ABENFISIO

LITERATURE REVIEW

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FORMS OF EXECUTION OF THE INSPIRATORY MUSCLE EXERCISE WITH LINEAR LOAD: SYSTEMATIC REVIEW

FORMAS DE EXECUÇÃO DO EXERCÍCIO MUSCULAR INSPIRATÓRIO COM CARGA LINEAR: REVISÃO SISTEMÁTICA

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ABSTRACT

Contextualization: inspiratory muscular exercise with linear load (IE) has been widely inserted in the respiratory Physical Therapy treatment for several abnormalities and respiratory clinical situations, however, it is possible to notice that there are different protocols of prescription referring to the form of execution, by time or repetition. **Objective:** to review the methods of execution of IE in different health conditions and to analyze the responses of the studied variables. **Methods**: three reviewers searched for randomized controlled trials in PubMed, SciELO (Scientific Electronic Library), PEDro, Scopus, Cochrane, and Bireme databases, also evaluating their methodological quality (PEDro scale). **Results**: 340 articles were found and, after verifying the eligibility criteria, 17 studies that evaluated the effect of IE we included. There was no uniqueness in the studied variables. In the analyzed studies, there were protocols of IE performed by time or repetition: on average, 15 minutes, or 3 to 5 sets of 10 breaths, respectively. The most evident outcomes were increase in maximal inspiratory and expiratory pressure (MIP and MEP), increase in functional capacity, and reduction in the sensation of dyspnea. **Conclusion**: in order to perform IE, there are a variety of devices; and the prescriptions are by time or number of repetitions, with predominance to repetition. Outcomes are significant and relevant to clinical practice, however, to date, no studies have been identified that have evaluated, in particular, the effects on the forms of IE implementation.

Keywords: Breathing exercise, respiratory; Inspiratory muscle training; Exercise therapy.

RESUMO

Contextualização: o exercício muscular inspiratório com carga linear (EI) vem sendo amplamente inserido no tratamento fisioterápico respiratório para diversas anormalidades e situações clínicas respiratórias. Entretanto, é possível notar que há diferentes protocolos de prescrição referente à forma de execução, por tempo ou repetição. **Objetivo**: revisar sobre as formas de execução do EI nas diferentes condições de saúde e analisar as respostas das variáveis estudadas. **Método**: três revisores buscaram ensaios clínicos controlados e randomizados nas bases de dados PubMed, SciELO (Scientific Eletronic Library), PEDro, Scopus, Cochrane e Bireme, avaliando também sua qualidade metodológica (escala de PEDro). **Resultados**: foram encontrados 340 artigos e, após verificar os critérios de elegibilidade, foram incluídas 17 pesquisas que avaliaram o efeito do EI. Não houve singularidade nas variáveis estudadas. Nos estudos analisados, havia protocolos de EI realizado por tempo ou repetição: sendo, em média, 15 minutos ou 3 a 5 séries de 10 respirações respectivamente. Os desfechos mais evidentes foram aumento na pressão inspiratória e expiratória máxima (PImáx e PEmáx), aumento na capacidade funcional e redução na sensação de dispneia. **Conclusão**: para a execução do EI, há variedade de dispositivos; e as prescrições são por tempo ou número de repetições, com predomínio à repetição. Os desfechos são significativos e relevantes à prática clínica, porém, não foram identificados, até o presente momento, estudos que têm avaliado designadamente os efeitos nas formas de execução do EI.

Palavras-chave: Exercício respiratório; Treinamento muscular inspiratório; Terapia de exercício.

INTRODUCTION

Respiratory physical therapy has been widely used in rehabilitation in various abnormalities and clinical situations, such as Chronic Obstructive Pulmonary Disease (COPD), post-operative myocardial revascularization and bariatric surgery, weaning from mechanical ventilation, in addition to individuals healthy and athletes. These situations can present abnormalities in the respiratory, cardiovascular and musculoskeletal systems, causing important implications for Quality of Life (QoL)[1-3]. During the last decade, several studies on Inspiratory Exercise (IE) and/or Inspiratory Muscle Training (IMT) have been reported. Thus, the effects of this treatment are: increased inspiratory muscle function, improved respiratory compliance, diaphragmatic morphological changes, reduced respiratory muscle fatigue, increased respiratory muscle strength and endurance, reduced dyspnea, improved functional exercise capacity and the QoL[1,2,4,5]. However, the prescription of this type of exercise is also important and useful to specifically and critically assess the benefits of physiotherapeutic interventions[6]. The literature focuses on the effects of the IMT, however, the studies do not pay attention to the form of execution and, consequently, the execution of the breathing exercise, whether by time or repetition. In the international and national literature, there is a predominance of prescription by repetition, however, some studies also describe interventions by time[7-13].

Therefore, the current study is justified by the fact that, until now – and unknown to the authors – there are no studies that have differentiated the approach regarding intervention through the execution of breathing exercises for inspiratory muscle stimulation. The purpose of this study is to review the ways of performing inspiratory exercise with linear load in different health conditions, analyze the types of variables studied and highlight the responses resulting from these interventions, which will provide subsidies to facilitate understanding and effectiveness in practice. clinical and the generation of experimental studies.

