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A SYSTEMATIC REVIEW OF EFFECTS OF RESPIRATORY MUSCLE TRAINING FOR INSPIRATORY STRENGTH, DYSPNEA, EXERCISE CAPACITY, AND OUTCOMES IN ASTHMA PATIENTS

KHALID OBAID ALANAZI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

KHALID HAMDAN ALANAZI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

ABDULAZIZ AHMED ALHAYTI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

MOHAMMED SAAD ALDOSARI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

OSAMA IBRAHIM ALMUJALLI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

YAZEED MOHAMMED ALKHALIFAH
Respiratory Therapist, Respiratory Care Section, Critical Care Department, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

ABDULLAH HASSAN ASIRI
Respiratory Therapist, Respiratory Care Section, Critical Care Department, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

ALWALEED AHMED AMRI
Respiratory Therapist, Respiratory Care Services, Intensive Care Unit, King Saud University Medical City (KSUMC), Saudi Arabia, Riyadh.

Abstract

Background: Asthma is a highly prevalent chronic respiratory disease associated with airway inflammation, variable expiratory airflow limitation, and respiratory muscle dysfunction. While pharmacological therapy remains the cornerstone of management, non-pharmacological interventions such as respiratory muscle training (RMT) have emerged as potential adjuncts to improve outcomes in asthmatic patients. **Methods:** This systematic review was conducted in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)* guideline. PubMed, Scopus, and Web of Science databases were searched for randomized controlled trials (RCTs) and quasi-experimental studies published between 2000 and 2017. Studies were eligible if they included patients with asthma of any severity undergoing inspiratory muscle training (IMT) or expiratory muscle training (EMT) as stand-alone interventions.

Data extracted included study design, participant demographics, intervention details, and outcomes such as inspiratory and expiratory muscle strength (PImax, PEmax), exercise capacity, dyspnea, lung function, health-related quality of life (HRQoL), and healthcare utilization. **Results:** Six studies met inclusion criteria, comprising five RCTs and one quasi-experimental study. IMT consistently improved inspiratory muscle strength (PImax) and reduced exertional dyspnea. Several studies demonstrated reductions in β2-agonist consumption and emergency department visits, whereas improvements in pulmonary function, expiratory muscle strength, and HRQoL were inconsistent. **Conclusion:** RMT, particularly IMT, appears to be a safe and beneficial adjunct to conventional asthma management. It enhances inspiratory muscle strength and reduces dyspnea, with potential to improve clinical outcomes. High-quality, large-scale trials are warranted to confirm these benefits and define optimal training protocols.

Keywords: Asthma; Respiratory Muscle Training; Inspiratory Muscle Training; Expiratory Muscle Training; Inspiratory Muscle Strength; Dyspnea; Exercise Tolerance; Pulmonary Function; Quality of Life.

INTRODUCTION

Asthma is one of the most prevalent chronic respiratory disorders worldwide and represents a major public health challenge due to its impact on morbidity, quality of life, and healthcare costs (1). Asthma accounts for 1–2% of total healthcare expenditure in developed nations, reflecting its significant economic burden (2). The condition is characterized by chronic airway inflammation, leading to recurrent respiratory symptoms such as wheezing, dyspnea, chest tightness, and cough, which vary in frequency and severity. These symptoms are associated with variable expiratory airflow limitation that may become persistent over time. In addition to airflow restriction, some patients with asthma experience respiratory muscle dysfunction, which can further compromise breathing efficiency and exercise tolerance (3).

This mechanical disadvantage of the diaphragm can cause dyspnea and greater strain for the inspiratory muscles, particularly during exercise when dynamic hyperinflation may develop (3). Furthermore, some research has demonstrated that steroid-induced myopathy or muscular weakening might result from large dosages of systemic corticosteroids given to asthmatic patients (4). Additionally, people with mild stable asthma have been shown to have thoraco-abdominal asynchrony with moderate exercise. Because it is non-invasive and volitional, the evaluation of maximum respiratory pressures is frequently used in clinical practice to detect respiratory muscle weakness. When the readings fall between 65% and 80% of the anticipated range, the maximal inspiratory pressure (PImax) and maximal expiratory pressures (PEmax) are deemed lowered (5).

