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Effectiveness of different protocols and loads used in inspiratory muscle training of individuals with COPD: a systematic review

Efetividade de diferentes protocolos e cargas utilizadas no treinamento muscular inspiratório de indivíduos com DPOC: uma revisão sistemática

Eficacia de diferentes protocolos y cargas utilizadas en el entrenamiento muscular inspiratorio de personas con EPOC: una revisión sistemática

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ABSTRACT | Chronic obstructive pulmonary disease (COPD) changes the musculoskeletal system, including the respiratory muscles, which are responsible for increasing dyspnea and reducing functional capacity. Several studies have already showed the effectiveness of inspiratory muscle training (IMT); therefore, it should be part of the pulmonary rehabilitation program. However, assessing the best way to do it is still necessary. Thus, this study aimed to evaluate, by a systematic review, the effectiveness of different IMT protocols and loads on the outcomes of inspiratory muscle strength and endurance, functional capacity, and dyspnea reduction. This systematic review was performed in accordance with the PRISMA protocol. Studies were searched in February 2021 in the PubMed, SciELO, PEDro. For the search, the following keywords were used: "COPD" and "breathing exercises, resistive training, respiratory muscle training." A total of 398 individuals previously diagnosed with COPD were included in the 10 selected studies. Different IMT devices were used and protocols varied in relation to loads and progression. Threshold was the most used IMT device. Its load was established according to the percentage of maximal inspiratory pressure (MIP) (30–80%) and readjusted according to new measurements taken every one or two weeks. Respiratory muscle training with both low loads and high loads presented positive results, however, establishing which is the best IMT protocol for individuals with COPD is not possible yet. Inspiratory muscle strength, functional capacity, and dyspnea get better with IMT.

Keywords | Pulmonary Disease, Chronic Obstructive; Breathing Exercises.

RESUMO | A doença pulmonar obstrutiva crônica (DPOC) provoca alterações no sistema musculoesquelético, afetando inclusive os músculos respiratórios e levando ao aumento da dispneia e à redução da capacidade funcional. Nesse sentido, o treinamento muscular inspiratório (TMI) deve fazer parte do programa de reabilitação pulmonar. Diversos estudos já demonstraram sua eficácia, contudo, ainda é necessário investigar qual a melhor forma de realizá-lo. Assim, o objetivo deste estudo foi investigar por meio de uma revisão sistemática a efetividade de diferentes protocolos e cargas de TMI sobre os desfechos de força e resistência dos músculos inspiratórios, bem como de capacidade funcional e redução da dispneia. Trata-se de uma revisão sistemática realizada de acordo com o protocolo PRISMA. A busca foi realizada em fevereiro de 2021, nas seguintes bases de dados: PubMed, SciELO, PEDro. Para a busca dos artigos, os seguintes descritores foram empregados: "COPD"; e "*breathing exercises, resistive training, respiratory muscle training*". Um total de 398 pacientes foram incluídos nos 10 estudos selecionados, todos previamente diagnosticados com DPOC. Foram utilizados diferentes dispositivos para o TMI, e os protocolos variaram em relação às cargas e progressão. O dispositivo mais utilizado entre os artigos foi o *Threshold*, com carga estabelecida de acordo com a porcentagem da pressão inspiratória máxima (30-80%),

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reajustada de acordo com novas medições a cada uma ou duas semanas. Houve semelhança de resultados positivos encontrados tanto em treinamentos com cargas baixas quanto com cargas altas, havendo uma melhora na força muscular inspiratória, capacidade funcional e dispneia. No entanto, mais estudos são necessários para definir o melhor protocolo de TMI para DPOC.
Descritores | Doença Pulmonar Obstrutiva Crônica; Exercícios Respiratórios.