METHODS

The present study is a systematic review on ways of performing IE with linear inspiratory load in different health conditions.

The review process was carried out by three researchers, two of whom carried out the searches for scientific articles independently and evaluated the methodological quality of each selected article, and the third evaluator was responsible for the general review and for remedying discrepancies in information, if any.

Inclusion criteria for selection of articles were: scientific articles available in full text; published in the period from 2008 to 2018, these being randomized clinical trials, controlled or not, in which the study population was adults, which addressed physiotherapeutic interventions related to the use of inspiratory muscle training devices – specifically, Threshold IMT® and PowerBreathe® –, and that had a score on the PEDro scale (Physiotherapy Evidence Database) between 9 and 10. Studies that presented incomplete or duplicate information were excluded, as well as experimental studies with an animal model or in patients on mechanical ventilation.

The data collection for this study was carried out from January to October 2018, based on searches in scientific publications indexed in the PubMed, SciELO (Scientific Electronic Library), PEDro, Scopus, Cochrane and Bireme databases. , which allow the use of common English terminology. The following descriptors were used: Breathing exercise; Inspiratory muscle training; exercise therapy. These descriptors were combined with each other according to the Boolean operators “and” and “or”.

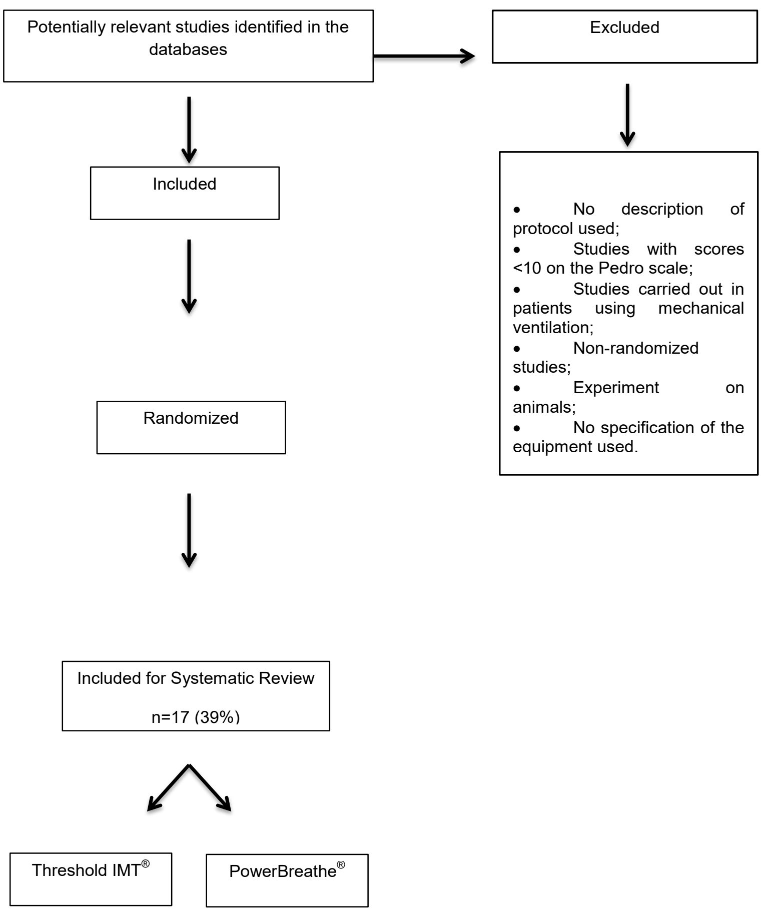
For the analysis of the methodological quality of the studies found, the PEDro scale (www.pedro.fhs.usyd.edu.au) was used, which is commonly used to investigate the effectiveness of physical therapy interventions, in which it assesses the quality methodology and statistical description of randomized controlled trials (RCT) or quasi-randomized (RCT) studies. This scale consists of 11 items, each item is worth one point for the final overall classification (0 to 10 points), with the exception of the first item. For the final analysis of each article by the scale, a score is obtained; and the higher the score, the better the methodological quality and statistical description of the study[14-16]. Data were presented descriptively by absolute and relative distribution.

RESULTS

Description of search and systematic review of studies

A total of 340 (100%) potentially relevant articles were found. Of these, 127 (37%) were selected according to the title and had their respective abstracts reviewed. Consequently, 213 (63%) articles that did not meet the inclusion criteria were excluded. Based on the abstracts and titles of the studies, the full text of the remaining 44 (35%) articles were examined in more detail. Only 17 studies met all inclusion criteria and were selected (Figure 1).

Figure 1. Representative flowchart of the selection process and research steps



Of the 17 studies included, 9 (53%) had a final PEDro score of 10[6,8-10,12,17-20] and 8 (47%) had a final score of 9[7,11,13,21-25] (Chart 1).

