Physiotherapy Theory and Practice, Early Online:1–7, 2012
Copyright © Informa Healthcare USA, Inc.
ISSN: 0959-3985 print/1532-5040 online
DOI: 10.3109/09593985.2012.731626

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healthcare

# Effect of diaphragmatic breathing exercise on quality of life in subjects with asthma: A systematic review

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## ABSTRACT

The aim of this systematic review was to determine if diaphragmatic breathing exercise improves quality of life (QoL) in asthma. Electronic databases were searched for randomized controlled trials (RCTs). Data were extracted and risk of bias was assessed by two independent reviewers. Three RCTs were eligible for inclusion (254 subjects). Two studies compared diaphragmatic breathing exercise to asthma education, and one compared with asthma medication. Meta-analysis was not possible due to clinical heterogeneity of the studies. All three studies had a low risk of bias. All studies reported short-term effects, and long-term effects of breathing exercise on asthma quality life. There is a moderate evidence of improvement in QoL following diaphragmatic breathing both in short-term and long-term basis.

## BACKGROUND

Asthma is a serious public health problem affecting an estimated 300 million people of all ages throughout the world. The World Health Organization has estimated that 15 million disability adjusted life years are lost annually due to asthma, representing 1% of the total disease burden (Global Initiative for Asthma, 2011). Asthma is a complex and multifaceted condition causing significant impairment of physical and psychosocial well-being in the affected individual. Thus improving the health-related quality of life (QoL) in patients is one of the primary goals in asthma treatment. QoL acquires more significance since traditional parameters including lung function have weak association with QoL outcome measures (Carranza Rosenweig et al, 2004; Moy et al, 2001; Wijnhoven et al, 2001).

Pharmacological therapy comprising of inhaled short acting beta-2 agonists and inhaled steroids are effective for alleviating asthma symptoms. They have been shown to reduce symptoms, improve lung function, and prevent exacerbations, with an acceptable safety profile (British Guideline on the Management of Asthma, 2012). It has been stated that failure to control asthma relates to a widespread fear or dislike of medications, notably inhaled corticosteroid (Apter et al, 1998; Boulet, 1998). There is a rise in interest in non-pharmacological management of asthma. Breathing techniques have been reported as the most frequently used method among non-pharmacological approaches to asthma (Ernst, 1998). Breathing techniques taught by various health-care professionals involve diaphragmatic breathing, Buteyko breathing, and pranayama breathing. Physiotherapists advise diaphragmatic breathing in their day to day practice for asthma management.

No known systematic reviews have evaluated the effect of diaphragmatic breathing exercise in the management of asthma. The aim of this review was to determine if diaphragmatic breathing exercise is beneficial for people with asthma; and the effect of diaphragmatic breathing exercise on QoL.

## METHODOLOGY

A computerized literature search database was done with the keywords (breathing exercise, asthma,

