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EFFECT OF AN INSPIRATORY MUSCLE STRENGTH TRAINING ON DYSPNOEA ARISING FROM UNSUPPORTED ARM ELEVATION IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Aim. Present study aimed to identify the effect of an inspiratory muscle strength training program versus sham inspiratory muscle strength training program on the dyspnoea arising from unsupported arm elevation in COPD patients. **Materials and Methods.** Forty four COPD patients (U-40 to U-50) and with severe COPD (FEV1 = 50–70 % of predicted) were recruited and assigned to an experimental (EXP) or control group (CON). The training program consisted of 5 sessions/wk, (6 × 3 minute bouts of loaded breathing with 2 minutes rest periods between bouts) during 10 wk. **Results.** The outcome measured included airway obstruction (FEV1, FVC, FEV1/FVC, and PEFR), inspiratory muscle strength (maximal inspiratory pressure (PI, max)), and exercise capacity (six minute walk distance test (6MWDT)). Our inspiratory muscle strength training program improves of all parameters of the EXP, but no significant improve is at the level of FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) after sham inspiratory muscle strength training program for CON. FEV1 before training for EXP was (54,81 ± 3,53) and after training improved into (70,87 ± 1,54) while for CON was (77,81 ± 6,00) before training and (77,93 ± 5,8) after training. **Conclusion.** Our study found that SIMT by using threshold loading device resulted in improve pulmonary function indices and then alleviate symptoms and improve UAE performance, in addition to develop dyspnoea. Therefore, S-SIMT didn't lead to develop breathing symptoms, pulmonary function, and accessory muscles strength then effected on arm elevation.

Keywords*: inspiratory muscle strength training, dyspnoea, unsupported arm elevation, chronic obstructive pulmonary disease.*

1. Introduction

Approximately 47,800 Iraqis (males and females) have some form of COPD [43]. COPD is characterised by narrowed airways and significant inspiratory muscle atrophy [23]. Patients breathe at high lung volumes to maintain patency of their narrowed airways and are forced to generate greater pressures to overcome elastic recoil of the hyper inflated respiratory system [5]. In such breathing patterns, the diaphragm operates at a disadvantageous part of its length-tension curve [8, 29] and the pressure generating capacity of the flattened diaphragm is severely compromised [15]. From a theoretical perspective it is clear that any further hindrance to inspiration is likely to result in dyspnoea in COPD patients. In support of this, it has been shown that during exercise, diaphragm work is increased in COPD [21] and COPD patients use a larger proportion of their maximal inspiratory pressure (PI, max) than healthy subjects at a given sub-maximal workload [1, 48].

This pattern of breathing is closely related to the dyspnoea sensation during exercise and may induce inspiratory muscle fatigue [4, 11]. This largely explains the reduced exercise capacity observed in COPD patients [31, 51]. Given the considerable work performed by the diaphragm at rest and particularly during exercise, the accessory inspiratory muscles are believed to play an important role in breathing in COPD patients. Previous studies have reported that unsupported arm elevation (UAE) can produce severe dyspnoea in COPD patients [50, 53]. Considering UAE is integral to many normal daily functions, for example hanging out the washing, shaving, brushing teeth and combing hair, dyspnoea arising from these activities can significantly impair quality of life in COPD patients.

Inspiratory muscle strength training (SIMT)

methods are used to improve inspiratory muscle atrophy and reduce dyspnoea in COPD patients [18]. SIMT protocols typically involve a high load with little repetitions (5–6 days a week, 15–30 minute at day, 4–12 weeks and training loads are 50–80 % of PI, max) [66, 17]. To examine the efficacy of SIMT, it is recommended that controls participate in sham-inspiratory strength training (S-SIMT) as it is suggested to provide the least biased estimates of treatment effects (Puhan and Schu¨nemann, 2009). S-SIMT protocols are the same as SIMT except the load is maintained at 10 % of PI, max [26, 58].