When managing asthma over the long term, respiratory muscle dysfunction must be taken into account. Comprehensive programs incorporating education, breathing exercises, and exercise training have been emphasized as adjuvant therapy to asthma pharmaceutical treatment (6), in accordance with the chronic care paradigm and multidisciplinary approach. Nevertheless, these regimens have not consistently incorporated respiratory muscle training (RMT). RMT has demonstrated efficacy in

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treating patients with various respiratory deficits and chronic obstructive pulmonary disease (COPD) (7). RMT's usefulness in treating asthmatics is yet unknown, though. Our goal in this study was to examine how respiratory muscle training affects asthmatic patients.

METHODOLOGY

This systematic review was conducted in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)* guidelines (8).

Search Strategy

A comprehensive search of the electronic databases PubMed, Scopus, and Web of Science was performed to identify relevant studies published between 2000 and 2025. Weekly automated updates from these databases were also screened for newly indexed articles. In addition, the reference lists of retrieved studies, prior systematic reviews, and key journals in the field were manually searched to capture any eligible publications not identified through the electronic search. The following search terms and their combinations were applied: *asthma, bronchoconstriction, bronchial spasm, breathing exercises, inspiratory muscle training (IMT), respiratory muscle training (RMT), expiratory muscle training (EMT), maximal voluntary ventilation, maximal respiratory pressures, dry powder inhalers, rescue medication, metered dose inhalers, respiratory function test, dyspnea, adverse effects,* and *exercise tolerance*.

Eligibility Criteria

We included randomized controlled trials (RCTs) and quasi-experimental studies involving patients with asthma of any severity. Eligible interventions were defined as inspiratory or expiratory muscle training programs applying an external load to increase inspiratory muscle strength (IMS) or endurance, provided as a stand-alone intervention. Studies combining IMT or EMT with other interventions were excluded unless the effect of respiratory muscle training could be isolated.

Study Selection

Four independent reviewers screened titles and abstracts for relevance after removal of duplicates. Full texts of potentially eligible studies were then assessed against the inclusion criteria. Discrepancies were resolved by consensus, with arbitration from a senior reviewer when required.

Data Extraction

Data were extracted using a standardized form and included: citation details, study design, country, sample size, asthma severity, participant characteristics, intervention type, comparator, outcome measures, and main findings. The primary outcomes were inspiratory and expiratory muscle strength, measured as maximal inspiratory pressure (PImax) and maximal expiratory pressure (PEmax). Secondary outcomes included exercise capacity, asthma symptoms, dyspnea, β2-agonist consumption, lung function,

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health-related quality of life (HRQoL), and healthcare utilization (emergency department visits).

