Title: Comparison between two inspiratory muscle training protocols, low loads vs high loads, in institutionalized elderly women: A Double-Blind Randomised Controlled Trial.

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Running Head: Inspiratory muscle training in elderly women.

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ABSTRACT

Background: Aging results in a decline in the function of the respiratory muscles. Inspiratory muscle training is presented as a possible solution to attenuate the loss of respiratory function in elderly. The objective of the study was to evaluate and compare the efficacy of two protocols with inspiratory muscle training (IMT), low loads and high loads, to improve respiratory strength, functional capacity and dyspnea in institutionalized elderly women, over 65 years.

Methods: The study was a controlled, randomised, double-blind trial and with allocation concealment performed on 26 institutionalized elderly women distributed in 2 groups, High Intensity Group (HIG) and Low Intensity Group (LIG). Over an 8-week period an IMT protocol was followed 5 days/week, 15 minutes/day. HIG trained with a load of 40% of the maximum inspiratory pressure (MIP) and LIG with 20%. MIP, maximum expiratory pressure (MEP), functional capacity and dyspnea were evaluated.

Results: After training, in HIG MIP, MEP and functional capacity increased 52%, 16% and 7% respectively (p=.000, p=.001, p=.001) and in LIG 30%, 18% and 9% respectively (p=.002, p=.014, p=.001). The improvement in MIP was significantly higher in HIG than in LIG (p=.042).

Conclusion: Inspiratory muscle training with low and high loads improves respiratory muscle strength and functional capacity in institutionalized elderly women. In addition, high loads were significantly more effective to improve MIP.

INTRODUCTION

Population ageing is a global phenomenon: Virtually every country in the world is experiencing growth in the size and proportion of older persons in their population. There were 703 million persons aged 65 years or over in the world in 2019.The number of older persons is projected to double to 1.5 billion in 2050 [1].

Aging results in a decline in lung function as in other systems. The principal changes in the respiratory system of the elderly include loss of chest wall compliance, decrease in strength of elastic recoil of lung parenchyma, decrease in respiratory muscle strength and decreased responsiveness to hypoxemia and hypercapnia. [2, 3]

In this sense, inspiratory muscle training (IMT) appears to be a possible intervention that can minimize harmful effects on respiratory muscles in the elderly. [4]Peripheral muscle exercises promote an increase in respiratory muscle strength and endurance. However, these gains appear to be higher when combined with specific training of the respiratory muscles [5], making this an option to supplement the training of peripheral muscles and generating benefits in different current comorbidities such as hypertension, obesity and diabetes that affect a large portion of the elderly. [6, 7]

Aging impairs the autonomic balance reducing the vagal and increasing the sympathetic components of heart rate variability (HRV) and this could be associated with a decline in physical capacity. IMT is a possible tool to attenuate this physical capacity decline in older women. [8]

Based on this information, the aim of this study was to evaluate and compare the efficacy of two protocols with IMT, low loads and high loads, to improve respiratory strength, functional capacity and dyspnea in older women.

METHODS

Study design

The study was a controlled, randomised, double-blind trial and with allocation concealment. The study protocol was approved by the Bioethics Committee of the University of Salamanca (number of registry 365, 22 may 2019).

The study was registered in the clinical trials database of the United States National Library of Medicine (www.clinicaltrials.gov) with the number of registration NCT03827356.

The research was carried on by Nursing and Physiotherapy Department of University of Salamanca. All volunteers signed a free and informed consent form.

Participants

Institutionalized elderly women aged between 75 and 95 years were included, who had more than 60 points at Barthel Index for Activities of Daily Living [9], were capable of walking without aid from another person and understood the objectives, the evaluations and the intervention of the trial. Exclusion criteria were: some respiratory pathology in the previous 4 weeks, difficulty carrying out the evaluation procedures or the exercises, smokers, presence of hemodynamic instability (heart rate >150 beats per minute (bpm), systolic blood pressure >140 millimeters mercury (mmHg) or diastolic blood pressure >90 mmHg), pulmonary comorbidities, heart disease and neuromuscular or degenerative diseases.

The sample size was determined by sampling calculation done from data collected during a pilot study with 10 volunteers, which established a sample of 10 individuals for each group to detect a difference of 12 cmH_2O for MIP, considering a power of 80%, security 95%.

Procedure and Measures of Outcomes

Anthropometric, clinical and demographic data were collected. Participants were completely evaluated at the beginning and at the end of the intervention period.