Chart 1. Methodological quality of studies based on the PEDro scale

Reviewed articles	Criteria										
	1	2	3	4	5	6	7	8	9	10	11	Total
Bargi et al. 2015[6]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Dronkers et al. 2008[8]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	10/10
Karadallı et al. 2016[9]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Kawauchi et al. 2017[10]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Pehlivan et al. 2018[12]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Archiza et al 2017[17]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	10/10
Charususin et al. 2018[18]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Ferreira et al. 2011[19]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	10/10
Kulnik et al. 2014[20]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10/10
Britto et al. 2011[7]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9/10
Nicolodi et al. 2016[11]	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	9/10
Zeren et al. 2016[13]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9/10
Duruturk et al. 2018[21]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9/10
López-de-Uralde-Villanueva et al. 2011[22]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	9/10
Medeiros et al. 2018[23]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	9/10
Souza et al. 2017[24]	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	9/10
Taskin et al. 2018[25]	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	9/10

Caption: Criteria: 1: specific eligibility criteria; 2: random allocation; 3: secret allocation; 4: comparison of baseline characteristics; 5: blind patient; 6: blind physiotherapists; 7: blind raters; 8: description of patient follow-up; 9: intention-to-treat analysis; 10: comparison between groups; 11: measurement variability and accuracy. Item 1 does not contribute to the total score.

PowerBreathe® and Threshold IMT® are the most prevalent devices used in the reviewed studies; these are linear pressure load respiratory boosters of great applicability and universal use[3,7-9,11-13,18-26], however, there are other types of equipment used in the studies, such as: Threshold Respifit-S, Ultrabreathe Tangent Healthcare, Threshold Loader Respironics, BreatheMAX, MicroRPM[10,20].

Studies that show and describe the protocols according to the NI prescription, by time and/or repetition, are shown in Chart 2.

Chart 2. Inspiratory muscle training prescriptions and their respective authors (continuation)

Study	Nationality	Sample studied	Objective	Protocol	IMT	Results
Dronkers et al. 2008[8]	USA	High risk undergoing elective abdominal aortic aneurysm surgery	To investigate the effects of preoperative IMT on the incidence of atelectasis/patients at high risk of PO pulmonary complications	Time: 15 min / 6 days a week / 2 weeks. pre-surgery	Threshold IMT®	↓ incidence of atelectasis in the PO.
Britto et al. 2011[7]	Brazil	CVA with chronicity	Evaluate the effectiveness of IMT in measures of strength, endurance, functional performance and QoL	Time: 30 min / 5 days a week / 8 weeks	Threshold IMT®	↑ MIP and MEP post-training.
Ferreira et al. 2011[19]	Brazil	Essential hypertension	Effects of IMT on BP and autonomic cardiovascular control	Repetition: 15 to 20 breaths / 7 days a week / 8 weeks	Threshold IMT®	↑ inspiratory muscle strength FMI; ↓ 24 hours of SBP and DBP; ↑ parasympathetic modulation, ↓ Sympathetic modulation and cardiac sympathetic outflow.
López-de-Uralde-Villanueva et al. 2011[22]	Spain	Stable phase asthma (18 to 60 years)	To assess whether the addition of manual therapy and therapeutic exercise protocol to IMT was more effective in improving MIP than IMT alone	Repetition: 5x 5 breaths / 2x week	PowerBreathe	Combined intervention demonstrated improvements in the IMT group in MIP and anterior head posture.
Bargi et al. 2015[26]	Türkiye	Allo-HSCT transplant candidates	Effects of IMT during allo-HSCT	Repetition: 10–15 breaths / 30 min / 7 days a week / 6 weeks	PowerBreathe	↑ RMS, EC, ↓ depression and dyspnea in allo-HSCT recipients.
Kulnik et al. 2015[20]	UK	Hemorrhagic or acute ischemic CVA	To investigate whether IMT improves RMS, cough, and reduces the risk of pneumonia in acute CVA	Repetition: 5x 10 breaths / Daily / 4 weeks	Threshold® IMT Philips Respironics	Improves MIP, MEP, PEF and voluntary cough. There were no differences in the 90-day incidence of pneumonia.
Karadallı et al. 2016[9]	Türkiye	Sarcoidosis	Effects of IMT on EC, RMS and peripheral, lung function and diffusion capacity, fatigue, dyspnea, depression and QoL	Time: 30 min day / 7 days a week / 6 weeks	PowerBreathe	Improves maximum functional exercise capacity and RMS, ↓ severe fatigue and perceived dyspnea.
Nicolodi et al. 2016[11]	Brazil	Cardiac insufficiency	Evaluate the acute effects of FES and IMT on autonomic control, endothelial function and levels of inflammatory cytokines	**Time:** 15 min	Threshold IMT®	↑ RR, ↑ IL-10 levels, and ↓ levels of TNF-α.