A recent systematic review [25] has shown few changes in quality of life, six minute walk, functional exercise capacity and MIP in the group who received IMT compared with the sham group which did not have a significant effect. Some other studies showed a 6 minute walk was improved after limb muscle strength training in COPD patients [47] 6 Minute Walk also is considered a good predictor for dyspnoea after training by another studies [42, 63]. In contrast, no study into the effects of SIMT with UAE on FVC, FEV1, FEV1/ FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) has been conducted in COPD patients. In addition, no study has compared effects between SIMT and sham-SIMT with UAE on previous parameters in COPD patients. Just studies which were used IMT to improve SIMT, endurance IMT, dyspnoea and some other symptoms such (VO_2 max, VE max and functional capacity). However, these results have not been enough to improve quality of life for patients with COPD and improve the impaired accessory inspiratory muscles which are responsible increasing dyspnoea in COPD patients [13]. It is also worth noting the time consuming nature of endurance training sessions which contrasts with the brief bouts of maximal contractions that can confer optimal gains in muscle strength [54, 67].

The most appropriate SIMT protocol to reduce dyspnoea during UAE, and improve exercise capacity remains unclear. Indeed, the most recent ACCP/AACVPR Pulmonary Rehabilitation Guidelines conclude that "*the scientific evidence does not support the routine use of IMT as an essential component of pulmonary rehabilitation*" and calls for a large-scale, multicentre randomised controlled trial (RCT) be performed with appropriate statistical power to more completely examine the role of IMT in treating patients with COPD [28, 30, 33]. However, the main aim of our study is to know the effects of SIMT vs S-SIMT on the dyspnoea arising from UAE in COPD patients.

2. Materials and Methods

2.1. Participants

The number of participants required for this study was calculated to be 44, based on the prevalence of moderate to severe COPD in Babylon, Iraq (n = 2400) [63], an effect size of 10 % ± SD 5 % and the power of the sample size calculation (0,80, C.I. = 20 % and P < 0,05). The effect size was estimated from previous studies that have reported a mean effect size of 0,73 for changes in PI, max, 0,20 for changes in six minute walk, 0,46 for changes in visual analog scale (VAS) [25, 37, 46]. Table 1 showed physical and pulmonary function characteristics in COPD subjects.

Participants recruited on the basis of age, sex, COPD severity, existing co-morbidities and treatment/management practices. The prevalence of COPD differs marginally between males and females in Iraq; however it does increase with age. The severity of COPD is typically classified/diagnosed by the percentage reduction in predicted FEV1, with dyspnoea most prominent in severe COPD patients (FEV1 = 50–70 %) [34]. Therefore, we intend to recruit 44 patients between the ages 40–50 years old with severe COPD (FEV1 = 50–70 % of predicted). Previous studies investigating the benefits of inspiratory

Table 1

Physical and pulmonary function characteristics in COPD subjects

Characteristics	Mean	SD	Median	Skewness coefficient
Age, Yr	43,13	4,02	45,00	0,54
Height, Cm	164,00	7,41	166,00	0,47
Weight, Kg	75,03	5,23	77,00	0,51
Duration of Disease, Mh	18,02	3,16	19,00	0,32
FEV1 % Pred	52,11	4,53	54,00	0,41
Duration of Smoking, Yr	14,14	2,52	15,00	0,53
BMI, Kg	27,8	3,14	25,00	0,44

Table 2

The equal between both groups in physical and pulmonary function characteristics

Characteristics	Experiment		Control		T-test		Significant
	Mean	SD	Mean	SD	Calculated	Sig	
FVC % pred	77,86	9,04	77,92	9,05	0,43	0,37	No S
FEV1 % pred	52,82	3,43	52,94	3,82	1,02	0,43	No S
FEV1/FVC % pred	67,37	4,05	67,5	4,22	0,596	0,59	No S
PEFR % pred	38,25	7,63	38,31	6,92	0,318	0,61	No S
6MWDT Meter	305,9	26,81	306,4	26,41	1,32	0,18	No S
SpO2 before 6MWDT % pred	94,50	1,76	94,62	1,91	0,59	0,39	No S
SpO2 after 6MWDT % pred	93,62	2,27	93,81	2,20	1,24	0,47	No S
PI, max cm H_2O	47,00	3,08	47,06	4,07	0,52	0,45	No S
VAS Degree	6,71	1,61	6,46	1,68	1,03	0,60	No S

muscle training have used similar cohorts [6, 32, 35, 36, 64].

