthmatic Patient: A Narrative Review

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Abstract: ***Introduction: Asthma, a prevalent chronic inflammatory airway disease affecting over 300 million people globally, presents challenges in effective management. This narrative review explores the potential of three non-pharmacological interventions—Inspiratory Muscle Training (IMT), Incentive Spirometry, and Deep Breathing Exercises—in improving asthma control and respiratory parameters. Methodology: A systematic literature search identified 30 relevant studies, with ten meeting inclusion criteria. These studies encompassed diverse populations and interventions, showcasing the effectiveness of IMT, incentive spirometry, and breathing exercises in improving pulmonary function, dyspnea perception, and quality of life in asthmatic patients. Discussion: The review discusses findings from selected studies, highlighting the positive outcomes of non-pharmacological interventions. It addresses the limitations, such as small sample sizes and a lack of direct comparisons and emphasizes the need for further research to establish definitive protocols and compare the interventions in a larger and more diverse population. Conclusion: In conclusion, IMT, incentive spirometry, and breathing exercises emerge as effective and low-cost adjunct therapies for asthma management. While acknowledging study limitations, the review calls for additional research to establish comprehensive protocols and compare the efficacy of these interventions in diverse asthmatic populations.***

Keywords: asthma, non-pharmacological interventions, Inspiratory Muscle Training IMT, incentive spirometry, deep breathing exercises

1. Introduction

Asthma is a chronic inflammatory airway disease characterized by airflow restriction and hyper-responsiveness More than 300 million people globally suffer from asthma. Asthma is becoming more prevalent in many nations, and it affects people of all ages. Because of its high prevalence and accompanying healthcare expenditures, asthma is rapidly being recognized as a public health concern. As a result, it is critical to explore lower-cost alternatives to established asthma treatment, as well as adjunct medicines to enhance traditional asthma treatment strategies for managing and altering its severity.[1]

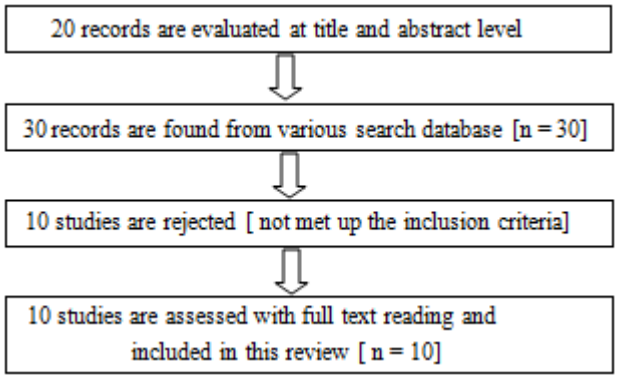
The form and position of the diaphragm alter because of chronic airflow limitation caused by asthma or chronic obstructive pulmonary disease. This change is thought to be caused by an increase in lung volume. Increased lung volume changes the geometry of the chest wall and shortens the Inspiratory muscles, lowering their capacity. Dyspnea and respiratory muscle exhaustion result from a decrease in the strength of the Inspiratory muscle.[2]

Airway blockage during exercise is associated with higher Inspiratory muscle effort because of resistance to airflow and dynamic hyperinflation of the lung (increased end-expiratory lung capacity,) in asthmatic persons. The increased work of breathing caused by dynamic hyperinflation has been found to be a significant predictor of dyspnea in people with asthma.[3]They increase the work of breathing, which may increase the danger of Inspiratory muscle fatigue. As a result, it is plausible to speculate that in patients with asthma. Who experience greater Inspiratory muscle work, increasing the strength of Inspiratory muscles may lessen the intensity of dyspnea and enhance exercise tolerance.[4]Over recent years; respiratory rehabilitation has been widely used as a non-drug treatment for chronic respiratory diseases. Respiratory rehabilitation is an individualized comprehensive intervention that follows comprehensive evaluation of a patient, and includes exercise training, education, and behavioral changes. The aim of respiratory rehabilitation is to improve a patient's physical and emotional status and promote long-term adherence to health-enhancing behaviors. Studies have shown that lung function can also improve by respiratory muscle training using incentive spirometry and diaphragmatic resistance