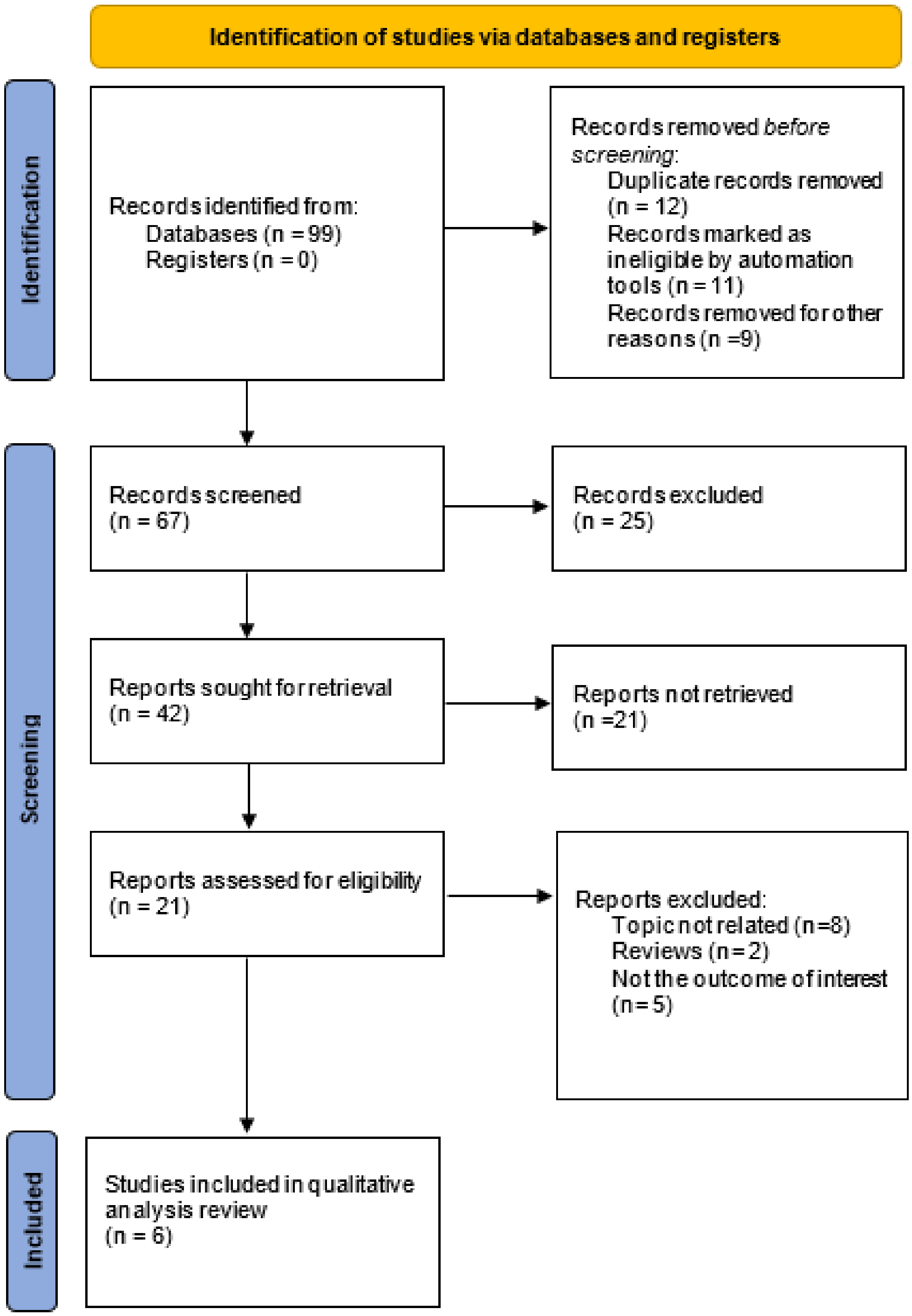

Fig 1: PRISMA consort chart

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RESULT AND DISCUSSION

This systematic review included six studies, comprising five randomized controlled trials (RCTs) and one quasi-experimental study, all investigating the effects of respiratory muscle training (RMT) interventions in patients with asthma. The interventions primarily focused on inspiratory muscle training (IMT), with one study combining IMT and expiratory muscle training (EMT). Collectively, the studies assessed a range of outcomes, including inspiratory muscle strength (PImax), expiratory muscle strength (PEmax), exercise capacity, exertional dyspnea, health-related quality of life (HRQoL), lung function, and healthcare utilization. Outcome measures used were (Exercise capacity, inspiratory muscle strength (IMS), Exertional dyspnea, Emergency department visits, and asthma symptoms, consumption of β_2-agonist, IMS and lung function (Table 1).