RESUMEN | La enfermedad pulmonar obstructiva crónica (EPOC) produce cambios en el sistema musculoesquelético, incluidos los músculos respiratorios, lo que provoca un aumento de la disnea y reducción de la capacidad funcional. En este sentido, el entrenamiento de la musculatura inspiratoria (EMI) debe formar parte del programa de rehabilitación pulmonar. Varios estudios ya reportaron su eficacia, pero todavía es necesario investigar la mejor manera de realizarlo. Por lo tanto, el objetivo de este estudio fue investigar, basándose en una revisión sistemática, la efectividad de diferentes protocolos y cargas de EMI en los resultados de fuerza y resistencia de la musculatura inspiratoria, así como en la capacidad funcional y la reducción de la disnea. Esta es una revisión sistemática que siguió el protocolo PRISMA. Se realizó una búsqueda de datos en febrero de 2021 en las siguientes bases de datos: PubMed, SciELO y PEDro. Para estas búsquedas se utilizaron los siguientes descriptores: "COPD" y "*breathing exercises, resistive training, respiratory muscle training*". Un total de 398 pacientes se incluyeron en los 10 estudios seleccionados, y todos los participantes habían recibido diagnóstico previo de EPOC. Se utilizaron diferentes dispositivos para EMI, y los protocolos variaron con relación a cargas y progresión. Entre los artículos, la herramienta más utilizada fue *Threshold*, con carga según el porcentaje de presión inspiratoria máxima (30-80%), reajustada conforme nuevas medidas cada una o dos semanas. Se encontraron resultados positivos similares en el entrenamiento con bajas cargas y en el con altas cargas, con mejora de la fuerza de la musculatura inspiratoria, de la capacidad funcional y de la disnea. Sin embargo, se necesitan más estudios para definir el mejor protocolo de EMI para EPOC.
Palabras clave | Enfermedad Pulmonar Obstructiva Crónica; Ejercicios Respiratorios.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the main causes of morbidity and mortality worldwide. This disease is characterized by a progressive airflow limitation—due to airway narrowing—and the destruction of the pulmonary parenchyma. These changes, which vary in intensity for each individual, are caused by long-term exposure to toxic particles and gases and influenced by personal factors[1]. The aging of the world population, associated with smoking and air pollution, increased the incidence of COPD in recent years—this disease affected 210 million people and is responsible for about 6% of deaths worldwide. A 30% increase in its mortality is also expected in the next decade, which would raise COPD to the third place among the main causes of death in 2030[2].

High COPD mortality and morbidity rates are mainly due to both pulmonary and musculoskeletal changes, besides the various comorbidities that follow this condition. Dyspnea is one of the main COPD symptoms and is related to hyperinflation among other factors. Patients begin to present a rapid and short breathing pattern, increasing the work of breathing and restricting the tidal volume. These changes are also related to an imbalance between demand and capacity of the inspiratory muscles, which show decreased strength and endurance[3]. Due to hyperinflation, the diaphragm needs to make a greater effort than usual to increase negative pressure and allow air to enter the lungs. This energy demand causes a thoraco-pulmonary distension and the rectification of this muscle, making its domes low and flattened[4]. To adapt itself to these changes and remain working, the number of diaphragm sarcomeres decrease, as well as their length. Thus, peak inspiratory flow is usually preserved, while ventilation, limited in pathology, is more susceptible to fatigue[5]. Since muscle fibers undergo a transformation from type II to type I, their capillarization and aerobic capacity[6]—as well as their workload and oxygen consumption—increase. As the disease progresses, patients have difficulty meeting this demand and, since their fibers were shortened, their inspiratory action becomes weak and accessory muscles are needed[5].

The abdominal and peripheral muscles, especially the quadriceps, also present important changes. In these muscles, the number of type I fibers decreases in comparison with type II fibers, which is related to exercise intolerance, worsening of pulmonary function, and higher mortality rates[6]. Moreover, most individuals are older adults and may have comorbidities, such as heart diseases and diabetes, thus, muscular atrophy, sarcopenia, and cachexia are common conditions. These conditions are characterized by reduced fiber size, loss of muscle mass, and weight loss and are related to hypoxia, hypercapnia, smoking, malnutrition, use of corticosteroids, and immobilization. Therefore, musculoskeletal dysfunction is directly linked to a poor prognosis of COPD[7].

All aforementioned factors are part of a cycle of inactivity and worsening of the characteristic symptoms of COPD. Hyperinflation and mechanical changes in the rib cage lead to dyspnea and intensify the work of breathing, increasing carbon dioxide (CO_2) levels. In turn, peripheral muscle atrophy and changes in fiber composition cause muscle strength and endurance deficit and increases lactic acid production and CO_2 concentration. As a result of this combination, patients start to reduce their activities for fear of exacerbating symptoms and become increasingly physically unconditioned, which consequently worsens their musculoskeletal and respiratory condition[6].