Accepted for publication 9 September 2012

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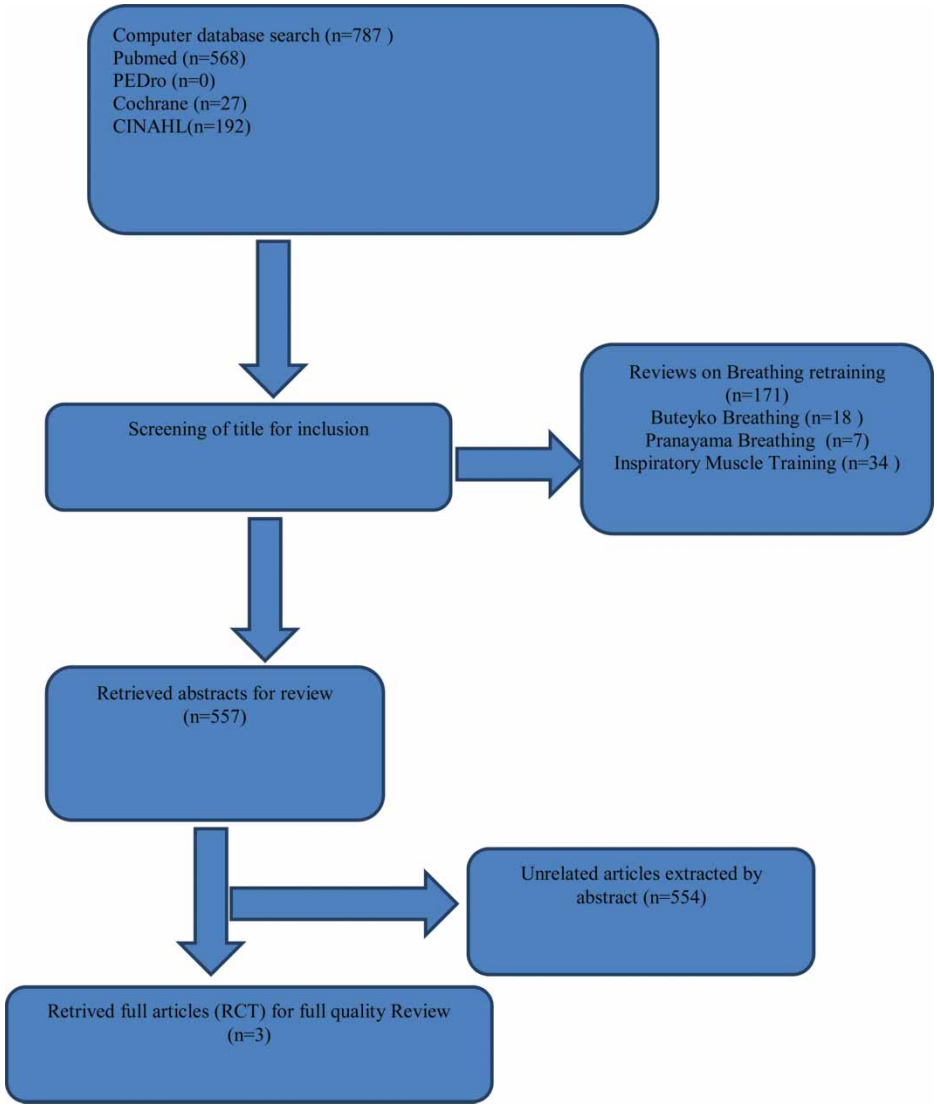


FIGURE 1 Flow chart: steps involved in the systematic review.



diaphragmatic breathing exercise, breathing retraining, and breath control) in Cochrane Library (Cochrane Database of Systematic Reviews), PubMed, MEDLINE, PEDro, and CINAHL for studies published until November 2011. A criterion for inclusion in the studies were randomized controlled trials (RCTs) assessing the effect of diaphragmatic breathing on asthma. With computer database search using the key words "breathing exercise" and "asthma", a total number of 787 studies were retrieved. The studies were retrieved from the following data bases: Cochrane 27, PubMed 568, Pedro 0, and CINAHL 192. Screening of the articles were done on the basis of title, and articles on Buteyko, pranayama, inspiratory muscle training, reviews on breathing exercise, animal studies, and studies related to pediatrics were excluded. Three full text RCTs were retrieved that met all the criteria of diaphragmatic breathing exercise in asthma for quality review, and the steps involved are shown in Figure 1. Qualities of the retrieved studies were evaluated by two independent assessors. The overview of treatment groups, participants, duration of study, outcome measures, and conclusion is provided in Table 1.

## RESULTS

### Trials

The search yielded potentially eligible studies. Following the exclusion process (Figure 1). Three studies included diaphragmatic breathing as an intervention

TABLE 1 Overview of treatment groups, participants, duration of study, outcome measures, and conclusion.

| Author and Journal | Treatment groups | Participants | Duration of study | Outcome measures | Conclusion |
|---|---|---|---|---|---|
| Grammatopoulou et al (2011), *Journal of Asthma* | Breathing retraining *vs.* usual asthma | 40 patients, experimental M/F: 13/7, mean age: 48.15, control: M/F: 10/10, mean age: 45.45 | 20 minutes each day, 2–3 times/day for 6 months | ACT, SF-36, NQ, $ETCO_2$, $FEV_1$% | Breathing training lead to significant improvement in ACT, $ETCO_2$, reduced respiratory rate, increased $FEV_1$% |
| Thomas et al (2009), *Thorax* | Diaphragmatic breathing *vs.* asthma education method | 183 patients, experimental M/F: 42/52, mean age: 46, control: M/F: 29/60, mean age: 46 | 10 minutes each day for 6 months | AQLQ score, with secondary outcomes including spirometry, bronchial hyperresponsiveness, exhaled nitric oxide, induced sputum eosinophil count and Asthma Control Questionnaire, hospital anxiety and depression, and hyperventilation (Nijmegen) questionnaire scores | Breathing training resulted in improvements in asthma-specific health status and other patient-centered measures but not in asthma pathophysiology |
| Thomas, McKinley, Freeman, and Foy (2003), *Thorax* | Diaphragmatic breathing *vs.* asthma education | 31 patients, experimental M/F: 13/4, mean age: 48, control: M/F: 13/3, mean age: 48 | 10 minutes each day for 6 months | AQLQ and Nijmegen scores | Improved outcomes in the overall score, symptoms, and environment domains were seen |

