Expiratory and Expiratory Plus Inspiratory Muscle Training Improves Respiratory Muscle Strength in Subjects with COPD: Systematic Review

Leonardo F Neves PT, Manoela H Reis PT, Rodrigo DM Plentz PT ScD, Darlan L Matte PT ScD, Christian C Coronel PT MSc, and Graciele Sbruzzi PT ScD

BACKGROUND: Inspiratory muscle training (IMT) produces beneficial effects in COPD subjects, but the effects of expiratory muscle training (EMT) and EMT plus IMT in ventilatory training are still unclear. The aim of this study was to systematically review the effects of EMT and EMT plus IMT compared to control groups of COPD subjects. METHODS: This study is a systematic review and meta-analysis. The search strategy included MEDLINE, Embase, LILACS, PEDro, and Cochrane CENTRAL and also manual search of references in published studies on the subject. Randomized trials comparing EMT and EMT plus IMT versus control groups of subjects with COPD were included. The outcomes analyzed were respiratory muscle strength and functional capacity. Two reviewers independently extracted the data. RESULTS: The search retrieved 609 articles. Five studies were included. We observed that EMT provided higher gain in maximum expiratory pressure ($P_{Emax}$ 21.49 cm H$_2$O, 95% CI 13.39–29.59) and maximum inspiratory pressure ($P_{Imax}$ 7.68 cm H$_2$O, 95% CI 0.90–14.45) compared to control groups. There was no significant difference in the 6-min walk test distance (29.01 m, 95% CI –39.62 to 97.65) and dyspnea (0.15, 95% CI –0.77 to 1.08). In relation to EMT plus IMT, we observed that $P_{Emax}$ (31.98 cm H$_2$O, 95% CI 26.93–37.03) and $P_{Imax}$ (27.98 cm H$_2$O, 95% CI 20.10–35.85) presented higher values compared to control groups. CONCLUSIONS: EMT and EMT plus IMT improve respiratory muscle strength and can be used as part of the treatment during pulmonary rehabilitation of subjects with severe to very severe COPD. Key words: COPD; obstructive pulmonary disease; pulmonary diseases; chronic obstructive; expiratory muscle training; breathing exercise; respiratory muscle training. [Respir Care 2014;59(9):1–#. © 2014 Daedalus Enterprises]
physiotherapy may act by improving the functional capacity of these subjects.\textsuperscript{6,7}

Respiratory muscle training is a part of rehabilitation for COPD subjects, as it promotes benefits such as improved pulmonary function and respiratory muscle strength,\textsuperscript{4} reduction of dyspnea severity,\textsuperscript{8} improved exercise tolerance,\textsuperscript{9} and enhanced functionality and quality of life.\textsuperscript{8} Studies that prove the efficacy of inspiratory muscle training (IMT) in subjects with COPD are well documented in the literature, demonstrating that this training leads to a reduction of dyspnea and improvement in pulmonary function, respiratory muscle strength, and functional capacity.\textsuperscript{10-12} However, the results of expiratory muscle training (EMT) in these subjects are not conclusive.

It has been demonstrated in the literature that specific EMT is efficient in improving strength and endurance of expiratory muscles compared to a control group (low load of 7 cm H\textsubscript{2}O\textsuperscript{13}); however, some authors found no significant effects of EMT on some outcomes such as decreased sensation of dyspnea.\textsuperscript{4} Thus, some authors do not recommend EMT when treating subjects with COPD due to the lack of scientific evidence and methodologically well-designed evidence.\textsuperscript{14,15} Therefore, there still appears to be a disagreement in the literature about the benefits of EMT in increasing strength and endurance in subjects with COPD. Hence, the purpose of this study was to determine the influence of EMT and EMT plus IMT compared to control groups in subjects with COPD, evaluating the outcomes of maximum expiratory and inspiratory muscle pressure, 6-min walk test (6MWT) distance, and dyspnea, through a systematic review and meta-analysis.