The treatment of COPD must be performed by a multidisciplinary team and its goals include relief of symptoms, improvement of the clinical picture and exercise tolerance, prevention of disease progression and exacerbations, and mortality reduction. This management of COPD involves smoking cessation, vaccination against influenza and pneumonia, use of bronchodilators and corticosteroids, patient education for self-care, and pulmonary rehabilitation—which is a protocol that includes supervised exercises, identification of physical needs, and assessment of the nutritional, psychological, and social status of patients[1].

Inspiratory muscle training (IMT), along with an exercise program, is an essential part of pulmonary rehabilitation. This treatment can be performed by two different methods: endurance training with linear load and non-linear load. The first method is independent from the airflow, provides constant endurance (cmH_2O), and uses a spring with one-way valve. The second uses a device with a variable diameter orifice and airflow limitation, thus, it is dependent on this[8]. Among linear load devices, Threshold IMT® is the most used and has shown greater effectiveness in comparison with non-linear load devices, such as Voldyne®[9]. POWERbreathe is another device developed for the same purpose, which is constituted of a resistive load provided by an electronically controlled valve[10]. The benefits of inspiratory muscle training include increased muscle strength and endurance, reduced dyspnea, and improvement of exercise tolerance and quality of life[11]. However, the lack of standardization of devices and loads used in previous studies still represents a difficulty to establish its real therapeutic effect.

Thus, the research question of this systematic review is: what are the effective protocols and loads for inspiratory muscle training of individuals with COPD? Therefore, this study aims to assess the best protocol and loads to perform inspiratory muscle training of individuals with COPD and review the effectiveness of this training on the outcomes of muscle strength and endurance, functional capacity, and dyspnea reduction.

METHODOLOGY

This is a systematic review of studies that assessed: (1) individuals with COPD subjected to inspiratory muscle training protocols with different devices; (2) randomized clinical trials comparing different protocols performed with different devices or with the same device, comparing the effect of a protocol with a control group that did not undergo exercise or a placebo group; and (3) studies in English, Portuguese, Spanish, and French published in full. Review articles, monographs, studies published only as scientific conference proceedings, book chapters, guidelines, and expert opinions were excluded.

Primary outcomes were variables that show respiratory muscle strength and endurance, such as maximal inspiratory pressure (MIP) and maximal voluntary ventilation (MVV). Secondary outcomes were variables related to cardiorespiratory fitness and functional capacity, such as maximal oxygen consumption (VO_2 max), time limit (Tlim), distance covered in the six-minute walk test (6'WT), baseline dyspnea index (BDI), transition dyspnea index (TDI), and the Medical Research Council (MRC) dyspnea scale.

Studies were searched in February 2021 in the PubMed, SciELO, and PEDro databases. For the search, the following keywords were selected from the Medical Subject Headings (MeSH) terms and divided according to population group and outcome: (1) population group: "COPD;" and (2) outcome: "breathing exercises, resistive training, respiratory muscle training." Only studies published in the last 10 years were selected. A bibliography manager software for the publication of scientific papers (EndNote®) was used to store studies and exclude duplicates.

For the risk of bias analysis, the Review Manager (RevMan 5) software was used. In it, random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and professionals (performance bias), blinding of outcome assessors (detection bias), incomplete outcomes (attrition bias), selective reporting (reporting bias), and other sources of bias were assessed.

RESULTS AND DISCUSSION

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart to organize the selection process of studies (Figure 1). We found 1,803 studies in the databases used, but held only 20 for full reading, after excluding duplicates and reading titles and abstracts. Finally, we included 10 studies in this study, following the pre-established inclusion and exclusion criteria.