The primary outcomes were respiratory muscle strength, functional capacity and dyspnea. Secondary outcomes were systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate and oxygen saturation (SpO2). All of them were evaluated pre- and post-treatment.

After the initial evaluation, the participants were randomly distributed in two groups using simple randomization with a computer-generated random numbers. The principal investigator and the participants did not know where they were allocated: High Intensity Group (HIG) or Low Intensity Group (LIG).

Respiratory muscle strength

Respiratory muscle strength was assessed by measuring maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) using a pressure transducer, Elka 15, from residual volume and total lung capacity, respectively. It obtained each measurement in millibar and converted it into the reference unit of centimeter of water (cm H2O) (1 mbar = 1.01973 cm H2O), following the rules of the American Thoracic Society/European Respiratory Society (ATS / ERS) [10]. The procedure was repeated at least 3 times or until 2 reproducible efforts (ie, within 5% each other). An interval of about 1 minute was allowed between the measurements to avoid short-term fatigue for respiratory muscles. The higher of 2 reproducible values was considered in the data analysis. MIP was assessed every 2 weeks to set the IMT workload in both groups.

Functional capacity

Six-minute walk test (6MWT) was used to evaluate functional capacity. This submaximal test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes [11]. We followed the statement of the American Thoracic Society (ATS), guidelines for the 6MWT [12].

In addition to measuring the total distance walked, it was evaluated the following parameters prewalk and postwalk to check the ability to the test of the elderly women. These evaluations were part of the 6MWT protocol:

- **Heart rate**
- **SpO2**
- **SBP, DBP**
- **Dyspnea and overall fatigue using the Borg scale [13]**

Dyspnea

Modified Medical Research Council (MMRC) was used to measure dyspnea [14]. It was evaluated before and after 8-week intervention period, in contrast to Borg scale which has also been used to evaluate dyspnea as a complement to 6MWT.

Experimental Protocol

Elderly women performed the intervention protocol over 8 weeks using Treshold IMT, with a frequency of 1 session per day, 5 days a week. The participants carried out 15 series of 1 minute with a 1-minute rest between them.

Treshold IMT provides consistent and specific pressure for inspiratory muscle strength and endurance training, regardless of how quickly or slowly patients breathe. This device incorporates a flow-independent one-way valve to ensure consistent resistance and features an adjustable specific pressure setting (in cm H2O) to be set by a healthcare professional. When patients inhale through Treshold IMT, a spring-loaded valve provides resistance.

The intensity of training was different in the groups: HIG was adjusted to 40% of MIP and LIG to 20% of MIP, measured during the initial evaluation. The load intensity adjustment was performed each 2 weeks by evaluating the MIP. During the entire period of the intervention protocol, the resistive load was in these percentages. The rest of parameters were the same in both groups.

The training protocol of both groups was carried out by a single therapist who supervised all the sessions with IMT, so the adherence to the program was very high and could report the presence of adverse effects (increased fatigue, breathing problems, dizziness or sickness).

Statistical Analysis

The results of the initial characteristics of the sample and statistical analysis of the data were expressed as mean and standard deviation (SD). The Saphiro-Wilk was used to evaluate the normality and homogeneity of the data. To compare initial values, final values and differences between them, parametric tests were used only where a normal distribution is assumed, we used the t-test for independent and paired samples to determine whether the differences in the means of the groups are large enough to allow the assumption that the corresponding population means are different; and the non-parametric Mann-Whitney U-test for independent samples and the Wilcoxon rank-sum test for paired data, both compare median rather than mean. HJ-Biplot was used to reduce the dimension and represent simultaneously the observations and variables in a small space where the interrelations between them are captured.

To compare the outcomes and the size of the effect t-test and Mann-Whitney test were used.

Biplot methods are techniques for reducing the dimension, specifically the HJ-Biplot allows to jointly represent the same interpretable graph observations and variables, as if it were a multivariate dispersion graph, where the interrelations between them are captured. In our case, patients are represented as points in the plane, so that their position is translated in terms of similarity, that is, two patients with a similar position in the plane have similar characteristics on the variables to study; and the variables used to assess the patient's lung capacity as vectors, where acute angles correspond to direct relationships, right angles reveal independence and obtuse angles refer to inverse relationships.