Zeren et al. 2016[13]	Türkiye	Atrial fibrillation	Investigate the effects of IMT on lung function, RMS and FC.	**Time:** 15 min / 2x a day / 7 days a week / 12 weeks	Threshold IMT®	↑ MIP, MEP, FC, VEF_1, FEF 25% -75%, PEF e 6MWT.
Archiza et al 2017[17]	Brazil	Women's soccer athletes	Effects of IMT on oxygenation of respiratory and peripheral muscles	Repetition: 30 breaths / 2x a day / 5 days a week / 6 weeks	PowerBreathe	↓ metaboreflex of the inspiratory musculature, improves the supply of O_2 and Hb for lower limbs/high intensity exercises, ↑ FMI, exercise tolerance and sprint performance.
Kawauchi et al. 2017[10]	Brazil	Chronic heart failure	Effects of low and moderate intensities on muscle strength, FC and QoL	Time: 30 min/1x a day/8 weeks	Threshold® IMT Philips Respironics	Improves QoL; FMI; Peripheral FM and distance walked at low intensity.
Souza et al. 2017[24]	Brazil	Obstructive sleep apnea (OSA)	Evaluate the effectiveness of IMT on sleep and functional capacity for exercise	Repetition: 3x 90 breaths / 30 min / 2x day / 7 days a week / 12 weeks.	PowerBreathe	Improves sleep quality.
Charususin et al. 2018[18]	Bélgica	COPD with FMI	To investigate whether IMT improves the benefits of pulmonary rehabilitation	Repetition: 30 breaths / 5 days a week / 12 weeks	PowerBreathe	↑FMI, further improvement in endurance time, ↓ Borg's dyspnea.
Duruturk et al. 2018[21]	Türkiye	Asthmatics	Investigate the effects of IMT on RMS, EC, dyspnea, fatigue, QoL and ADLs	Repetition: 30 breaths / 2x a day / 6 weeks	PowerBreathe	Improved FMI, EC, ADLs, QoL, ↓ of dyspnea and fatigue sensation.
Medeiros et al. 2018[23]	Brazil	Individuals with chronic kidney disease undergoing hemodialysis	Effects of daily IMT on RMS, regional chest wall volumes, diaphragm mobility and thickness, lung function, FC and QoL	Repetition: 3x 30 breaths / 2x a day	PowerBreathe	↑ at MIP ↑ MEP, ↑ inspiratory capacity, ↑ PEF.
Pehlivan et al. 2018[12]	Türkiye	Lung transplant/severe lung disease	To investigate whether IMT improves EC, perception of dyspnea and respiratory functions	Time: 15 min / 2x a day / 5 days a week / 3 months	PowerBreathe	↑ distance traveled, MIP, and alveolar volume ratio of carbon monoxide diffusing capacity.
Taskin et al. 2018[25]	Türkiye	Lung resection	Effects of preoperative IMT on PO complications	Repetition: 3x 10 breaths / 2x day / 5 days a week	Threshold IMT®	↑ RMS, improves EC and ↓ hospitalization.

Caption: FMI: inspiratory muscle strength; O2: oxygen; Hb: hemoglobin; FC: functional capacity; EC: Exercise Capacity; MIP: maximal inspiratory pressure; MEP: maximal expiratory pressure; PEF: peak expiratory flow; IMT: inspiratory muscle training; FES: functional electrical stimulation; MMII: lower members; allo-HSCT: Allogeneic hematopoietic stem cell transplantation; QoL: Quality of life; CVA: cerebrovascular accident; BP: blood pressure; PO: Postoperative; ADL: activity of daily living; IL-10: inflammatory cytokines Interleukin-10; TNF-α: alpha tumor necrosis factor.; RR: distance between two successive R waves.

Furthermore, in Chart 3, it is possible to contemplate the loads and the ways of performing the inspiratory exercise used in the studies, as well as the score attributed to the study according to the PEDro scale.

Chart 3. Forms of prescriptions and intensity of breathing exercise used in the studies

Study	Intensity (% MIP)	Time / Repetitions	Frequency (days/week)	Duration (weeks)
Dronkers et al. (2008)[8]	20%	15 min	6 / week	2
Britto et al. (2011)[7]	30% adjusted fortnightly	30 min	5 / week	8
Ferreira et al. (2011)[19]	30%	15-20 repetitions	7 / week	8
López-de-Uralde-Villanueva et al. (2011)[22]	Progressively 30% to 60%	25 repetitions	2 / week	6
Kulnik et al. (2014)[20]	50%	50 repetitions	7 / week	4
Bargi et al. (2015)[26]	40%	10-15 repetitions	7 / week	6
Karadallı et al. (2016)[9]	40%	30 min	7 / week	6
Nicolodi et al. (2016)[11]	30%	15 min	1 / week	3
Zeren et al. (2016)[13]	30%	15 min	7 / week	12
Archiza et al. (2017)[17]	50%	30 repetitions	5 / week	6
Kawauchi et al. (2017)[10]	Progression 15% or 30% / every 15 days	30 min	7 / week	8
Souza et al. (2017)[24]	50-60%	90 repetitions	7 / week	12
Charususin et al. (2018)[18]	50%	30 repetitions	5 / week	12
Duruturk et al. (2018)[21]	50%	30 repetitions	5 / week	6
Medeiros et al. (2018)[23]	50%	90 repetitions	5 / week	8
Pehlivan et al. (2018)[12]	30 to 60%	15 min	2 / week	12
Taskin et al. (2018)[25]	15% (beginning) up to 45%	30 repetitions	*	3

Caption: MIP: maximal inspiratory pressure; T: time; R: repetitions; *: In all, there were six sessions, the authors did not specify how many per week.