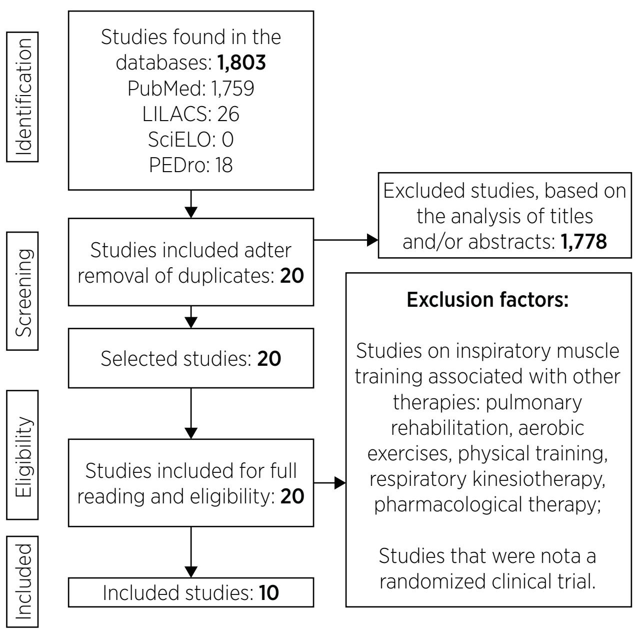

Figure 1. Flowchart of the selection process of studies

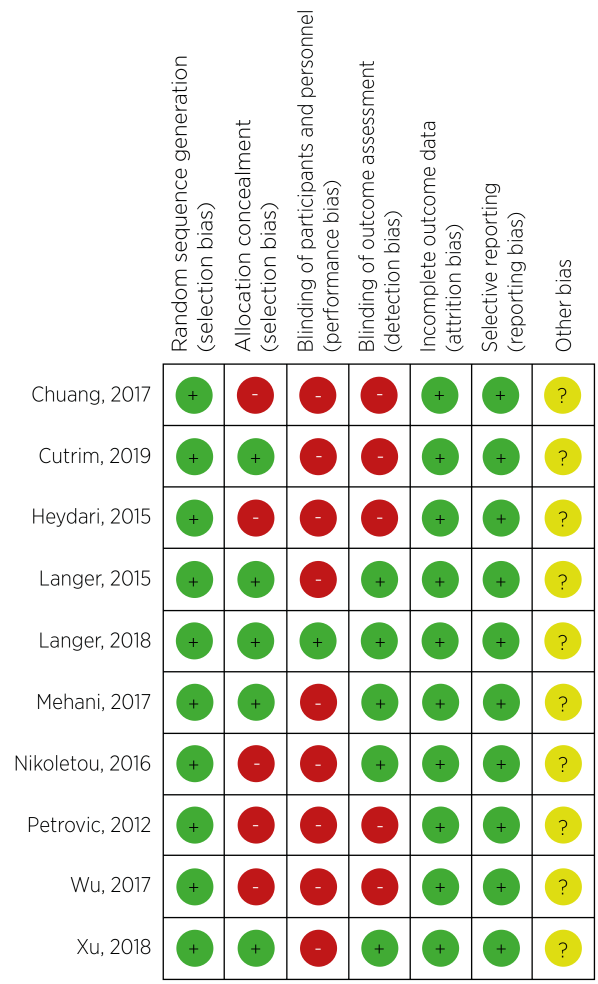

Figure 2. Risk of bias summary: analysis on the risk of bias of the included studies

Figure 2 shows that half of the included studies met the inclusion criteria[10,12-15]. The other half did not present allocation concealment[2,11,16-18]. Only one study showed blinding of subjects[13]. Regarding the blinding of outcome assessors, half of the studies met the requirement[10,13-15,17].

Table 1 presents the characteristics of the samples of the included studies, such as age, sex, and pulmonary function of individuals, and IMT protocols, including prescription, weekly frequency and progression, intensity and progression of the load, adjustment of the load, duration, and devices.