Notes: ACT, Asthma Control Test; SF 36, Short Form 36; NQ, Nijmegen Questionnaire; $ETCO_2$, End-tidal $CO_2$; $FEV_1$%, Forced Expiratory Volume in one second in percentage; AQLQ, Asthma Quality of Life Questionnaire, ACQ, Asthma Control Questionnaire, HAD, Hospital Anxiety and Depression scale.



and met the inclusion criteria (Grammatopoulou et al, 2011; Thomas, McKinley, Freeman, and Foy, 2003; Thomas et al, 2009).

## Characteristics of included studies

All three studies were single-center trials conducted in either Greece (Grammatopoulou et al, 2011) or England (Thomas, McKinley, Freeman, and Foy, 2003; Thomas et al, 2009). All three of the studies had a long-term follow-up of up to 6 months.

Sample sizes ranged from 31 to 183 individuals. Two of the studies undertook power calculations to estimate sample size (Grammatopoulou et al, 2011; Thomas, McKinley, Freeman, and Foy, 2003). Recruitment of participants varied between studies. One study recruited subjects from the asthma department (Grammatopoulou et al, 2011) and two recruited from primary care physicians (Thomas, McKinley, Freeman, and Foy, 2003; Thomas et al, 2009). Two studies recruited participants with mild to moderate asthma (Grammatopoulou et al, 2011; Thomas et al, 2009) and the degree of asthma severity was unclear in the Thomas, McKinley, Freeman, and Foy (2003) study. The study of Thomas, McKinley, Freeman, and Foy (2003) included participants with Nijmegen score >23, while in the study of Thomas et al (2009) participants had a score of asthma QoL >5.5. Finally, the study of Grammatopoulou et al (2011) was comprised of patients with stable asthma. Comparison of baseline function between the three trials was not possible due to the differences in outcomes used.

## Interventions

Diaphragmatic breathing was the intervention in the study of Thomas, McKinley, Freeman, and Foy

TABLE 2 Risk of bias assessment.

| | Grammatopoulou et al (2011) | Thomas, McKinley, Freeman, and Foy (2003) | Thomas et al (2009) |
|---|---|---|---|
| Randomization | Yes | Yes | Yes |
| Allocation concealment | Yes | No | No |
| Blinding of patient | No | No | No |
| Blinding of care provider | No | No | No |
| Blinding of outcome assessor | Yes | Yes | No |
| Baseline comparability | Yes | Yes | Yes |
| Co-interventions avoided or similar | No | No | Yes |
| Similar timing of outcome assessment | Yes | Yes | Yes |
| Acceptable dropout rates | Yes | Yes | Yes |
| Intention to treat analysis | No | Yes | No |
| Compliance acceptable? | Yes | Yes | Yes |



(2003) while in the study of Thomas et al (2009) diaphragmatic breathing was accompanied by nasal breathing exercise. Two studies compared diaphragmatic breathing with asthma education (Thomas, McKinley, Freeman, and Foy, 2003; Thomas et al, 2009) and one study compared diaphragmatic breathing plus routine asthma medication with routine asthma medication (Grammatopoulou et al, 2011). All three studies had two group allocations but comparisons differed.

Number of treatment sessions varied between the studies. In the Thomas, McKinley, Freeman, and Foy (2003) study, subjects were trained in small groups of 4–5 for 45 minutes each. Further, they were individually trained in 15 minute sessions in the first and second weeks making the total duration of contact time to be 75 minutes. Subjects practiced breathing exercise 10 minutes a day for 6 months. In Thomas et al (2009) subjects were trained in an initial 60 minute small group session (2–4 subjects) followed by two individual sessions of 30–45 minutes each. Subjects were encouraged to practice breathing exercises for 10 minutes daily. In the Grammatopoulou et al (2011) study, following 12 individual sessions (three per week) of nearly an hour of training, each of the subjects practiced the exercises for 20 minutes 2–3 times/day for 5 months.