RESULTS

Between April and June 2019, 59 elderly women were interviewed in their institutionalization centers, 26 participants were selected for the intervention and randomly distributed in the HIG (n=14) or LIG (n=12) (Figure 1). Training adherence was 100%, all the training sessions were supervised by a professional. Following the interventions, there were no adverse events in participants.

Baseline characteristics of the sample are shown in Table 1. No differences were found between the groups at the beginning of the trial. There were no losses during the intervention period.

Pre and post-intervention primary outcomes comparisons between HIG and LIG are shown in Table 2. Initial values, final values and the difference between them were compared in the statistical analysis.

Respiratory muscle strength

Significant effects were observed on MIP and MEP between pre- and post- treatment, in HIG (p=.000, p=.002) and LIG (p=.002, p=.0014). Percentage changes of MIP were significantly different between the groups, in favour of HIG (p=.025), so MIP improvement was significantly in HIG.

MEP significantly increased after intervention in both groups, and the improvement achieved was similar between them.

Functional capacity

Distance walked at 6MWT significantly increased in both groups after the intervention. 6MWT changes were similar between HIG and LIG (p=.001, p=.001).

Heart rate values did not show significant differences between the groups (p=.116).

SpO2 changes were similar between HIG and LIG (p=.156).

SBP decreased after the intervention in HIG, before 6MWT (p=.009) and after 6MWT (p=.036). DBP did not change after the training in anygroup. No significantly difference between the groups was found.

Percentage changes of dyspnea and overall fatigue measured with Borg scale were not significantly different between the HIG and LIG (p=.872).

Dyspnea

Dyspnea improved significantly in LIG (p=.017), in HIG we observed a decrease of dyspnea but not statistically significant.

No statistical differences were found in MMRC improvements between the groups (p=.139).

HJ Biplot analysis is shown in Figure 2 and 3, comparison of evaluated parameters evolution during the intervention

DISCUSSION

This is the first study to investigate the effects of a supervised IMT in elderly women comparing two different protocols**.** Using a double-blind, randomized controlled trial our results revealed that 8-week IMT improves respiratory muscle strength and functional capacity in elderly women. High loads got better results in MIP and low loads in dyspnea. In the rest of studied parameters the results were similar and elderly women achieved an improvement of respiratory muscle strength, functional capacity and dyspnea.

The analyzed sample was elderly institutionalized women with medium age 88 years and lower respiratory strength values than reference data. According these terms, it was decided to train with low loads and the nomenclature agreed for the groups was "High intensity group" (HIG) for those patients that trained at 40% MIP and "Low intensity group" (LIG) for those that trained at 20% MIP.

Previous scientific evidence on the efficacy of IMT in elderly women is very reduced, these studies used loads of 40-50% MIP as moderate intensity training in women aged between 60 and 80 years. Studies in younger people and studies in patients with any disease, like multiple sclerosis or chronic obstructive pulmonary disease, were consulted, training load was between 20% and 80%, being the main load used 30%. Based on this evidence and analyzing the own characteristics in elderly women, to assign the name “high loads” (intensity training 40% MIP) and “low loads” (intensity training 20% MIP) was decided.

Effects of IMT on respiratory muscle strength

Respiratory muscle strength (MIP and MEP) increased in both groups, high intensity and low intensity. The main improvement was in MIP, and the results found were similar to other studies conducted on elderly people [15-19]. In addition to MIP, there was an increase in MEP, similar in both groups [4]. This can be explained by the neural conditioning resulting from repeated exposures to the same task (learning effect), a mechanism that generates an increase in respiratory muscle strength by improving neuromuscular recruitment pattern [20].

One important result from the present study was to find that the increasing in MIP was significantly higher in HIG than in LIG (52.3% vs 29.8%), so high loads were more effective to increase inspiratory muscle strength than low loads. Nowadays there are no trials in older women comparing high loads vs low loads with IMT protocols. Last trials affirm high intensity is more effective than low intensity to improve MIP, but we have to consult trials carried on in general population [21-22].

Previous studies in elderly adults reported benefits in MIP between 21-39% [4, 15, 23, 24]. Souza H [4], Mills D [23] and Roldan A [24] trained with 50% MIP load and Aznar S [15] with 30%. Our patients trained with high loads (40% MIP) achieved higher increase in MIP (52.3%) than these researchers, and our patients trained with low loads (20% MIP) were within range 21-39% (29.8%). This finding is very significant because recent trials carried out in general population have affirmed high intensity is more effective than low intensity to improve MIP, which is in concordance with our results, but in elderly people is possible to improve MIP with lower IMT loads, as it has been demonstrated in our study group LIG. Training with 20% MIP load improved inspiratory strength similar to previous studies carried out with higher loads in elderly people.