Table 1. Characteristics of the samples of the studies and inspiratory muscle training protocols

Study	Sample	Protocol				
	Group	Prescription	Weekly frequency and duration	Intensity and progression of the load	Adjustment of the load	Device
Chuang et al., 2017[2]	**G1:** IMT (n=27) **G2:** control (n=28)	21-30min/session 7×2min active and 1min resting	5×/week for eight weeks	1st week: 15cmH_2O 2nd week: 20cmH_2O 4th week: 30cmH_2O 6th week: 40cmH_2O	Every two weeks	Threshold
Cutrim et al., 2019[12]	**G1:** IMT (n=11) **G2:** control (n=11)	30min/session 15-20 diaphragmatic breaths/min	3×/week for 12 weeks	Load fixed at 30% MIP	Fixed load	Threshold

(continues)

Table 1. Continuation

Study	Sample	Protocol				
	Group	Prescription	Weekly frequency and duration	Intensity and progression of the load	Adjustment of the load	Device
Heydari, Farzad, and Ahmadi hosseini, 2015[16]	**G1:** IMT (n=15) **G2:** incentive spirometry (n=15)	15min/session 2×/day	4-2×/week for four weeks	**G1:** initial load of 40% MIP **G2:** 10-15 slow and deep breaths for 3s	**G1:** 5-10% in each session, up to 60% MIP **G2:** none	**G1:** Threshold **G2:** Respiflo
Langer et al., 2015[10]	**G1:** linear mechanical pressure load (n=10) **G2:** conical flow resistive load (n=10)	2×/day 30 breaths	7×/week for eight weeks	Minimum 40% MIP	2×/week, to match at least 50% MIP	**G1:** Threshold or POWERbreathe Medic **G2:** POWERbreathe KH1
Langer et al., 2018[13]	**G1:** IMT (n=10) **G2:** placebo (n=10)	2-3 sessions/30 breaths 4-5min/session	7×/week for eight weeks	**G1:** initial load of 40% MIP **G2:** ≤10% initial MIP	Weekly, up to 40-50% MIP	POWERbreathe KHZ
Mehani, 2017[14]	**G1:** IMT+placebo EMT (n=20) **G2:** EMT+placebo IMT (n=20)	6×5 breaths	3×/week for eight weeks	**G1:** initial load of 15% MIP+placebo EMT 7cmH$_2$O **G2:** initial load of 15% MIP+placebo IMT 7cmH$_2$O	**G1:** 1×/week, 5-10% up to 60% MIP **G2:** 1×/week, 5-10% up to 60% MIP	Threshold
Nikoletou et al., 2016[17]	**G1:** IMT (n=21) **G2:** placebo (n=18)	2×/day 30 breaths Maximum 1-min breaks	6×/week for seven weeks	**G1:** initial load of 30% MIP **G2:** Load fixed at 15% MIP	**G1:** 1×/week, up to 62% MIP	POWERbreathe
Petrovic et al., 2012[18]	**G1:** IMT (n=10) **G2:** control (n=10)	1×/day 10×strength 10×endurance	7×/week for eight weeks	**Strength:** 80% MIP for 1s **Endurance:** 60% MIP for 1min	Every two weeks	Respifit S
Wu et al., 2017[11]	**G1:** Pflex (n=21) **G2:** Threshold (n=19) **G3:** control (n=20)	2×/day 15min	2×/week for eight weeks	**G1:** 60% PTP MIP **G2:** 60% PTP MIP	Every two weeks	**G1:** Pflex **G2:** Threshold
Xu et al., 2018[15]	**G1:** IMT (n=23) **G2:** IMT+EMT=cycle (n=23) **G2:** IMT+EMT≠cycle (n=23) **G4:** control (n=23)	1×/day, 48min each	7×/week for eight weeks	**IMT:** initial load of 30% MIP **EMT:** initial load of 15% MEP **Placebo:** no load	**IMT:** 5% every 2 weeks, up to 45% MIP **EMT:** 5% every 2 weeks, up to 30% MEP	Modified Threshold

IMT: inspiratory muscle training; EMT: expiratory muscle training; MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure; PTP MIP: pressure-time product of MIP.

This study included 398 individuals. The samples were from North America[13], South America[12], Asia[2,11,14-16], and Europe[10,17,18]. All individuals were previously diagnosed with COPD. Most of them were men and the mean age ranged from 50 to 73 years old (mean±SD). Different IMT devices were used, mainly Threshold and POWERbreathe, and protocols varied in relation to loads and progression.

Table 2 presents the results of the studies analyzed, divided between primary outcomes (inspiratory muscle strength assessment) and secondary outcomes (functional capacity).