Methods

This study was approved by the Ethics Committee in Research of the Instituto de Cardiologia do Rio Grande do Sul, Fundaç\textsuperscript{c}a\textsuperscript{a}o Universitária de Cardiologia, Porto Alegre, Rio Grande do Sul, Brazil (number 4673/11), and follows the recommendations proposed by the Cochrane Collaboration\textsuperscript{16} and the PRISMA Statement.\textsuperscript{17}

Eligibility Criteria

We included randomized control trials (RCTs) that compared EMT versus a control group or EMT plus IMT versus a control group in subjects with COPD, which evaluated any of the following outcomes: maximum expiratory pressure (P\textsubscript{Emax}, cm H\textsubscript{2}O), maximum inspiratory pressure (P\textsubscript{Imax}, cm H\textsubscript{2}O), distance (or exercise tolerance) in 6MWT (meters), and dyspnea (Borg scale). EMT was considered as expiration against a resistance device, which could be a threshold or any other equipment that aimed to increase air-flow resistance during expiration. EMT is usually performed in a threshold device with a percentage of the P\textsubscript{Emax} for the purpose of increasing expiratory muscle strength. Exclusion criteria were summarized as follows: hospitalization during the training period and studies using pursed-lip breathing or CPAP for EMT. If a trial had multiple publications (or substudies), the study was included only once.

Search Strategy

We searched the following electronic databases independently, in duplicate, from inception to February 2013: MEDLINE (accessed by PubMed), Physiotherapy Evidence Database (PEDro), Cochrane Central Register of Controlled Trials (CENTRAL), Embase, and LILACS. In addition, we performed a manual search of references in published studies on the subject. The search was performed on February 18, 2013, and included the following terms: “Breathing Exercises,” “Chronic Obstructive Pulmonary Disease,” “Exercise, Breathing,” “Respiratory Muscle Training,” “Expiratory Muscles Training,” “Inspiratory Muscles Training,” “pulmonary disease, chronic obstructive,” “COPD,” “Obstructive Pulmonary Disease” (associated with a list of sensitive terms to search for RCTs, prepared by Robinson and Dickersin\textsuperscript{18}). The search strategy used to in PubMed is provided in Table 1. There was no language restriction in the search.

Study Selection and Data Extraction

The titles and abstracts of all articles identified by the search were evaluated by 2 independent reviewers. All abstracts that did not provide sufficient information on the inclusion and exclusion criteria were selected to evaluate the full text. In this second phase, the same reviewers independently assessed the full articles and made their
Table 1. Search Strategy Used in PubMed

<table>
<thead>
<tr>
<th>MeSH = Medical Subject Heading</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
</table>
| "pulmonary disease, chronic obstructive"[MeSH] OR "pulmonary disease, chronic obstructive" OR "COPD" OR "chronic obstructive pulmonary disease" OR "COAD" OR "chronic obstructive airway disease" OR "chronic obstructive lung disease" OR "airflow obstruction, chronic" OR "airflow obstructions, chronic" OR "chronic airflow obstructions" OR "chronic airflow obstruction" | "breathing exercises"[MeSH] OR "breathing exercises" OR "exercise, breathing" OR "respiratory muscle training" OR "muscle training, respiratory" OR "training, respiratory muscle" OR "expiratory muscle training" | (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized controlled trials[mh] OR random allocation[mh] OR double-blind method[mh] OR single-blind method[mh] OR clinical trial[pt] OR clinical trials[mh] OR ("clinical trial"[tw]) OR ((singl*[tw] OR double*[tw] OR trebl*[tw] OR tripl*[tw]) AND (mask*[tw] OR blind*[tw]) OR ("latin square"[tw]) OR placebo*[tw] OR placebo* OR placebo) OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR placebo OR 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for the total subjects studied. The characteristics of the studies are summarized in Table 2. Four trials4,8,13,20 compared EMT versus a control group (total n = 71, EMT group n = 37), whereas 2 trials13,21 compared EMT and IMT versus a control group (total n = 48, EMT and IMT group n = 24). None of the 5 studies reported detrimental effects of EMT.