Asthma QoL Questionnaire (AQLQ) was the outcome measure in studies by Thomas et al (2009) and Thomas, McKinley, Freeman, and Foy (2003). Two studies measured pulmonary function indices such as resting minute volume, respiratory rate, forced expiratory volume in one second ($FEV_1$), percentage predicted of forced expiratory volume in one second ($FEV_1\%$), bronchial hyperreactivity, end-tidal carbon dioxide ($ETCO_2$); and exhaled nitric oxide (Grammatopoulou et al, 2011, Thomas et al, 2009). Finally, in the study conducted by Grammatopoulou et al (2011) the asthma control test (ACT) was the main outcome variable. None of the studies reported any adverse events and compliance to exercise.

## Risk of bias

Two independent assessors (KB, NS, or HK) scored the risk of bias for each article, using criteria recommended by (Van Tulder, Furlan, Bombardier, and Bouter, 2003). A study with a low risk of bias was defined as a trial fulfilling 6 or more of the 11 criteria, while a study with less than 6 of the criteria was classified as having a high risk of bias. In the case of disagreements the authors tried to reach consensus and if necessary a third author assessed the article to resolve disagreements. In Grammatopoulou et al (2011) intention to treat analysis is not required since there were no withdrawals across the 6 months of study period. The assessment of the three RCTs for risk of bias ranged from 6 to 7 out of a maximum score of 11, indicating low risk of bias (Table 2).

## Levels of evidence

The results of the included trials were combined qualitatively using a best-evidence synthesis (Van Tulder, Furlan, Bombardier, and Bouter, 2003):

- Strong: consistent findings among high-quality RCTs.
- Moderate: consistent findings among multiple low-quality RCTs and/or non-randomized clinical controlled trials (CCTs) and/or one high-quality RCT.

- Limited: one low-quality RCT or CCT or consistent findings from pre- to post-trials.
- Insufficient: insufficient evidence to support or refute the effectiveness of the intervention with no RCT and/or CCT, or a single pre–post-trial.
- Conflicting: inconsistent findings among multiple trials.

### Best evidence synthesis

There is moderate evidence that diaphragmatic breathing exercise leads to improvement in asthma QoL.

### Breathing exercise plus routine asthma medication compared to regular asthma medication

The study of Grammatopoulou et al (2011) revealed a significant improvement in asthma control for the experimental group compared to the control group. Specifically, for the experimental group the score of ACT was $18 \pm 2.5$ at baseline and became $22 \pm 3.3$ after 6 months. $ETCO_2$ increased significantly following training by 4 mmHg, in agreement with an earlier study (Meuret, Ritz, Wilhelm, and Roth, 2007). Respiratory rate demonstrated significant decrease of seven breaths per minute, the difference was greater than the minimal important difference of two breaths per minute according to Benson and Klipper (1975). $FEV_1\%$ showed a significant difference of 4%, which is in accordance with the improvement of lung function demonstrated by Thomas et al (2009).

### Breathing exercise compared to asthma education

Thomas, McKinley, Freeman, and Foy (2003) demonstrated improvement of 0.79 units in AQLQ following 6 months breathing training for the patients diagnosed with dysfunctional breathing. The minimal important clinical difference for asthma QoL is 0.5. Thomas et al (2009) demonstrated significant improvement of 1.12 units in AQLQ following 6 months training of diaphragmatic breathing exercise, which is a larger change compared to the minimal important clinical change of 0.5 units. However, the latter study did not demonstrate any effect on lung physiological indices such as resting minute volume, $ETCO_2$, bronchial hyperresponsiveness, induced sputum differential cell count analysis, and exhaled nitric oxide.

## DISCUSSION

This is the first known systematic review to evaluate the effect of diaphragmatic breathing exercise on patients with asthma. The small number of included studies indicates the limited research to date. Despite random allocation in Grammatopoulou et al (2011), the pre-prepared sealed envelopes method could be subjected to bias over computer-generated numbers (Pocock, 1983; Schulz, 1995). Randomization was unclear in the study by Thomas et al (2009). Assessor blinding was performed in Grammatopoulou et al (2011) and was unclear in the study by Thomas, McKinley, Freeman, and Foy (2003). Blinding for data entry and analysis was performed in the Thomas et al (2009) study.