Previous studies have shown that in elderly population, the decrease in skeletal muscle mass and function is constant. In people over 65, this percentage reaches a 14% loss. The diaphragm is the main inspiratory muscle, responsible for 75% of inspiration. An equal amount of maintenance and gain becomes essential [25].

Functional capacity

All the elderly women in both groups improved significantly the distance walked measured with 6MWT, corroborating previous studies in elderly patients and demonstrating once again that exercise increases and maintains function and activity in the elderly [16, 26, 27].

No differences between HIG and LIG were found after the intervention, in this case, the training intensity was not relevant for 6MWT results. Recent studies evidence IMT increases functional capacity [8, 25-28], but some trials are not able to improve it and only manage to hold the initial results [29, 30].

These results demonstrated that respiratory rehabilitation with IMT was able to improve respiratory parameters but also functional capacity in older women. Nowadays, new studies which recruit representative random samples of community based older people are needed to improve knowledge in functional capacity [31].

Dyspnea

Dyspnea improved significantly in LIG, in HIG we observed a decrease of dyspnea but not statistically significant.

Recent studies showed IMT improved dyspnea, even if the mechanisms are nowadays poorly understood, accepted theory states dyspnea relief occurred in conjunction with a reduced activation of the diaphragm relative to maximum in the absence of significant changes in ventilation, breathing pattern, and operating lung volumes. Dyspnea is influenced by inspirational muscle strength and the load placed upon the inspiratory muscles. [32, 33]. Pazzianotto E [34] trained with a load of 55% MIP and improved dyspnea (-1.0 ± 0.27 Borg units) in 16 obese women. Huang C [35] improved dyspnea in older subjects training with high loads (75-80% MIP). Ramsook AH [33] improved dyspnea after training with maximum intensity (pre: 7.6 ± 2.5 vs. post: 6.8 ± 2.9 Borg units), but not training with 10% MIP load, with no weekly adjustments. Karadalli M [36] managed to decrease dyspnea training for 6 weeks at 40% of MIP but not training at 5%. These results demonstrated IMT was able to improve dyspnea using higher loads, but lower loads (5-10% MIP) didn´t manage to decrease dyspnea. Our results proved an IMT load of 20%MIP improved dyspnea in elderly women, even it was more effective than higher loads (40% MIP) in this parameter. This finding let us establish an IMT load of 20% MIP as minimum load to improve dyspnea in elderly women.

IMT is postulated as a great complement to treat dyspnea in elderly women.

General conclusion

The reviewed studies revealed a positive trend for the effectiveness of IMT in improving muscle performance in elderly women but the information to evaluate other outcomes like functional capacity is very limited [37]. There was heterogeneity in the protocols described for this population with respect to the total training time (4-8 weeks), intensity (30-80% of MIP), and weekly frequency (5 or 7 sessions). This study will increase evidence to support IMT in elderly women.

Trial limitations and Recommendations

The inclusion of a third group, with the same characteristics of our sample, which did not train with any respiratory dispositive, as a control group, to contrast results.

An important limitation is the time of intervention, however as the vast majority of exercise protocols, understanding the “acute” effects of IMT in elderly women, may ensure better programming chronic protocols, and increase our understanding of the possible beneficial and side effects.

The lack of follow-up of the volunteers in the subsequent months after the training did not allow to evaluate the long-term efficacy of IMT.

Future research that aims to investigate the benefits in institutionalized elderly women obtained with IMT should evaluate spirometry parameters to achieve a global vision of the respiratory system. Follow-up of the volunteers for 6 months would be interesting to meet the efficacy of IMT once the participants stopped using it.

Conclusion

This study showed that an 8-week protocol with IMT improved respiratory muscle strength and functional capacity in elderly women. Training with high loads was more effective to improve inspiratory muscle strength and training with low loads to improve dyspnea. A minimum 20% MIP load was enough to improve dyspnea, inspiratory strength, expiratory strength and functional capacity in elderly women.

Statements

Acknowledgement

We would like to express our special thanks of gratitude to every woman who participate in this project which will help us to improve the treatments in elderly women.