The training load ranged from 10 to 60% of PEmax between studies. The duration of each session in the studies ranged between 15 and 30 min, with total time varying from 5 to 40 weeks of training. All studies included individuals with GOLD (Global Initiative for Chronic Obstructive Lung Disease) stage III and/or IV of severity.

Risk of Bias

Of the included studies in the systematic review, all studies presented an adequate sequence generation, 20% reported allocation concealment, 40% had a blinded assessment of outcomes, 80% described losses to follow-up and exclusions, and 60% used the intention-to-treat principles for statistical analyses (Table 3).

Effects of Interventions

Analysis 1: Expiratory Muscle Training Versus Control Group

Respiratory Muscle Strength: PEmax and PImax. Four trials4,8,13,20 (n = 71) comparing EMT to a control group evaluated PEmax, and 3 articles4,13,20 (n = 55) evaluated PImax. We observed that EMT provides a higher gain in PEmax (21.49 cm H2O, 95% CI 13.39–29.59, I² = 0%) and PImax (7.68 cm H2O, 95% CI 0.90–14.45, I² = 0%) (Fig. 2) compared to control groups.

Functional Capacity. Three articles4,8,13 (n = 55) evaluated distance walked in 6MWT, and 2 studies8,20 (n = 32) assessed dyspnea. There was no significant difference in 6MWT (29.01 m, 95% CI 39.62 to 97.65, I² = 0%) (Fig. 3). Figure 4 illustrates that there is no difference between EMT and a control group for dyspnea (0.15, 95% CI −0.77 to 1.08, I² = 0%).

Analysis 2: Expiratory Muscle Training Combined With Inspiratory Muscle Training Versus Control Group

Respiratory Muscle Strength: PEmax and PImax. The 2 trials13,21 (n = 48) comparing EMT plus IMT to a control group evaluated PEmax and PImax. PEmax had higher values in the combined EMT and IMT group (31.98 cm H2O, 95% CI 26.93–37.03) than in the control group (Fig. 5). EMT combined with IMT also showed higher results for PImax (27.98 cm H2O, 95% CI 20.10–35.85) compared to the control group (Fig. 5). There were insufficient data to perform the meta-analysis with these articles evaluating functional capacity.

Discussion

Summary of Evidence

In this systematic review and meta-analysis of RCTs, we wanted to evaluate the influence of EMT and IMT plus IMT compared to control groups in subjects with COPD, evaluating respiratory muscle training and functional capacity. We observed that EMT and IMT combined with IMT provide higher gains in PEmax and PImax compared to control groups, but not in functional capacity and dyspnea.

The data analyzed demonstrated that EMT provides benefits in PEmax4,13,20 and PImax4,8,13,20 Studies have shown that respiratory muscle weakness is associated with increased mortality in subjects with COPD.22 In addition, expiratory muscle weakness is a risk factor for re-admission to hospital due to exacerbations,23 and a recent study showed that the degree of air-flow obstruction and hyperinflation at hospitalization is related to expiratory muscle strength.24 Also, it is known that severe acute exacerbations have an independent negative impact on the prognosis for COPD patients.25 These data demonstrate the importance of treating muscle strength in subjects with COPD. In a practice guideline for physiotherapists treating subjects with COPD,14 cough effectiveness and forced expiration are important clinical conditions to decrease retention of mucus and avoid respiratory infections and are recommended as a way to treat COPD subjects. Therefore, the favorable outcomes shown in this paper can contribute to these objectives.

Moreover, it is known that expiratory muscles are activated during expiration in subjects with COPD, most often at the end of expiration.26 Weiner et al13 demonstrated that when IMT is performed alone, there is no improvement in PEmax. Therefore, it is important that COPD subjects perform EMT to increase PEmax.