DISCUSSION

In the analyzed studies, it was possible to identify the relevant details about the prescription regarding the mode of prescription, established load (%) and exercise execution protocol; above all, there was the description of the training session with prescription by time or repetition.

The results were described in the long term, that is, the exercises were performed for a minimum of 2 weeks and a maximum of 12 weeks, which were performed once or twice a day, between 3 or 5 consecutive days a week.

All studies clearly outlined procedures for inspiratory muscle testing, as well as appropriate referral sources. There were also classic evaluative criteria and valid measurement standards for: lung function, dyspnea and fatigue, QoL, tolerance and functional capacity (FC); maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP); respiratory muscle strength (RMS); activity of daily living (ADL); peak expiratory flow (PEF), systolic and diastolic blood pressure (SBP and DBP)and autonomic control[7,13,18,19,21-24].

Four studies measured dyspnea on functional activities during IMT, resulting in clinical improvement[9,21,26-28].

Some studies used the Modified Medical Research Council dyspnea scale (MRC)[9,29-32], one study used the Borg scale[18]. In these studies, it was possible to observe a decrease in the sensation of dyspnea and fatigue.

Two studies that evaluated QoL proved both statistically and clinically significant improvement. The first used the Saint George's Respiratory Questionnaire (SGRQ) in 20 asthmatic patients. Patients who underwent IMT showed improvement in performance in ADL and health-related QoL (symptom score). Emphatically, the authors reported that this study was the first showing the positive effects of IMT[21]. A second study evaluated the QoL in 13 patients with heart failure (HF). The assessment instrument was the Minnesota Living with Heart Failure Questionnaire (MLHFq), which identified significant improvement after 8 weeks of IMT[10].

Some authors analyzed the effectiveness of IMT on respiratory muscle strength. Subjects with different clinical conditions were part of these studies, such as: candidates for hematopoietic stem cell transplantation, hypertensive patients, with sarcoidosis, with chronic HF, candidates for pulmonary resection, with COPD, with inspiratory muscle weakness and asthma, respectively. There was a unison result for an increase in respiratory muscle strength in the group that used the inspiratory exercisers[9,10,18,19,21,23,26]. Five studies analyzed exercise tolerance and functional capacity[9,17,21,25,26,27], as expected, there was an increase in these physical performance variables after performing the IMT.

Of the randomized studies, 14 found beneficial repercussions on MIP and MEP; among these, 8 evaluated resistance and/or inspiratory and expiratory muscle strength. Archiza et al.[17] evaluated the oxygenation of the respiratory and peripheral muscles during a maximum exercise tolerance test and in the performance of repetitive effort, with a sample of ten professional female soccer players. The results indicated that the IMT attenuated the metaboreflex of the inspiratory muscles and, consequently, improved the blood and oxygen supply to the lower limbs during high-intensity exercises, with a potential impact on the inspiratory muscle strength.

One study evaluated autonomic cardiovascular control, with the intention of elucidating the effects of IMT. Thirteen patients diagnosed with essential hypertension participated in the study, which lasted 8 weeks. It was possible to observe an increase in the high-frequency component (HF) and a reduction in the low-frequency component (LF), which shows favorable changes in the sympathetic discharge in the post-training group. In addition, IMT altered the RR interval (distance between two successive R waves) and parasympathetic modulation[19].

Furthermore, a study was carried out in patients with HF with the aim of evaluating the acute effect of functional electrical stimulation (FES) and IMT on the autonomic nervous system, endothelial function, cytokine and lactate levels.

The protocol consisted of three types of intervention: FES, IMT, and FES combined with IMT. The results obtained were that, after a session of EEP, IMT or the association of FES + IMT, there were alterations in the autonomic cardiovascular control and in the levels of inflammatory cytokines, without alterations in the endothelial function or in the levels of lactate. Specifically, after IMT, there was a reduction in HR from 68.5 bpm to 64.5 bpm and an increase in heart rate variability (HRV)[11].

A single study carried out by Ferreira et al.[19] aimed to evaluate the effects of IMT in an 8-week program, on systemic blood pressure in individuals with arterial hypertension, resulting in a decrease in SBP (-7.9 mmHg) and diastolic (-5.5 mmHg) after IMT.