Table 2. Effects of inspiratory muscle training according to primary and secondary outcomes

Study	Primary outcomes	Secondary outcomes
Chuang et al., 2017[2] **G1:** IMT **G2:** control	**G1 vs G2:** Significant increase in MIP after IMT in G1 in comparison with G2 (p<0.001).	**G1 vs G2:** Significant increase in the distance covered in the 6'WT and the BDI score in G1 in comparison with G2 (p<0.001).
Cutrim et al., 2019[12] **G1:** IMT **G2:** control	**G1 vs G2:** Significant increase in MIP in G1 in comparison with G2 (p<0.05).	**G1 vs G2:** Clinically significant increase in the distance covered in the 6'WT (ES=1.09).
Heydari, Farzad, and Ahmadi hosseini, 2015[16] **G1:** IMT **G2:** incentive spirometry	**G1 vs G2:** Significant increase in MIP and MVV in G1 in comparison with G2 (p=0.025).	No secondary outcomes were assessed.
Langer et al., 2015[10] **G1:** linear mechanical pressure load **G2:** conical flow resistive load	**G1 vs G2:** Both showed an increase in MIP, but it was more expressive in G2 when compared with G1 (p<0.01).	**G1 vs G2:** Significant increase in Tlim in G2 in comparison with G1 (p=0.02).
Langer et al., 2018[13] **G1:** IMT **G2:** placebo	**G1 vs G2:** Significant increase in MIP in G1 in comparison with G2 (p<0.05). No significant difference in MVV between the two groups (p>0.05).	**G1 vs G2:** Significant decrease in dyspnea in G1 in comparison with G2 (p<0.05).
Mehani, 2017[14] **G1:** IMT+placebo EMT **G2:** EMT+placebo IMT	**G1 vs G2:** Significant increase in MIP in G1 in comparison with G2 (p=0.0001).	**G1 vs G2:** Significant increase in the distance covered in the 6'WT in G1 in comparison with G2 (p=0.0001).
Nikoletou et al., 2016[17] **G1:** IMT **G2:** placebo	**G1 vs G2:** Significant increase in MIP in G1 in comparison with G2 (p=0.04).	**G1 vs G2:** Significant increase in the distance covered in the shuttle walk test in G1 in comparison with G2 (p=0.05).
Petrovic et al., 2012[18] **G1:** IMT **G2:** control	**G1 vs G2:** Significant increase in MIP in G1 in comparison with G2 (p<0.001).	**G1 vs G2:** Significant increase in maximum exercise capacity in G1 in comparison with G2 (p<0.001).
Wu et al., 2017[11] **G1:** IMT Pflex **G2:** IMT Threshold **G3:** control	**G1 vs G2 vs G3:** Significant increase in MIP in G1 and G2 in comparison with G3 (p<0.01), without significant difference between them (p>0.05).	**G1 vs G2 vs G3:** Significant increase in VO_2 max in G1 and G2 (p<0.05) in comparison with G3, without significant difference between them (p>0.05). No significant increase in BDI in the three groups. Significant increase in TDI in G1 and G2 (P<0.05) in comparison with G3.

(continues)

Table 2. Continuation

Study	Primary outcomes	Secondary outcomes
Xu et al., 2018[15] **G1:** IMT **G2:** IMT+EMT same cycle **G3:** IMT+EMT different cycles **G4:** placebo	**G1 vs G2 vs G3 vs G4:** Significant increase in MIP in G1, G2, and G3 in comparison with G4 (p<0.05), without difference between them.	**G1 vs G2 vs G3 vs G4:** Significant increase in dyspnea in G1, G2, and G3 in comparison with G4 (p<0.05), without difference between them. No difference in the 6'WT between groups (p=0.097).

IMT: inspiratory muscle training; EMT: expiratory muscle training; MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure; PTP MIP: pressure-time product of MIP; MVV: maximal voluntary ventilation; VO_2 max: maximal oxygen consumption; MRC: Medical Research Council dyspnea scale; 6'WT: six-minute walk test; BDI: baseline dyspnea index; Tlim: inspiratory time with submaximal load; TDI: transition dyspnea index; ES: effect size.

Regarding primary outcomes—inspiratory muscle strength and endurance—all groups that underwent IMT showed significant improvement in MIP in comparison with those that did not. Two studies also assessed MVV, but only one showed a significant improvement in this variable[16].