Table 1 shows that participants were homogeneous in our study characteristics because all skewness coefficient values are between (–1 to +1).

Researcher divided participants into two groups (experiment and control groups), each group involved (22) patients and to achieve the equal between groups we used independent samples T-test and the results are shown in table 2.

Table 2 shows that T-test values greater than (0,05) which mean no significant differences between both groups in physical and pulmonary function characteristics. However, both groups are equal.

2.2. Exclusion criteria

Patients dependent on supplemental oxygen therapy are excluded, as it has been shown that long-term oxygen therapy of hypoxemic COPD patients with chronic respiratory failure can improve exercise capacity, survival, sleep, dyspnoea, PI, max and quality of life [2, 49, 61, 62]. Additionally, patients diagnosed as asthmatic, suffering acute or chronic heart failure (hypoxemia, hypercapnia, right heart failure and left ventricular systolic dysfunction, etc), or suffering hayfever, chronic sinusitis and pneumoconiosis were not eligible for inclusion in this study. Only those who meet strict inclusion criteria invited to participate in the study. Twenty two, healthy, age and sex matched controls recruited to participate in baseline testing measures.

Patients with severe COPD recruited for the study from a Morjan hospital. The patients were all new to an SIMT program and patients unable to complete a program of SIMT did not recruit. Our institutional ethics board approved all protocols and all the patients gave their informed consent prior to participating in the study.

2.3. Outcome Measures

2.3.1. Airway Obstruction

FEV1, FVC, FEV1/FVC, and PEFR used to assess the severity of airway obstruction. A spirometer [10] used to measure FEV1, FVC, FEV1/FVC, and PEFR. The spirometer is a simple test and an essential tool in the diagnoses of airway obstruction. Variability of spirometric measurements is greater than in most other clinical laboratory tests because the result is highly dependent on the consistency of the efforts made by patients and technicians [14, 65]. In addition, American thoracic society recommends the use of FEV1, FVC, FEV1/FVC, and PEFR to diagnose the severity of airway obstruction to detect COPD in patients [3].

Testing Procedures:

– *Pre-test instructions:* Participants asked not to smoke or drink tea or coffee on the morning of the measurements.

– *Testing instructions:* FEV1, FVC, FEV1/FVC, and PEFR assessed under 1 condition: seated with unsupported arm elevation (UAE). Patients instructed to breathe in fully, seal their lips around the mouthpiece, force the air out of the chest as hard and fast as they can until their lungs are completely “empty” and breathe in again and relax. Exhalation must continue until no more air can be exhaled, must be at least 6 seconds, and can take up to 15 seconds or more [10]. Three trials conducted using a computerized spirometer and the best trial recorded.

2.3.2. Severity of Dyspnoea

A visual analogue scale (VAS) [16, 68, 5] used to quantify the severity and progression of dyspnoea. The VAS is a 100 mm scale with severity descriptors, such as “no change in breathlessness” and “great breathlessness” which correspond to markings along the scale [16]. The VAS is simple to administer and has been found to be

a valid measure of the intensity of breathlessness [5], reliable over short periods of time, sensitive to change, and correlates with minute ventilation and oxygen consumption during exercise in subjects with COPD [40, 41]. For example, a difference of one point on the VAS has clinical significance [60]. Furthermore, the VAS is a widely used tool for quantifying dyspnoea during exercise testing in patients with chronic obstructive pulmonary disease (COPD) [45].

Testing Procedure:

– *Pre-test instructions:* Participants asked not to smoke or drink tea or coffee on the morning of the measurements.