The mean age of the patients were very similar in three studies with a range of 46–48 years. One trial had more female participants (Thomas et al, 2009), while the other two trials had similar representation in both genders (Grammatopoulou et al, 2011; Thomas, McKinley, Freeman, and Foy, 2003).

Based on lung function test ($FEV_1\%$), subjects with mild to moderate severity were included in two studies (Grammatopoulou et al, 2011; Thomas et al, 2009) and disease severity was unclear in the study by Thomas, McKinley, Freeman, and Foy (2003). There is lack of studies on the effect of diaphragmatic breathing exercise on chronic asthma subjects.

All three studies were heterogeneous regarding the breathing exercise and co-interventions. In the Grammatopoulou et al (2011) study, patients were advised to perform diaphragmatic breathing, nasal breathing, and breath holding accompanied by physical activity, whereas in the Thomas et al (2009) study the patients were advised to perform diaphragmatic breathing and nasal breathing. On the contrary Thomas, McKinley, Freeman, and Foy (2003) advised only slow diaphragmatic breathing.

AQLQ was the primary outcome measure in two studies (Thomas, McKinley, Freeman, and Foy, 2003; Thomas et al, 2009). Thomas, McKinley, Freeman, and Foy (2003) study on diaphragmatic breathing alone demonstrated significant improvement at the end of 1 month with an increase of 0.6 units which is higher than the minimal important clinical difference of 0.5 units required for AQLQ. Thomas et al (2009) study with combined intervention of diaphragmatic breathing and nasal breathing did not demonstrate improvement at the end of 1 month compared to the control group. However, Thomas et al (2009) study demonstrated a greater improvement of 1.12 units compared to 0.79 units

observed in the Thomas, McKinley, Freeman, and Foy (2003) study at the end of 6 months. In the Grammatopoulou et al (2011) study the primary outcome measures of the ACT and Short Form-36 (SF-36) improved significantly in the experimental group compared to the control group at 6 months duration. In the Thomas et al (2009) study the outcome measures of airway inflammatory marker exhaled NO, airway hyperresponsiveness methacholine PC20, sputum eosinophils, $ETCO_2$, and minute ventilation did not demonstrate significant difference between diaphragmatic breathing exercise and asthma education group at 6 months duration. The study by Grammatopoulou et al (2011) on breathing retraining demonstrated significant improvement in pulmonary function, $ETCO_2$, and respiratory rate.

The varied duration and frequency of treatment between the studies might have influenced the outcomes. Patients performing breathing exercise for 20 minutes each day and 2–3 times per day for 5 months following 1 month of training in the Grammatopoulou et al (2011) study demonstrated significant improvement on asthma control and pulmonary function. Studies by Thomas, McKinley, Freeman, and Foy (2003) and Thomas et al (2009) demonstrated improvement in QoL following 10 minutes of breathing practice for 6 months. No improvement was observed on pathophysiology of asthma and lung function in the study by Thomas et al (2009). There is a large body of evidence on the prevalence of hyperventilation in patients with asthma providing rationale for advising breathing exercise. The physiological mechanism responsible for improvement in asthma symptoms is due to decreased hyperventilation thereby raising $ETCO_2$ levels causing airway bronchodilatation (Herxheimer, 1946; McFadden and Lyons, 1968; Osborne et al, 2000; Thomas, McKinley, Freeman, and Foy, 2001; Van den Elshout, Van Herwaarden, and Folgering, 1991).

### Implications for practice

The results demonstrate that breathing exercise improves QoL in the short term and long term compared to asthma medication and education. There is evidence for mechanism on effect of breathing retraining on asthma through reduction of hyperventilation measured with increased $ETCO_2$ and decreased respiratory rate. This systematic review has some limitations. We also warrant caution since only full text articles published in English language were included for review. Hence, there is likelihood to have omission of articles published in non-English languages.

### Implications for research

There is a need for further research to confirm these results. Methodological quality should be enhanced with adequate randomization, concealed allocation, and blinding of outcome assessor; even if blinding of care provider or patients is not possible. Future studies should include long-term outcome assessments with duration of more than 6 months.

## CONCLUSION

There is moderate evidence for improvement of QoL following diaphragmatic breathing both in short and long term as demonstrated by three studies. The physiological mechanism could be through reduced hyperventilation measured through $ETCO_2$ and respiratory rate.

***Declaration of interest:*** The authors report no conflict of interest.

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