training. Breathing exercise also reduce the levels of anxiety and depression. Breathing training exercise which included breathing control, pursed -lip breathing, diaphgmatic breathing exercises and thoracic expansion exercise. Inspiratory muscle training is a technique that aims to improve the strength and endurance of the diaphragm and accessory muscles that are recruited during inspiration. The effect of Inspiratory muscle training is achieved through the inspiratory muscles adjusting to overcome the 'resistance'. Inspiratory muscle training expected effect and possible involvement in asthma patients include increased diaphragm thickness and strength, decreased exertion dyspnea, and decreased oxygen cost of breathing.[1]Incentive spirometer is a mechanical breathing device in which the patients is expected to take long, slow deep breaths mimic like natural sighing which gives positive visual feedback. Incentive spirometer either is available by volume of inspiration (volume oriented) or flow rate (flow oriented). It is simple to use and its use results in a prolonged phase of effective inspiration, more controlled flow, and greater enthusiasm to practice. There are no known side effects with the use of Incentive spirometer and it is affordable while patients do not require supervision once trained in their use.[5]Professionals have consistently employed breathing exercises to control the hyperventilation symptoms of asthma. The goal of this technique is to help asthma patients adjust to an adequate breathing pattern with longer expiration and a lower respiratory rate, reducing hyperventilation and hyperinflation. Breathing exercise and Inspiratory muscle training are non-pharmacological interventions that improve asthma control. Both exercises have been widely used and are low cost, easy to apply, safe, and considered important adjuncts for asthma treatment.[1]Many studies done on breathing Inspiratory muscle training and in combination with breathing exercise in asthma and these studies have been consider effective and clinically relevant because these techniques prevent and treat pulmonary function and reduce respiratory muscle strength, and asthma control and health related quality of life.[1]

2. Method

Studies are search from the following search engine PubMed, Google scholar, ResearchGate and Cochrane library to review the literature. Studies include that investigate respiratory parameters, SPO2 and Asthma complications. Keyword used to search studies are incentive spirometer, breathing exercise, inspiratory muscle training, conventional therapy, Asthma.



Several studies have shown that inspiratory muscle training, conventional therapy helps in asthma patients, improving respiratory parameters, pulmonary function and quality of life.

Author, journal, Year	Objective	Design	Characteristics of participants sample size	Method	Outcome measures	Results
2006[3]	This study was to examine the relationship between respiratory symptom intensity and quality and dynamic lung hyperinflation during induced bronchoconstriction in asthma.	Same deigned experimental	15 subjects aged 25	spirometry and lung volume measurement dose methacholine challenge testing Dyspnea intensity was measured after each dose of methacholine. Qualitative descriptors of breathlessness and functional residual capacity were measured	Lung volume, dyspnea, breathlessness and functional residual capacity	The contribution of home spirometry in the diagnostic process for asthma in schoolchildren with nonspecific respiratory symptoms is limited.
2010[6]	To assess the usefulness of home spirometry in children with nonspecific lower respiratory tract symptoms, to diagnose or exclude asthma	Same subject experimental	48 asthmatic patient age between 25 and 65 years old	Children measured peak expiratory flow (PEF) and force expiratory flow in 1 sec (FEV_1) twice daily for 2 weeks on a home spirometer, from which diurnal variation was calculated. The value of home spirometry to diagnose asthma was calculated.	Quality of life, anxiety and depression, daily living physical activity, and maximal exercise capacity	The benefits of breathing and aerobic exercise have been extensively studies the comparison between both has never investigated. Furthermore, the finding of ore result will allow to understand its application and suitability to patients that have more benefits for every intervention its effect
2014[7]	Asthma is a chronic inflammatory airway disease characterized by reversible by obstruction,	Same subject experimental	45 participate between age of 21 and 65 years	In this study randomized clinical trial with 2 group that will receive. 48 asthmatic patients will be	respiratory muscle strength, exercise capacity, quality of life, daily living	Our finding shows that the use of Is and DRT beneficial effect in improving selected