Hyperinflation is common in subjects with COPD and can be caused by daily activities or exercise, and this increases the sensation of dyspnea and, in advanced COPD subjects, can reflect CO2 retention during exercise.27-29 Although no significant difference was found, hyperinflation was reduced in the group that performed EMT in one of the studies, and it is possible that EMT decreases hyperinflation, improving abdominal muscle tone and decreasing the elevation of the diaphragm.8

In relation to distance walked in 6MWT and dyspnea, there was no significant improvement for EMT. The distance walked is associated with clinical outcomes such as hospitalization and mortality.30,31 Changes in 6MWT distance are used to evaluate the efficacy of therapeutic
Table 2. Characteristics of Studies Included in This Review

<table>
<thead>
<tr>
<th>Reference</th>
<th>Patients (Intervention/Control), n</th>
<th>Patient Characteristics</th>
<th>Age (Intervention/Control), Mean ± SD</th>
<th>Male (Intervention/Control), n</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mota et al&lt;sup&gt;8&lt;/sup&gt;</td>
<td>10/6</td>
<td>Stage III or IV according to GOLD classification; FEV&lt;sub&gt;1&lt;/sub&gt;: % of predicted for intervention (27 ± 3) and sham (28 ± 3) groups (mean ± SD)</td>
<td>62 ± 2/66 ± 3</td>
<td>10/6</td>
<td>EMT group = general physiotherapy techniques plus EMT with threshold; load of 50% of P&lt;sub&gt;Emax&lt;/sub&gt;; three 30-min sessions per week for 5 weeks Control group = general physiotherapy techniques plus threshold with no additional load</td>
</tr>
<tr>
<td>Nield et al&lt;sup&gt;20&lt;/sup&gt;</td>
<td>7/9</td>
<td>Stage III or IV according to GOLD classification; FEV&lt;sub&gt;1&lt;/sub&gt;: % of predicted for intervention (43 ± 16) and sham (40 ± 15) groups (mean ± SD)</td>
<td>63 ± 5/69 ± 8</td>
<td>7/9</td>
<td>EMT group = threshold with 10% of the subject’s baseline P&lt;sub&gt;Emax&lt;/sub&gt; with the objective of prolongation of expiration; 10 min in the 1st week, 15 min in the 2nd week, 20 min in the 3rd week, and 25 min from the 4th week for 12 weeks every day Control group = received pamphlets of the American Lung Association</td>
</tr>
<tr>
<td>Weiner et al&lt;sup&gt;4&lt;/sup&gt;</td>
<td>12/11</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; &lt; 50% of predicted and FEV&lt;sub&gt;1&lt;/sub&gt;/FVC &lt; 70% of predicted who received a diagnosis of COPD according to the American Thoracic Society (Stage III or IV according to GOLD classification); FEV&lt;sub&gt;1&lt;/sub&gt;: % of predicted for intervention (37 ± 2.4) and sham (39 ± 2.9) groups (mean ± SD)</td>
<td>63.3 ± 2.9/61.1 ± 2.8</td>
<td>9/10</td>
<td>EMT group = threshold with 15% of P&lt;sub&gt;Emax&lt;/sub&gt; in the 1st week, increasing the load by 5–10% in each session up to 60%; weekly measurement of P&lt;sub&gt;Emax&lt;/sub&gt;, with EMT maintained at 60% of the value; 30 min 6 times per week for 12 weeks Control group = threshold with 7 cm H&lt;sub&gt;2&lt;/sub&gt;O; same period and number of sessions</td>
</tr>
<tr>
<td>Weiner et al&lt;sup&gt;13&lt;/sup&gt;</td>
<td>8 or 8/8</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; &lt; 50% of predicted and FEV&lt;sub&gt;1&lt;/sub&gt;/FVC &lt; 0.7 of predicted who received a diagnosis of COPD according to the American Thoracic Society (Stage III or IV according to GOLD classification); FEV&lt;sub&gt;1&lt;/sub&gt;: % of predicted for EMT (43 ± 2.6), EMT + IMT (45 ± 3.0), and sham (43 ± 2.9) groups (mean ± SD)</td>
<td>65.4 ± 3.3/62.7 ± 3/61.8 ± 3.2</td>
<td>7 or 6/7</td>
<td>EMT group = threshold with 15% of P&lt;sub&gt;Emax&lt;/sub&gt; in the 1st week, increasing the load by 5–10% in each session up to 60%; weekly measurement of P&lt;sub&gt;Emax&lt;/sub&gt;, with EMT maintained at 60% of the value; 30 min 6 times per week for 12 weeks EMT + IMT group = threshold with 15% of P&lt;sub&gt;Emax&lt;/sub&gt; and P&lt;sub&gt;Imax&lt;/sub&gt; in the 1st week, increasing the load by 5–10% in each session up to 60%; weekly measurement of P&lt;sub&gt;Emax&lt;/sub&gt; and P&lt;sub&gt;Imax&lt;/sub&gt; with EMT + IMT maintained at 60% of the value; 30 min 6 times per week for 12 weeks Control group = threshold with 7 cm H&lt;sub&gt;2&lt;/sub&gt;O; same period and number of sessions</td>
</tr>
<tr>
<td>Battaglia et al&lt;sup&gt;21&lt;/sup&gt;</td>
<td>16/16</td>
<td>Stage III or IV according to GOLD classification; FEV&lt;sub&gt;1&lt;/sub&gt;: % of predicted for intervention (59.9 ± 3.72) and sham (55.65 ± 4.12) groups (mean ± SD)</td>
<td>66/69</td>
<td>10/9</td>
<td>EMT + IMT group = Resipolv alone for 10 days, then Resipolv plus Respilift (using the mouth in inspirations and expiration); 30 min every day for 40 weeks Control group = training at a load known not to yield improvements in inspiratory muscle training (± 5% P&lt;sub&gt;Imax&lt;/sub&gt;)</td>
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</table>