– *Testing instructions:* Dyspnoea assessed under 1 condition: seated with unsupported arm elevation (UAE). Subjects asked to breathe at a rate and depth that would be most comfortable to them and such that they can maintain the breathing pattern for at least 10–15 min. the participant sit on the chair with their arms flexed to 90° without any additional support (UAE) for a period of 3 minutes. Every minute, the subject will be asked to rate breathlessness on the VAS by pointing to the value corresponding to their most relevant descriptor of breathlessness [46].

2.3.3. Inspiratory Muscle Strength

Maximal inspiratory pressure (PI, max) assessed as a measure of inspiratory muscle strength. It is validity and reliability to measure PI, max [13]. A (Model MP-45, Validyne Corp, Northridge, California, USA) pressure transducer used to measure airway pressures which connects into PowerLab (ML848/ 426-0341, AD Instruments, Australia). A tube type mouthpiece connected to a pressure transducer by 60 cm of pressure tubing. And an air leak provided at mouthpiece with a small hole (diameter = 1,6 mm) to minimize the contribution of ducal muscles during the maneuver. Using a pressure transducer to measure relaxed airway pressure (mouth pressure) is the most valid and reliable way [6].

Testing Procedure:

– *Pre-test instructions:* Participants asked not to smoke or drink tea or coffee on the morning of the measurements.

– *Testing instructions:* Maximal inspiratory pressure assessed under 1 condition: Subjects seated with their arms flexed to 90º without any additional support (UAE) asked to perform 2 sets of five PI, max maneuvers with 1 minute rest between maneuvers and 5 minutes rest between sets. The inspiratory pressure measured at the mouth from residual volume to total lung capacity. The PI, max defined as the trial with the largest negative and positive pressure respectively, sustained for 1 second against an occluded airway [13]. The procedure then repeated.

2.3.4. Exercise Capacity

The six minute walk distance test (6MWDT) used to assess exercise capacity. The 6MWDT is a reliable and safe tool to assess the functional status of patients suffering from pulmonary diseases [20] and has previously been used to as an outcome measure to determine the effectiveness of treatment for patients with COPD [20]. It is also commonly used to evaluate breathlessness during walking [12]. The 6MWDT performed in accordance with the standard protocol provided by Guyatt and his colleagues (1985). The distance the patient was able to walk in 6 min determined in a measured corridor as described for the 6-min walk test by [27].

Testing Procedure:

– *Pre-test instructions:* Participants asked not to smoke or drink tea or coffee on the morning of the measurements.

– *Testing instructions:* Participants commenced a 6MWD test. Participants instructed to walk at their fastest pace and cover the longest possible distance in 6 minutes. The test performed just once. At the beginning of the test and immediately after the sixth minute, SpO_2 was assessed by use Pulse Oximeter device.

Inspiratory Muscle Strength

Training Procedures

Participants with COPD randomized into two SIMT groups. Participants attended a 1 hour familiarization session where the specific training protocol instructed and the necessary training equipment and exercise adherence diary distributed. Two groups completed a 30 minute training protocol using the same inspiratory muscle strength training device (occluded airway device that allows variable loading), five days per week for 10 consecutive weeks. Training completed by myself in the lap of Morjan hospital. The specific training protocol slightly differ for each group as follows.

Group 1 – SIMT with UAE: The participant remains seated with arms rose to 90 degrees flexion (UAE) and completes 6 x 3 minute bouts of loaded breathing with 2 minute rest periods between bouts. The patients breathed against a load equivalent to 50–70 % of their baseline PI, max. The starting load was 50 % in week 1, 2, 3 and 4. Then, the load increased up to 55 % in week 5, 6, 7 and 8. In last 2 weeks, the load increased up to 60 %.

Group 2 – S-SIMT with UAE: The participant remains seated with arms rose to 90 degrees flexion (UAE) and completes 6 x 3 minute bouts of low-unloaded breathing with 2 minute rest periods between bouts. Patients breathed against a load equivalent to 10 % of their baseline PI, max throughout the 10 week period.