	inflammation and hyperresponsiveness to different stimulus. Aerobic and breathing exercise have been demonstrated to benefits asthmatic patients there.			randomly divided into either aerobic or breathing exercise patient will perform exercise twice a week for 3 months, total session 24 session recorded the before and afterinterventions	activities	pulmonary parameter (FEV, FVC, PEFR) the use DRT is clinically more benefic and its thus recommended to be a part of the patient with asthma
2017[8]	This study was comparing the effect of incentive spirometry and diaphragmatic resistance training on selected cardiopulmonary parameter in patients with asthma	Same subject experimental	28 asthmatic patients between 18 and 65 years of age	In this group randomly assigned to 3 group.group A received aerobic exercise with Is group B received aerobic exercise and DRT and group C received only aerobic exercise for 6 week, 3 times a week	Lung function	These finding suggest that IMTany be effective modality to enhance respiratory muscle strength, exercise capacity, quality of life, daily living activities, reduced perception of dyspnea and fatigue in asthmatic patients.
2018[9]			50- to 60-year-old and 40 postmenopausal women			Inspiratory muscle training in patients with postmenopausal asthma improved ventilatory function by improving ventilatory muscle strength and endurance pattern and reduced symptoms in patients with asthma by increasing FVC and overall lung volume
2020[10]	In this study investigate the effects of inspiratory muscle training on respiratory muscle strength, exercise capacity, dyspnea, fatigue, quality of life and daily living activity of asthmatic patient	Same subject ‘experimen-tal	60 asthma patients [40-65 years old]	this studyrandomly divided into 2 group IMT [n=20] or control group [n=18] IMT group [perform 30 breaths using a threshold pressure device, twice daily for 6 week at 50% maximal inspiratory pressure in addition breathing exercise	Spirometry data, maximal inspiratory and expiratory pressures [[PImax andPEmax], asthma control test, asthma controlquestionnaire, six-minutewalk, andthree-dayphysical activity log recorded	In this study except for forced vital capacity, which was reduced in BTE group all other measured variables improved in both groups and no significant between group different were found.IMT more effective than breathing exercise IMT act alternative to conventional breathing exercises for middle aged and elderly asthma patients.
2021[1]	To compare the effectiveness of inspiratory muscle training (IMT) and incentive spirometer on ventilatory functions in post-menopausal asthmatic women.	Same subject ‘experimenta l Same subject experimental	Asthma patients agedbetween 18 to 65 years old,22 uncontrolled and partially controlled asthmatic patients	this studyrandomly divided two groupA group received inspiratory muscle training in addition to chest physical therapy group (B): received chest physical therapy and incentive spirometer, 3 sessions per week for six weeks. Patients in both groups were assessed before treatment then after treatment	Pulmonary function test, asthma control test, asthma quality of life questionnaire, inspiratory muscle training	The study was added on IMT to standard medical treatment could improve asthma control by strengthening inspiratory muscles of uncontrolled asthmatic patient. IMT could be considered in the non-pharmacological treatments of uncontrolled asthmatic patients. The limited no of patients this study revealed that IMT might have positive outcomes for uncontrolled asthma patients. Combining respiratory muscle and exercise training on the basis of the routine drug treatment and health education significantly improve inspiratory muscle
2022[11]	This study aims to investigate and compare the effect of conventional breathing exercises and	Same subject experimental	50 children	Randomly assigned sixty asthma patients to either conventional breathing exercises or inspiratory	Inspiratory muscle strength, exercise capacity, spirometry measurements, asthma control	

	inspiratory muscle training intervention on clinical symptoms in asthma patients.			muscle training group for 12-week intervention period. Outcome measurement before and after the intervention		strength the level of asthma control and the quality of life in children with asthma more research is needed to explore its rolein asthma in the future
2023[12]	Breathing exercises are reported to improve quality of life and reduce symptoms 'IMT to increase diaphragm and inspiratory muscle endurance; in this study IMT had been performed in uncontrolled asthma patient its effect on respiratory symptoms and pulmonary function.			Twenty-two uncontrolled and partially controlled asthmatic patients were included in this study. Population was randomized into two groups. The standard care group [n= 10] received standard medical treatment while the intervention [n= 12 group practiced a threshold IMT device		
	To investigate the effect of combined respiratory muscle and exercise training on inspiratory muscle strength, exercise capacity, spirometry measurements, asthma control the quality of life in children with asthma			Fifty children with asthma, who were treated children hospital were selected and randomly divided into a rehabilitation group and a control group by using a random number table. The control group was given routine drug treatment and health education while the rehabilitation group received a combination of respiratory muscle and exercise training on the control group.		