EMT = expiratory muscle training  
P<sub>Emax</sub> = maximum expiratory pressure  
IMT = inspiratory muscle training  
P<sub>Imax</sub> = maximum inspiratory pressure
interventions, including pulmonary rehabilitation.\textsuperscript{32} It is possible that non-favorable results were found for dyspnea and 6MWT because of the small number of studies included and the small number of individuals in each study.

Of the 2 studies that evaluated dyspnea, one seems to be favorable to EMT\textsuperscript{8} and the other one not.\textsuperscript{20} One of the causes of these findings is that the study conducted by Nield et al\textsuperscript{20} used a training protocol to prolong expiration and not to strengthen expiratory muscles. The authors used only 10\% of the subject’s baseline $P_{E_{\text{max}}}$ in the training protocol. Another important consideration regarding this study is that the subjects evaluated had less severe COPD compared with the others.

When we analyzed EMT combined with IMT versus the control group, we found higher $P_{E_{\text{max}}}$ and $P_{I_{\text{max}}}$. These results of EMT combined with IMT for these variables may be due to the combination of 2 effective forms of respiratory muscle training. A recent systematic review showed that in normal subjects, the combination of IMT plus EMT is more effective in increasing the performance exercise compared with IMT or the control group.\textsuperscript{33}
IMT is already well elucidated in the literature as a good method to increase inspiratory muscle strength.10-12 In this meta-analysis, we found that EMT is an effective way to improve strength of the inspiratory and expiratory muscles. Hence, as expected, the combination of EMT and IMT showed very good results for improving respiratory muscle strength. However, it was not possible to determine which is the best technique to increase expiratory muscle strength, EMT or EMT plus IMT, through this meta-analysis.

**Strengths and Limitations of the Review**

An important positive factor is that there was no heterogeneity of the studies included in these meta-analyses. Another strong methodological point was the systematic review of the literature, with explicit and reproducible eligibility criteria, without language limitations, performed independently by 2 reviewers.