2.4. Data Analysis

We choose FVC, FEV1, FEV1/ FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) at baseline tests post training. We compared between improvements in FVC, FEV1, FEV1/ FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) that can be achieved and sustained during 10 weeks program of SIMT with UAE vs sham-SIMT. On theoretical grounds, it seems plausible that inspiratory muscle strength training should improve PI, max and alleviate the dyspnoea during UAE in COPD patients, regardless of whether such dyspnoea is due to impaired mechanical action of the accessory inspiratory muscles, stiffening of the ribcage or weight bearing load on the ribcage.

3. Results and Discussion

3.1. Results

Through the functional and physical measurements of participants (Table 2), no statistical differences were noted between the 2 groups for the above variables: FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) ($P > 0,05$). The T-test allowed us to conclude that the two groups SIMT and S-SIMT have similar dyspnoea.

The differences in the FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) values of the experiment and control groups of our population before versus after training program are summarized in Table 3 and 4. In experiment group, the FVC increase is significant; it is of the order of 77,86 ± 9,04 and 85,18 ± 3,31 (% Pred), respectively ($P < 0,05$), while it is only 77,81 ± ± 6,00 and 77,93 ± 5,8 (% Pred) in control group ($P > 0,05$).

Similarly, the FEV1, FEV1/FVC, PEFR, SpO_2 before 6MWDT and SpO_2 after 6MWDT, PI, max, and dyspnoea VAS increase is more

Table 3

FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) before versus after training program of experiment group

Parameters	Before		After		T-test		Significant
	Mean	SD	Mean	SD	Calculated	Sig	
FVC % pred	79,87	9,04	84,18	3,31	3,31	0,005	S
FEV1 % pred	54,81	3,53	70,87	1,54	16,07	0,000	S
FEV1/FVC % pred	69,37	5,05	86,37	2,62	14,9	0,000	S
PEFR % pred	38,25	7,63	87,75	3,27	20,6	0,000	S
6MWDT Meter	326,9	28,91	490,3	44,28	10,48	0.000	S
SpO_2 before 6MWDT % pred	94,5	1,75	96,87	0,71	5,32	0.000	S
SpO_2 after 6MWDT % pred	93,62	2,47	95,68	1,35	3,84	0,02	S
PI, max cm H_2O	47,00	4,08	48,25	4,38	2,26	0,04	S
VAS Degree	6,51	1,60	4,57	1,02	3,91	0,001	S

Table 4

FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) before versus after training program of control group

Parameters	Before		After		T-test		Significant
	Mean	SD	Mean	SD	Calculated	Sig	
FVC % pred	77,81	6,00	77,93	5,8	1,00	0,33	No S
FEV1 % pred	55,63	3,3	59,00	7,30	1,50	0,15	No S
FEV1/FVC % pred	69,19	5,90	73,5	6,14	12,02	0,16	No S
PEFR % pred	44,18	8,47	41,37	4,68	1,24	0,23	No S
6MWDT Meter	304,6	25,65	318,0	21,97	0,605	0,55	No S
SpO_2 before 6MWDT % pred	95,18	2,48	94,87	2,24	0,96	0,35	No S
SpO_2 after 6MWDT % pred	93,18	2,90	93,25	2,56	0,293	0,771	No S
PI, max cm H_2O	44,75	4,53	44,18	4,27	1,37	0,18	No S
VAS Degree	7,75	1,34	7,50	1,09	1,29	0,21	No S

pronounced in the experimental group compared to that of control group. In the experimental group it is, respectively, before training 54,81 ± ± 3,53, 69,37 ± 5,05, 38,25 ± 7,63; 326,9 ± 28,91, 94,5 ± 1,75; 93,62 ± 2,47 (% Pred); 47,00 ± 4,08 (cm H_2O), and 6,51 ± 1.60 (Degree) ($P < 0.05$), and after training 70,87 ± 1,54, 86,37 ± 2,62, 87,75 ± 3,27, 490,3 ± 44,28, 96,87 ± 0,71, 95,68 ± ± 1,35 (% Pred); 48,25 ± 4,38 (cm H_2O), and 4,57 ± 1,02 (Degree) ($P < 0.05$). In control group increase is before training only 77,81 ± 6,00, 55,63 ± 3,3, 69,19 ± 5,90, 44,18 ± 8,47, 304,6 ± ± 25,65, 95,18 ± 2,48, 93,18 ± 2,90 (% Pred); 44,75 ± 4,53 (cm H_2O), and 7,75 ± 1,34 (Degree) ($P < 0,05$), while after training is only 77,93 ± ± 5,8, 59,00 ± 7,30, 73,5 ± 6,14, 41,37 ± 4,68, 318,0 ± 21,97, 94,87 ± 2,24, 93,25 ± 2,56 (% Pred), 44,18 ± 4,27 (cm H_2O), 7,50 ± 1,09 (Degree) ($P < 0,05$). No significant increase is noticeable in control group compared to experiment group.