This comprehensive review shown that an IMT program is a useful intervention for enhancing IMS in individuals with asthma. It also raises the possibility that this intervention may positively impact IMS, the need for rescue medicine, and exertional dyspnea while having no negative side effects. The data are conflicting on the effects of IMT for exercise capacity, hospital admissions, and HRQoL. It did not increase expiratory muscular strength or lung function.

The present systematic review includes additional outcomes, such as exercise capacity, health related QoL, and respiratory muscle endurance, than the review published in 2013 (9). Higher PImax and PEmax were seen in the expiratory muscle training (EMT) group compared to the control group in a systematic evaluation of COPD patients, and these effects were more pronounced when IMT and EMT were combined. Moreover, there was a correlation found between increased exacerbations, hospital admissions, and death with weakening of the expiratory muscles (10). Thus, we think that more research is necessary to examine the potential advantages of EMT in conjunction with IMT for asthma.

When compared to no intervention or instructional programs, IMT can cause an increase in PImax in individuals with asthma. The majority of research conducted on chronic respiratory disorders used sham-IMT with training loads ≤15% PImax, which did not result in changes to strength (6). Therefore, we think that the control group's inspiratory muscular strength was likely increased by a load of 20% PImax (11).

The primary conclusions of the TURNER et al. study is that asthmatic patients undergoing six weeks of IMT get a decreased oxygen consumption and the experience of dyspnea during exercise; enhanced IMS and demonstrated reduction of exercise-induced inspiratory muscle fatigue; and raised Tlim during constant-power exercise.

Consistent with the findings of TURNER et al. study, impaired IMS prior to exercise has been demonstrated to exacerbate exertional dyspnea in asthmatic individuals (12) and may also decrease exercise tolerance in these individuals (9). Additionally, IMT has been demonstrated to decrease the perception of exercise dyspnea in healthy individuals (13) and during pressurized threshold inspiratory loading in asthmatics (12). One important indicator of dyspnea during bronchoconstriction is the increased inspiratory muscle effort

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linked to increased airway resistance and dynamic hyperinflation (14) It might be caused by a variety of things, such as the recruitment of extra accessory respiratory muscles, a decrease in IMS because to their shorter operational duration, and an increase in inspiratory activity during expiration (15).

According to the TURNER et al. research, the decrease in dyspnea perception that they observed was probably caused by an IMS improvement following IMT rather than by modifications to lung function. Furthermore, literature indicates a negative correlation between changes in IMS and the severity of dyspnea during an inspiratory loading test after IMT (16).

To be more precise, after inspiratory muscle training, a lower proportion of maximum force-generating capacity would be needed to provide the necessary pressure for a given volume change. This would lower the central motor demand and, consequently, the perception of effort (17).

Aerobic training (18) and the injection of bronchodilators (19) have been demonstrated to diminish exertional dyspnea, one of the symptoms of asthma that is linked to poor exercise tolerance (20). TURNER et al. study conclude that, among recreationally active persons with moderate asthma, IMT can lessen the sense of dyspnea and increase exercise tolerance. This discovery raises the possibility of IMT serving as a supplemental intervention for this population.

It should be highlighted, nonetheless, that for the tiny percentage of asthmatics who have a poor perception of dyspnea, a decrease in that perception might be harmful as it could lead to an under estimation of the severity of asthmatic exacerbations.

Asthma sufferers may have decreased exercise tolerance in correlation with expiratory flow restriction and dynamic hyperinflation during exercise (19). TURNER et al. study participants showed a progressive increase in end-inspiratory lung volume (EELV) as exercise duration increased; however, those in the IMT group exhibited a tendency toward a reduction in the degree of hyperinflation during the first five minutes of exercise following IMT, as well as a significant attenuation at that point.

Following intervention, there was a comparable trend for EILV to decrease in the IMT group. According to earlier studies, a rise in EELV during intentional hyperpnea raised the oxygen cost of ventilation and the elastic work of breathing (21).