A limitation of the studies included in this review is that most of them presented low methodological quality. None of the studies had a description of the sample calculation. Only the study carried out by Battaglia et al21 described randomization to be based on a sealed envelope randomization list. All of the studies described the exclusions,4,8,13,20,21 and only one study13 did not describe losses. Three studies4,8,13 described the blinding of outcome assessors. Some types of intervention allow blinding of subjects enrolled in the study. This was shown in the studies in which the sham group performed the same intervention as the intervention group but with a different load in "Threshold," for example. In this paper, this method can be seen in 2 studies.4,13 Moreover, there were a limited number of studies included in this review since only 5 of them met the eligibility criteria, showing a lack of studies on the interventions in this population. Perhaps with a higher number of studies and individuals included in the analyses, it would be possible to show the benefit of EMT on the distance walked in 6MWT and dyspnea. Another limitation of this review concerns the EMT protocols and the loads used in the studies. Nield et al20 used a program of prolonged exhalation with EMT and not expiratory muscle strengthening. This protocol was different from that used in the other studies included in this paper. In the studies that used a device to increase expiratory muscle strength, there were differences in the training load used ranging from 10 to 60% of PEmax.

### Table 1: Comparison between expiratory muscle training (EMT) and control groups for dyspnea.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI</th>
<th>Mean Difference IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battaglia et al, 2009</td>
<td>97</td>
<td>8</td>
<td>16</td>
<td>64</td>
<td>8</td>
<td>16</td>
<td>83.0%</td>
<td>33.00 [27.46, 38.54]</td>
<td></td>
</tr>
<tr>
<td>Weiner et al, 2003b</td>
<td>105</td>
<td>13.8</td>
<td>8</td>
<td>78</td>
<td>11</td>
<td>8</td>
<td>17.0%</td>
<td>27.00 [14.77, 39.23]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>24</td>
<td></td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td>100.0%</td>
<td>7.68 [0.90, 14.45]</td>
<td></td>
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<tr>
<td>Heterogeneity: Tau² = 0.00; Chi² = 0.98, df = 1 (P = 0.38); I² = 0%</td>
<td></td>
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<td></td>
<td>Test for overall effect: Z = 12.41 (P &lt; 0.00001)</td>
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</table>

### Table 2: Comparison between expiratory muscle training (EMT) combined with inspiratory muscle training (IMT) and control groups for maximum expiratory pressure (PEmax) and maximum inspiratory pressure (PImax).

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI</th>
<th>Mean Difference IV, Random, 95% CI</th>
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<td>Battaglia et al, 2009</td>
<td>81</td>
<td>8</td>
<td>16</td>
<td>64</td>
<td>8</td>
<td>16</td>
<td>50.4%</td>
<td>25.00 [13.91, 36.09]</td>
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<tr>
<td>Weiner et al, 2003b</td>
<td>90</td>
<td>13.8</td>
<td>8</td>
<td>78</td>
<td>11</td>
<td>8</td>
<td>49.6%</td>
<td>31.00 [19.82, 42.18]</td>
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<tr>
<td>Subtotal (95% CI)</td>
<td>24</td>
<td></td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td>100.0%</td>
<td>10.00 [-1.91, 21.91]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.00; Chi² = 0.56, df = 1 (P = 0.46); I² = 0%</td>
<td></td>
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<td></td>
<td></td>
<td>Test for overall effect: Z = 6.97 (P &lt; 0.00001)</td>
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</table>

Fig. 4. Comparison between expiratory muscle training (EMT) and control groups for dyspnea.

Fig. 5. Comparison between expiratory muscle training (EMT) combined with inspiratory muscle training (IMT) and control groups for maximum expiratory pressure (PEmax) and maximum inspiratory pressure (PImax).
Conclusions

This systematic review and meta-analysis showed that EMT and EMT combined with IMT increase respiratory muscle strength but not functional capacity and dyspnea. Thus, this intervention can be used as part of the treatment during pulmonary rehabilitation of subjects with severe to very severe COPD. However, further studies with a more robust methodological design and a greater number of individuals are necessary to adequately respond to these issues.

REFERENCES