Of the analyzed studies, there was a greater predilection for a load of 50% of the MIP. For this exercise intensity, it was possible to observe an increase in inspiratory and expiratory muscle strength, PEF, greater exercise tolerance, reduction in dyspnea, improvement in ADL and QoL[18,20,21,23].

Other studies used a load of 40% of MIP, which resulted in increased RMS and exercise capacity, decreased dyspnea and fatigue[9,30]. The 30% load, on the other hand, generated results such as increased inspiratory and expiratory muscle strength, lung volumes and capacities and the distance covered in the six-minute walk test (6MWT), decreased SBP and BPD[11,13,19].

Of all the studies analyzed, only the one by Dronkers et al.8 employed the intensity at 20% of MIP, causing a decrease in the incidence of atelectasis in the postoperative period of elective surgery for abdominal aortic aneurysm.

Some authors used the load progressively, increasing it as the subject evolved and/or the weeks passed[7,0,12,22,24-28]. Loads ranged from 15% to 60%, resulting in an increase in RMS, distance covered, improvement in QoL, sleep and exercise capacity, reduction in postoperative hospital stay after pulmonary resection.

Regarding the form of execution of the exercise, by time or repetition, several studies have prescribed the IMT by number of repetitions[17-26,29-37]. Changes were recorded in the post-intervention period, such as: increase in muscle strength and performance, decrease in fatigue, dyspnea and respiratory work, improvement in QoL, decrease in SBP and DBP, increase in autonomic modulation, improvement in head posture, improvement in sleep quality and decrease in postoperative hospital stay.

Not unlike the others, two studies had the purpose of evaluating the repercussions of PEF after IMT. These evaluated the cough peak flow by means of a pneumotachograph, voluntary and involuntary cough before and after a period of 4 weeks of IMT, in subjects after acute ischemic or hemorrhagic stroke, showing improvement in the voluntary cough peak flow[34]. Zeren et al.[13] evaluated the effect of IMT in subjects with atrial fibrillation after 12 weeks of treatment. The PEF value had an increase of 19.82% after the intervention period.

On the other hand, other studies carried out the pro-exercise exercise, through which it was possible to obtain the following findings: increase in MIP and MEP, decrease in the incidence of atelectasis, dyspnea and fatigue, improvement in FC and QoL performance, changes in markers inflammation and improved lung ventilation[7-13].

During the analysis of studies in the literature, it was also possible to find the prescription of IMT in situations other than non-pathological, which investigated whether the addition of IMT to the soccer training program would increase exercise tolerance and sport-specific performance in players recreational football. The twice-daily intervention protocol was adopted with 30 individual breaths per session, that is, breathing exercise performed by repetition, resulting in a significant improvement in exercise tolerance, detected by the cumulative distance in a running test and also in the improvement of MIP[37], which corroborates the studies already mentioned[21,25].

A single study specifically aimed to determine whether 6 weeks of IMT could lower blood pressure in normotensive adults and to identify the specific respiratory stimulus for this outcome. The execution protocol used was 30 daily breaths, 5 days a week[38]. To identify the stimulus that caused the cardiovascular repercussion, the authors created five training groups that differed from each other regarding the magnitude and direction of lung volumes and/or intrathoracic pressures generated by the individual during training; thus, it was found that, in all groups, there was an increase in MIP of 31.3%, and of 36.2% in MEP. All groups used a load of 75% of the MIP, except for group 5, which used 15%. The IMT alone caused a reduction in SBP (9.68 mmHg), BPD (6.13 mmHg) and mean arterial pressure – MAP (7.32 mmHg), the IMT performed with large positive intrathoracic pressures and large lung volumes also promoted a reduction: SBP (10.80 mmHg), DBP (4.33 mmHg) and MAP (6.49 mmHg). In the IMT with negative intrathoracic pressures and minimal generation of lung volume, the reduction in pressures were as follows: SBP (6.40 mmHg), DBP (5.28 mmHg) and MAP (5.65 mmHg). It was possible to verify that the declines in pressures already started in the second week of the IMT, and that large lung volume excursions associated with training cannot explain the decline in blood pressure, but large negative or negative intrathoracic pressures are sufficient to explain these results[38].

Continuing, a study conducted by Edwards et al.[1] evaluated the effect of the IMT program in overweight and obese individuals in relation to the distance covered. The protocol consisted of 2 sets of 30 breaths, daily for 4 weeks, with a load of 55% of MIP. There was an average increase of 62.5 m in the distance covered in the 6MWT (functional capacity) and the MIP value increased by 19.4 cmH2O.

In view of the above, it is evident that the inspiratory exercise with linear load, in its variety of device models available, regardless of the form of prescription, be it by execution time or number of repetitions, or load used, results in beneficial effects on the more diverse health conditions with repercussions on QoL, physical-functional performance, respiratory muscle strength and reduction in the sensation of dyspnea. There is a predominance of performing the breathing exercise by repetition with repercussions similar to the exercise performed by time; however, the standardization of the execution of the inspiratory exerciser must be debated. Furthermore, specific investigations for this purpose are needed

REFERENCES

1. Edwards AM, Maguire GP, Graham D, Boland V, Richardson G. Four Weeks of Inspiratory Muscle Training Improves Self-Paced Walking Performance in Overweight and Obese Adults: A Randomised Controlled Trial. J Obes 2012; 2012:1-6.