Before training, all our parameters were significantly similar in the two groups. FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS), Table 3 shows significant differences between before and after training ($P < 0,005$).

Our SIMT program improves of all parameters in the experimental group, but no significant improve is at the level of FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI, max, and dyspnoea (VAS) after S-SIMT.

3.2. Discussion

This study measured the effects of inspiratory muscle strength training (SIMT) vs sham inspiratory muscle strength training (S-SIMT) on the dyspnoea arising from unsupported arm elevation in COPD subjects. The findings of this study revealed that in the experimental group, the FVC, FEV1, FEV1/FVC, PEFR, 6MWDT, SpO_2 before and after 6MWDT, PI,max, and dyspnoea (VAS) significantly increased. In the control group, there was no significant difference between before and after training in all study parameters which mentioned above.

Very little researches into the effects of inspiratory muscle strength training have been conducted in COPD patients. When comparing the relative merits of strength versus inspiratory muscle endurance training. Our founding agreement with founding of [9] showed that inspiratory muscle strength training uses to improve muscle strength and maximal sustainable ventilation capacity or maximal voluntary ventilation. Mador et al. [39] found when added strength training to an endurance exercise program can produce significant improvements in muscle strength in patients with COPD but does not in quality of Life and maximal exercise capacity because the improvement in muscle strength was not large enough.

Recently studies have used threshold loading, maximal sustained voluntary ventilation and inspiratory resistive breathing techniques to improve the respiratory muscle endurance and strength training and then quality of life in patients with COPD [52]. The result studies were different, [52] using targeted inspiratory resistive and threshold training to improve respiratory muscles in COPD patients. In addition, [24] showed that training using threshold loading improves significantly inspiratory muscle endurance but not muscle strength. In contrast, Weiner and colleagues (1992) found that training for 6 months by using threshold loading improves inspiratory muscle endurance and strength. Our results confirm that SIMT by using threshold loading device during UAE lead to improve breathing muscles strength and pulmonary function as well as dyspnea.

To my personal knowledge, the different results for these studies to improve dyspnoea and quality of life by using inspiratory muscle endurance and strength training are due to small attention to training intensity, study design, outcome measures and statistical power that will help to provide better guidance regarding the role of inspiratory muscle training in pulmonary rehabilitation programs. However, it shows that no study used inspiratory muscle strength training by threshold pressure device during UAE to improve accessory inspiratory muscles, severity of dyspnoea and then quality of life in COPD patients. Our study compared between two kinds of training with UAE such as moderate intensity and low intensity, we found that moderate intensity results in improve accessory inspiratory muscles, severity of dyspnoea and then quality of life in COPD patients, but we couldn't find that with low intensity training.

Clinical studies have shown that inspiratory muscle training with moderate to high intensity is of benefit to COPD patients [19, 35, 44]. Such patients report a reduction in the dyspnoea and fatigue, increased exercise tolerance, and improved health status and quality of life, and display a reduction in the rate of hospital admissions [7, 36]. An improvement in exercise strength fol-

lowing a pulmonary rehabilitation program is usually accompanied by improved muscle condition, improved mechanical efficiency, and beneficial adaptations to the breathing pattern [22].