Statement of ethics

This randomised trial complies with internationally-accepted standards for research and practice reporting. All the subjects signed an informed consent. The study protocol was approved by the Bioethics Committee of the University of Salamanca (number of registry 365, 22 may 2019).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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There was no external financial support.

Authors´ Contributions

CARLOS MARTIN SANCHEZ has been responsible for the design of the protocol, the experimental part and the redaction of the manuscript. Corresponding author and responsible for the integrity of manuscript.

FAUSTO JOSE BARBERO IGLESIAS has collaborator in the project to advise in the main themes of the study and to carry out the evaluation material.

VICTOR AMOR-ESTEBAN has collaborated in the project to complete statistical evaluation.

ANA MARIA MARTIN NOGUERAS has collaborated in the project to advise and guide in the redaction of the manuscript, the statistical evaluation and the proper elaboration of the complete manuscript.

REFERENCE LIST

1. United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Ageing 2019: Highlights (ST/ESA/SER.A/430)

2. Lowery EM, Brubaker AL, Kuhlmann E, Kovacs EJ. The aging lung. *ClinInterv Aging*. 2013; 8:1489–1496. doi:10.2147/CIA.S51152

3. Lalley PM. The aging respiratory system-pulmonary structure, function and neural control. RespirPhysiolNeurobiol. 2013; 187: 199-210. doi:10.1016/j.resp.2013.03.012

4. Souza H, Rocha T, Pessoa M, Rattes C, Brandão D, Fregonezi G, et al. Effects of inspiratory muscle training in elderly women on respiratory muscle strength, diaphragm thickness and mobility. J GerontolABiolSci Med Sci. 2014;69((12)):1545–53. doi: 10.1093/gerona/glu182.

5. Illi SK, Held U, Frank I, Spengler CM. Effect of respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis. *Sports Med*. 2012; 42:707–724. doi:10.2165/11631670-000000000-00000.

6. Silva Mdos, Martins Ac, Cipriano G, Ramos LR, Lopes GS. Inspiratory training increases insulin sensitivity in elderly patients. GeriatrGerontol Int. 2012; 12: 345-351. doi:10.1111/j.1447-0594.2011.00755.x

7. Abreu RM, Santos P, Minatel V, dos Santos G, Catai A. Effects of inspiratory muscle training on cardiovascular autonomic control: A systematic review. AutonMeurosci. 2017; 208: 29-35. Doi.org/10.1016/j.autneu.2017.09.002

8. Rodrigues GD, Gurgel JL, Gonçalves TR, da Silva Soares PP. Inspiratory muscle training improves physical performance and cardiac autonomic modulation in older women. Eur J Appl Physiol. 2018 Jun; 118(6): 1143-1152.doi: 10.1007/s00421-018-3844-9.

9. Liu W, Unick J, Galik E, Resnick B. Barthel Index of activities of daily living: ítem response theory analysis of ratings for long-term care residentes. Nursing research. 2015; 64(2): 88-99.doi: 10.1097/NNR.0000000000000072

10. American Thoracic Society/European Respiratory S. ATS/ERS statement on respiratory muscle testing. *Am J RespirCrit Care Med*. 2002; 166: 518–624.

11. Gochicoa L, Mora U, Guerrero S, Silva M, Cid S, et al. Prueba de caminata de 6 minutos: recomendaciones y procedimientos. Neumol Cir Torax. 2015; 74(2): 127-136.

12. American Thoracic Society. American thoracic society statement: guidelines for the six-minute walk test. Am J RespirCrit Care Med. 2002;166:111–7.

13. Borg GAV. Psycho-physical bases of perceived exertion. Med Sci Sports Exerc. 1982; 14: 377-381.

14. Munari AB, Gulart AA, Dos Santos K, Venancio R, Karloh M, Mayer A. Modified Medical Research Council Dyspnea Scale in GOLD Classification Better Reflects Physical Activities of Daily Living.Respir Care. 2018; 63(1): 77-85. doi.org/10.4187/respcare.05636

15. Aznar-Lain S, Webster AL, Cañete S. Effects of inspiratory muscle training on exercise capacity and spontaneous physical activity in elderly subjects: a randomized controlled pilot trial. Int J Sports Med. 2007; 28:1025-1029.

16. Alvarenga GM, Charkovski SA, Santos LKD, Silva MABD, Tomaz GO, et al. The influence of inspiratory muscle training combined with the pilates method on lung function in elderly women: A randomized controlled trial. Clinics (Sao Paulo). 2018; 73:e356.