2. Paiva DN, Assmann LB, Bordin DF, Gass R, Jost RT, Bernardo-Filho M, et al. Inspiratory muscle training with threshold or incentive spirometry: Which is the most effective? .Rev Port Pneumol 2015; 21(2)76-81.

3. Bissett B, Leditschke A, Green M, Marzano V, Collins S, Haren FV. Inspiratory muscle training for intensive care patients: A multidisciplinary practical guide for clinicians. Australian Critical Care 2018:1-7.

4. Santos LBN, Gardenghi G. Treinamento Muscular Inspiratório como intervenção para melhorar pressão inspiratória máxima e pressão expiratória máxima em pacientes com alterações respiratórias e cardíacas: Uma revisão de literatura. RESC 2016; 6(2)66-78.

5. Vendrusculo FM, Heinzmann-Filho JP, Piva TC, Marostica PJC, Donadio MVF. Inspiratory Muscle Strength and Endurance in Children and Adolescents with Cystic Fibrosis. Respir Care 2015; 61(2)184-191.

6. Adamopoulos S, Schmid JP, Dendale P, Poerschke D, Hansen D, Dritsas A, et al. Combined aerobic/inspiratory muscle training vs. aerobic training in patients with chronic heart failure. Eur J Heart Fail 2014; 16(5)574–582.

7. Britto RR, Rezende NR, Marinho KC, Torres JL, Parreira VF, Teixeira-Salmela LF. Inspiratory muscular training in chronic stroke survivors: a randomized controlled trial. Arch Phys Med Rehabil 2011; 92(2)184-190.

8. Dronkers J, Veldman A, Hoberg E, van der Waal C, van Meeteren N. Prevention of pulmonary complications after upper abdominal surgery by preoperative intensive inspiratory muscle training: a randomized controlled pilot study. Clin Rehabil 2008; 22(2)134-142.

9. Karadalli MN, Bosnak-Guçlu M, Camcıoglu B, Kokturk N, Turktas H. Effects of Inspiratory Muscle Training in Subjects With Sarcoidosis: A Randomized Controlled Clinical Trial. Respiratory Care 2015; 61(4) 483-494.

10. Kawauchi TS, Umeda IIK, Braga LM, Mansur AP, Rossi-Neto JM, Sousa GMR, et al. Is there any benefit using low-intensity inspiratory and peripheral muscle training in heart failure? A randomized clinical trial. Clin Res Cardiol 2017; 106 (9)676-685.

11. Nicolodi GV, Sbruzzi G, Macagnan FE, Dipp T, Macedo ACP, Casali KR, et al. Acute Effects of Functional Electrical Stimulation and Inspiratory Muscle Training in Patients With Heart Failure: A Randomized Crossover Clinical Trial. Int J Cardiovasc Sci 2016; 29 (3)158-167.

12. Pehlivan E, Mutluay F, Balcı A, Kılıç L. The effects of inspiratory muscle training on exercise capacity, dyspnea and respiratory functions in lung transplantation candidates: a randomized controlled trial. Clin Rehabil 2018; 32(10)1-12.

13. Zeren M, Demir R, Yigit Z, Gurses HN. Effects of inspiratory muscle training on pulmonary function, respiratory muscle strength and functional capacity in patients with atrial fibrillation: a randomized controlled trial. Clin Rehabil 2016; 30(12)1-10.

14. Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. Aust J Physiother 2009; 55(2)129-133.

15. Grams ST, Ono LM, Noronha MA, Schivinski CIS, Paulin E. Breathing exercises in upper abdominal surgery: a systematic review and meta-analysis. Rev Bras Fisioter 2012; 16(5)345-53.

16. Shiwa SR, Costa LOP, Moser ADL, Aguiar IC, Oliveira LVF. PEDro: a base de dados de evidências em fisioterapia. Fisioter Mov 2011; 24(3)523-533.

17. Archiza B, Andaku DK, Caruso FCR, Bonjorno Junior JC, Oliveira CR, Ricci PA, et al. Effects of inspiratory muscle training in professional women football players: a randomized sham-controlled trial. Eur J Sport Sci 2017; 36(7)771-780.

18. Charususin N, Gosselink R, Decramer M, Demeyer H, McConnell A, Saey D, et al. Randomised controlled trial of adjunctive inspiratory muscle training for patients with COPD. Thorax 2018; 73(10)942-950.

19. Ferreira JB, Plentz RDM, Stein C, Casali KR, Arena R, Lago PD. Inspiratory muscle training reduces blood pressure and sympathetic activity in hypertensive patients: A randomized controlled trial. Int J Cardiol 2013; 166(1)61-67.