3. Discussion

The purpose of this review was to find out the effects of incentive spirometer, inspiratory muscle training and deep breathing exercises in asthmatic patients. Asthma symptoms have a significant impact on patient's life and the proper clinical treatment is very important to reduce those symptoms; however, sometimes clinical control is difficult, despite the appropriate number of prescribed medications. Aerobic and breathing exercises have been considered important as complementary therapies in addition to the pharmacological treatment mainly for patients with controlled or partially controlled asthma, because they improve disease control. In addition, asthmatic patients have 2 main clinical conditions that support the importance of these non-pharmacological interventions: they are more prone to be physically deconditioned compared with their peers and they also have a high prevalence of hyperventilation symptoms. Because of that, asthmatic patients tend to face more negative attitudes towards exercise and present higher levels of anxiety and depression.[8]

Aweto HA et al. concluded that there was an improvement in asthma control and quality of life for patients with asthma in addition to a significant difference in maximal respiratory pressures, spirometryvariables and oxygen saturation in patients who underwent incentive spirometry after CABG. Evaristo KB et al. compared breathing and aerobic exercise on clinical control in patients with moderate to severe asthma and concluded that both exercises were effective.[13]Impaired inspiratory muscle strength before exercise has been shown to intensify exertional dyspnea in individuals with asthma and may reduce exercise tolerance in these individuals. IMT has previously been shown to reduce the perception of dyspnea during exercise in healthy individuals and during pressure threshold inspiratory loading in asthmatic individuals. The increased inspiratory muscle work associated with increased airway resistance and dynamic hyperinflation is an important predictor of dyspnea during bronchoconstriction and may be related to several factors such as reduced strength of the inspiratory muscles due to their shortened operating length, recruitment of additional accessory respiratory muscles, and increased inspiratory activity during expiration.[14]

Exertional dyspnea, which is one of the symptoms of asthma that is associated with impaired exercise tolerance has been shown to be reduced by aerobic training and after bronchodilator administration The novel finding of this study is that IMT can improve exercise tolerance and reduce the perception of dyspnea in recreationally active asthmatic individuals with mild asthma, suggesting a potential role for IMT as a complementary intervention in this population. However, it should also be noted that a reduction in the perception of dyspnea may be potentially dangerous in the small population of asthmatic individuals who have a low

perception of dyspnea and may cause them to underestimate the severity of asthmatic exacerbations.

Through above studies, it is found that inspiratory muscle training, incentive spirometer and deep breathing exercises, all three techniques are effective in reducing exertional dyspnea, quality of life, anxiety and depression and also helps in improving inspiratory muscle strength, spirometry variables and oxygen saturation in asthmatic patients.

4. Conclusion

Inspiratory muscle training, incentive spirometer and deep breathing exercise are effective methods for asthmatic patients. All above mention studies have multiple limitations such as inadequate sample size, no comparison of inspiratory muscle training with incentive spirometry along with deep breathing exercise there was not even single study that suggests the supremacy of one therapy over another, no studies mentioned or suggested use of deep breathing exercise, incentive spirometer and inspiratory muscle training as important treatment options. Very less studies are done on comparison on inspiratory muscle training and incentive spirometer and no study explained the exact protocol for asthmatic patients.

Hence in order to establish a definitive protocol and to overcome all limitations, there is a need to compare inspiratory muscle training and incentive spirometry along with deep breathing exercises on pulmonary function, inspiratory muscle strength, heart rate, oxygen saturation, chest expansion, quality of life dyspnea, fatigue and asthma control assessments in asthmatic patients.

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