The findings of the Lima et al. study are consistent with those of studies involving adults with obstructive illnesses (16,22), demonstrating that following particular IMT, IMS improved, leading to a corresponding improvement in clinical status. An evaluation of a respiratory treatment program in eight distinct locations was conducted by a multicenter, randomized, cross-over controlled research (23).

In addition to breathing exercises and instructional materials, the program featured IMT, relaxation methods, bronchial hygiene practices, and leisure activities. Exercise tolerance and patient quality of life were shown to have significantly improved.

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Table 1: characteristics and main findings of the included studies

Citation	Study design	Study participants	Outcomes measures	Intervention	Findings
Turner et al. (25)	Quasi experimental	Mild to moderate asthma	Exertional dyspnea and IMS	IMT	Following the intervention, there was no discernible difference in Time to the limit of exercise tolerance (Tlim), respiratory muscle exhaustion, or the placebo group's experience of dyspnea. A substantial 16% decrease in dyspnea during exercise was also observed. Despite the extended Tlim, the exercise-induced decline in intervention group was reduced from 10% before to IMT to 6% following IMT. The levels of pulmonary function in the pacebo and IMT groups did not alter. IMT improves exercise tolerance, lessens the sensation of dyspnea, and attenuates inspiratory muscle fatigue. According to these results, IMT could be a useful addition to asthma treatment that helps increase this group's engagement and adherence to exercise regimens. Breathlessness, however, is also a significant indicator of bronchoconstriction, therefore if this symptom is unusually low, care should be taken.
Lima et al. (26)	RCT	Uncontrolled asthma	Emergency department visits, asthma symptoms and IMS	Breathing exercises, IMT	In addition to enhancing peak expiratory flow and severity factors, programs using IMT and respiratory workouts can boost the mechanical efficiency of the respiratory muscles.
Sampaio et al. (27)	RCT	Clinical diagnostic of asthma	IMS	IMT	In the intervention group PImax: Pre vs Post; $p < 0.05$ PEmax: Pre vs Post; $p < 0.05$ No significant changes in PEmax and PImax

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Weiner et al. (16)	RCT	Mild to moderate asthma	Consumption of β2-agonist, IMS and lung function	IMT	The mean daily consumption of beta2-agonists and the baseline maximum inspiratory pressure did not exhibit a strong association with each other, nor with the perception of dyspnea (POD). Nonetheless, a noteworthy association was seen between the POD and the average daily intake of beta2-agonists. The decline in POD and the reduction in beta2-agonist intake were strongly linked with the increase in IMS following inspiratory muscle training.
Delgado et al. (24)	RCT	Controlled asthma	Exercise capacity and IMS	Inspiratory muscle training (IMT)	Intervention group PImax (cmH_2O): pre vs post ($p < 0.05$) 6MWT (m): pre vs post ($p < 0.05$) No changes in pulmonary function:
Weiner et al. (28)	RCT	Mild to moderate asthma	β_2-agonist consumption, IMS, and lung function.	IMT	In the female individuals, mean daily 2-agonist intake and POD were considerably greater, whereas baseline PImax was significantly lower. By the conclusion of the twentieth training week, PImax was on par with the male participants. A statistically significant reduction in mean daily 2-agonist usage and POD, comparable to that observed in male patients, was linked to an increase in PImax.

CONCLUSION

This systematic review demonstrates that inspiratory muscle training (IMT) is an effective adjunctive intervention for patients with asthma, consistently improving inspiratory muscle strength without adverse effects. Beyond enhancing PImax, IMT was associated with reductions in dyspnea perception and β2-agonist use, and in some cases, improved exercise tolerance and decreased healthcare utilization.

Its effects on pulmonary function and expiratory muscle strength remain inconclusive, reflecting heterogeneity in study design and training protocols. These findings support the integration of IMT into comprehensive asthma management programs, particularly for patients with impaired inspiratory muscle performance.

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