20. Kulnik ST, Birring SS, Moxham J, Rafferty GF, Kalra L. Does Respiratory Muscle Training Improve Cough Flow in Acute Stroke? Pilot Randomized Controlled Trial. Stroke 2015; 46(2)447-453.

21. Duruturk N, Acar M, Doğrul MI. Effect of Inspiratory Muscle Training in the Management of Patients With Asthma. J Cardiopulm Rehabil Prev 2018. 38:198-203.

22. López-de-Uralde-Villanueva I, Candelas-Fernández P, de-Diego-Cano B, Mínguez-Calzada O, del Corral T. The effectiveness of combining inspiratory muscle training with manual therapy and a therapeutic exercise program on maximum inspiratory pressure in adults with asthma: a randomized clinical trial. Clin Rehabil 2018; 32(6)752-765.

23. Medeiros AIC, Brandão DC, Souza RJP, Fuzari HKB, Barros CESR, Barbosa JBN. Effects of daily inspiratory muscle training on respiratory muscle strength and chest wall regional volumes in haemodialysis patients: a randomised clinical trial. Disabil Rehabil 2018:1-8.

24. Souza AKF, Andrade AD, Medeiros AIC, Aguiar MRI, Rocha TDS, Pedrosa RP, et al. Effectiveness of inspiratory muscle training on sleep and functional capacity to exercise in obstructive sleep apnea: a randomized controlled trial. Sleep Breath 2017; 22(3)p.631-639.

25. Taşkin H, Atalay OT, Yuncu G, Taşpinar B, Yalman A, Şenol H. Postoperative respiratory muscle training in addition to chest physiotherapy after pulmonary resection: A randomized controlled study. Physiother Theory Pract 2018:1-8.

26. BARğđ, G, Güçlü MB, Arıbaş Z, Akı SZ, Sucak GT. Inspiratory muscle training in allogeneic hematopoietic stem cell transplantation recipients: a randomized controlled trial. Supportive Care In Cancer 2015; 24(2)647-659.

27. Petrovic M, Lahrmann H, Pohl W, Wanke T. Idiopathic diaphragmatic paralysis—Satisfactory improvement of inspiratory muscle function by inspiratory muscle training. Respir Physiol Neurobiol 2009; 165(2-3)266-267.

28. Tong TK, Fu FH, Chung PK, Eston R, Lu K, Quach B, et al. The effect of inspiratory muscle training on high-intensity, intermittent running performance to exhaustion. Appl Physiol Nutr Metab 2008; 33(4)671-68.

29. Silveira JM, Gastaldi AC, Boaventura CM, Souza HC. Inspiratory muscle training in quadriplegic patients. J Bras Pneumol 2010; 36(3)313-319.

30. Pellizzaro CO, Thomé FS, Veronese FV. Effect of Peripheral and Respiratory Muscle Training on the Functional Capacity of Hemodialysis Patients. Ren Fail 2013; 35(2)189–197.

31. Ahmad H, Justine M, Othman Z, Mohan, V, Mirza, F. The Outcomes of Short Term Inspiratory Muscle Training (IMT) Combined with Chest Physiotherapy in Hospitalized COPD Patients. Bangladesh J Med Sci 2013; 12(4)398-404.

32. van Adrichem EJ, Meulenbroek RL, Plukker JTM, Groen H, van Weert E. Comparison of Two Preoperative Inspiratory Muscle Training Programs to Prevent Pulmonary Complications in Patients Undergoing Esophagectomy: A Randomized Controlled Pilot Study. Ann Surg Oncol 2014; 21:2353-2360.

33. Charususin N, Gosselink R, McConnell A, Demeyer H, Topalovic M, Decramer M, et al. Inspiratory muscle training improves breathing pattern during exercise in COPD patients. Eur Respir J 2016;47(4)1261–1264.

34. Salazar-Martínez E, Gatterer H, Burtscher M, Orellana JN, Santalla A. Influence of Inspiratory Muscle Training on Ventilatory Efficiency and Cycling Performance in Normoxia and Hypoxia. Front Physiol 2017; 8:1-11.

35. Turky K, Afify AMA. Effect of Preoperative Inspiratory Muscle Training on Alveolar-Arterial Oxygen Gradients After Coronary Artery Bypass Surgery. J Cardiopulm Rehabil Prev 2017; 37(4)290-294.

36. blosakka-Jones C, Tongdee P, Pachirat O, Jones DA. Slow loaded breathing training improves blood pressure, lung capacity and arm exercise endurance for older people with treated and stable isolated systolic hypertension. Exp Gerontol 2018; 108:48-53.

37. Guy JH, Edwards AM, Deakin GB. Inspiratory Muscle Training Improves Exercise Tolerance in Recreational Soccer Players Without Concomitant Gain in Soccer-Specific Fitness. J Strength Cond Res 2014; 28(2)483-491.

38. Vranish JR, Bailey EF. Daily respiratory training with large intrathoracic pressures, but not large lung volumes, lowers blood pressure in normotensive adults. Respir Physiol Neurobiol 2015; 216:63-69.

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