Several studies have investigated the role of inspiratory muscle training with support arm elevation in COPD patients that have aimed to improve inspiratory muscle endurance rather than inspiratory muscle strength with UAE. Such studies have typically reported only insignificant improvements in dyspnoea scores, exercise tolerance and quality of life. Smith et al. [59] found little evidence of clinically important benefits of IMT beyond an improvement in results of inspiratory muscle endurance tests. Although randomized controlled trials that evaluated the effect of inspiratory muscle training were considered, no distinction was made between trials of IMT vs conventional care and trials in which IMT was added to exercise therapy. In addition, Mador et al. [38] found that inspiratory muscle endurance training does not improve in quality of life or exercise performance. In contrast, Scherer et al. [57] found that inspiratory muscle endurance training improves dyspnoea, health-related quality of life, exercise performance and respiratory muscle in COPD patients.

4. Conclusion

In summary, our study found that SIMT by using threshold loading device resulted in improve pulmonary function indices and then alleviate symptoms and improve UAE performance, in addition to develop dyspnoea. Therefore, S-SIMT didn't lead to develop breathing symptoms, pulmonary function, and accessory muscles strength then effected on arm elevation.

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ВЛИЯНИЕ СИЛОВОЙ ТРЕНИРОВКИ ДЫХАТЕЛЬНЫХ МЫШЦ НА ОДЫШКУ, ВОЗНИКАЮЩУЮ ПРИ ПОДЪЕМЕ РУК БЕЗ ПОДДЕРЖКИ У ПАЦИЕНТОВ С ХРОНИЧЕСКОЙ ОБСТРУКТИВНОЙ БОЛЕЗНЬЮ ЛЕГКИХ

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Цель. Целью настоящего исследования было выявить влияние программы силовой тренировки дыхательных мышц (СТДМ) на одышку, возникающую при подъеме рук без поддержки у пациентов с хронической обструктивной болезнью легких (ХОБЛ), по сравнению с эффектом имитационной программы силовой тренировки дыхательных мышц

(И-СТДМ). **Материалы и методы исследования.** Участники исследования – 44 пациента с ХОБЛ в возрасте от 40 до 50 лет, в том числе пациенты с тяжелой стадией ХОБЛ (ОФВ1 – 50–70 % от должного) – были распределены на две группы: экспериментальную (ЭГ) и контрольную (КГ). Тренировочная программа включала 5 занятий в неделю (6 трехминутных кругов дыхательных упражнений с нагрузкой с двухминутными интервалами отдыха) на протяжении 10 недель. **Результаты исследования.** В ходе исследования измерялись показатели обструкции дыхательных путей (ОФВ1, ФЖЕЛ, индекс Тиффно и ПОС), сила дыхательных мышц (максимальное давление вдоха (PI, max)) и способность к физической нагрузке (проба с шестиминутной ходьбой (6мхп)). Установлено, что предложенная программа силовой тренировки дыхательных мышц в ЭГ способствовала значительному улучшению всех исследуемых параметров у испытуемых. При этом в КГ, где применялась имитационная программа силовой тренировки дыхательных мышц, не было зафиксировано статистически значимых улучшений таких показателей, как ФЖЕЛ, ОФВ1, индекс Тиффно, ПОС, насыщение кислородом до и после 6мхп, PI,max и одышка (оценивалась по визуально-аналоговой шкале). Показатель ОФВ1 в ЭГ перед началом тренировки составлял 54,81 ± 3,53, а после тренировки возрос до 70,87 ± 1,54. При этом соответствующий показатель в КГ составил 77,81 ± 6,00 до тренировки и 77,93 ± 5,8 после тренировки. **Заключение.** Установлено, что СТДМ с применением пороговой нагрузки улучшает показатели функции легких, купируя симптомы и облегчая подъем рук без поддержки, в том числе купируя одышку. Вместе с тем, применение И-СТДМ не имело положительного эффекта на респираторную симптоматику, функцию легких и силу вспомогательных мышц, не влияя, таким образом, на показатели подъема рук без поддержки.

***Ключевые слова**: силовая тренировка дыхательных мышц, одышка, поднятие рук без поддержки, хроническая обструктивная болезнь легких.*

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