Secondary outcomes were assessed using different devices and concern cardiorespiratory fitness and functional capacity. Four studies used the 6'WT and three of them showed a significant increase in the distance covered[2,12,14]. Only one study used the shuttle walk test and its groups did not present a significant difference. However, after the test, the experimental group presented lower heart rate, which shows a possible improvement in exercise tolerance[17]. Two studies analyzed the VO_2 max value and both showed improvement in this variable in groups that underwent IMT[11,18]. Two studies assessed inspiratory muscle endurance by Tlim and both showed a significant increase in groups that underwent the protocol[10,18].

Four studies assessed the effect of IMT on dyspnea reduction. Two of them used the MRC scale and both showed improvement in scores after treatment[13,15]. Two other studies analyzed BDI, but only one showed a significant improvement in score[2]. On the other hand, this study that did not show improvement in BDI obtained significantly satisfactory TDI results[11].

Seven of the 10 studies analyzed used Threshold, thus, it was the most used IMT device[2,10-12,14-16]. IMT proved to be more effective than the incentive spirometry[16] and POWERbreathe KH1 (conical flow resistive load) proved to be more effective than POWERbreathe Medic and Threshold (linear mechanical pressure load)[10]. Using Pflex presented no significant difference in comparison with using Threshold[11]. Only one study assessed the effects of inspiratory and expiratory muscle training, in the same cycle or different cycles, using a modified Threshold device. This type of treatment presented no significant difference in comparison with the exclusively inspiratory one, both in primary and secondary outcomes[15].

Nine of the 10 studies estimated the loads used in relation to MIP, from 30% to 80% of the initial value, and eight of them adjusted their loads every one or two weeks, according to new measurements taken periodically. Only one study used predefined loads, from 15 to 40cmH_2O[2], and only one kept the load fixed at 30% MIP during the entire analyzed period[12]. The treatment time ranged from four to 12 weeks in the 10 studies.

Tables 1 and 2 showed that the prescription of IMT exercises is still heterogeneous in the literature. Apparently, the results of the studies analyzed did not present any difference between them in relation to the different types of device, loads, progression of loads, and treatment time. Thus, establishing if higher load values are more effective in the outcomes analyzed, as well as what would be the ideal weekly frequency for the treatment, is not possible yet. Moreover, the use of different linear load devices seems to provide equivalent results.

Regarding treatment time, a systematic review performed by Figueiredo et al.[19], which analyzed 48 studies and 1,996 individuals, presented similar findings on the effect of IMT alone or not on individuals with COPD. Regarding groups that showed improvement in the outcomes analyzed, those that underwent the protocol for shorter or longer periods presented no difference between them. Regarding load, those that used from 60% to 80% MIP obtained slightly higher gains than those that used from 35% to 50% MIP.

No other systematic reviews in the recent literature sought to answer the question about which IMT protocols would be most effective for individuals with COPD. However, evidence prove the benefits of the treatment in improving inspiratory muscle strength, functional capacity, cardiorespiratory fitness, and dyspnea reduction.

Beaumont et al.[20] performed a systematic review of 43 studies that analyzed the effect of IMT alone or not with 1,427 individuals. Results showed an increase in the MIP, 6'WT, and quality of life values (we did not analyze this variable in this study) and dyspnea reduction by BDI.

This study selected only studies that used IMT alone, excluding the influence of other pulmonary rehabilitation techniques on the results.

The number of participants and studies used was a limitation of this study, as it was small due to the exclusion of techniques other than IMT. The studies analyzed used several protocols, with different loads, intensities, devices, and treatment times, which makes it difficult to establish the best way to strengthen the inspiratory muscles of individuals with COPD. Thus, new randomized controlled trials are still needed for a more assertive conclusion on IMT for the treatment of COPD.

CONCLUSION

Most studies used Threshold to perform IMT, with load established according to the percentage of MIP (30-80%), which was adjusted according to new measurements taken every one or two weeks. The equivalence of positive results found both in training with low loads and high loads was an important finding, as the use of high resistance may compromise the treatment. Inspiratory muscle training improve inspiratory muscle strength, functional capacity, and dyspnea of individuals with COPD.

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