17. Watsford M, Murphy A. The effects of respiratory-muscle training on exercise in older women. J Aging Phys Act. 2008 Jul; 16(3):245-60.

18. Feriani DJ, Coelho HJ, Scapini KB, de Moraes OA, Mostarda C, Ruberti OM, et al. Effects of inspiratory muscle exercise in the pulmonary function, autonomic modulation and hemodynamic variables in older women with metabolic syndrome. J ExercRehabil. 2017 Apr 30; 13(2): 218-226.

19. Reychler G, Delacroix S, Dresse D, Pieters T, Liistro G. Randomized controlled trial of the effect of inspiratory muscle training and incentive spirometry on respiratory muscle strength, chest wall expansión and lung function in elderly adults. J Am Geriatr Soc. 2016 May; 64(5): 1128-30. doi: 10.1111/jgs.14097.

20. Kamen G. Aging, resistance training, and motor unit discharge behavior. Can J Appl Physiol. 2005; 30: 341-351.

21. Parreiras KK, Nascimento LR, Ada L, Avelino PR, Polese JC, Mota MT, et al. High-Intensity respiratory muscle training improves strength and dyspneapoststroke: A double-blind randomized trial. Arch Phys Med Rehabil. 2019 Feb; 100(2):205-212. doi: 10.1016/j.apmr.2018.09.115.

22. Menezes KKP, Nascimento LR, Polese JC, Ada L, Teixeira LF. Effect of high-intensity home-based respiratory muscle training on strength of respiratory muscles following a stroke: a protocol for a randomized controlled trial. Braz J PhysTher. 2017 Sep-Oct; 21(5): 372-377. doi: 10.1016/j.bjpt.2017.06.017.

23. Mills DE, Johnson MA, Barnett YA. The effects of inspiratory muscle training in older adults. Med Sci in Sports Exerc. 2015 Apr; 47(4): 691-697.

24. Roldan A, Cordellat A, Monteagudo P, Garcia-Lucerga C, Blasco-Lafarga NM, et al. Beneficial effects of inspiratory muscle training combined with multicomponent training in elderly active women. Res Q Exerc Sport. 2019 Dec; 90(4): 547-554. Doi: 10.1080/02701367.2019.1633009

25. Santilli V, Bernetti A, Mangone M, Paoloni M. Clinical definition of sarcopenia. Clin Cases Miner Bone Metab. 2014 Sep; 11(3): 177-80.

26. Duruturk N, Acar M, Dogrul MI. Effects of inspiratory muscle training on respiratory muscle strength, exercise capacity, physical fitness and daily living activities in patients with asthma. EurResp Soc. 2015; 46: PA967.doi: 10.1183/13993003.congress-2015.

27. Ferraro FV, Gavin JP, Wainwright T, McConell A. The effects of 8 weeks of inspiratory muscle training on the balance of healthy older adults: a randomized, double blind, placebo-controlled study. Physiol Rep. 2019 May; 7(9): e14076. doi: 10.14814/phy2.14076.

28. Majewski M, Dabrowska G, Pawik M, Rozek K. Evaluation of a home-based pulmonary rehabilitation program for older females suffering from bronchial asthma. AdvClinExp Med. 2015 Nov-Dec; 24(6): 1079-83. doi.org/10.17219/acem/31679

29. Molino R, Pasquini G, Vannetti F, Zipoli R, Razzolini L, Fabbri V, et al. Ventilatory strategies in the six-minute walk test in older patients receiving a three-week rehabilitation programme after cardiac surgery through median sternotomy. J Rehabil Med. 2013 May; 45(5): 504-9. doi.org/10.2340/16501977-1126

30. Espinoza A, Arenas G, Fernández R, Ravanales O, González J, Zafra E. Efecto del entrenamiento de la musculaturainspiratoria con válvula umbral sobre la capacidadfuncionalenmujeresfísicamenteactivasmayores de 60 años. Univ. Salud [Internet]. 2019 Aug [cited 2020 Feb 01]; 21(2): 119-126. Available from: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0124-71072019000200119&lng=en.

31. Sun F, Norman IJ, While AE. Physical activity in older people: a systematic review. BMC Public Health. 2013 May 6; 13: 449.

32. Langer D, Ciavaglia C, Faisal A, Webb K Neder J, Gosselink R, et al. Inspiratory muscle training reduces diaphragm activation and dyspnea during exercise in COPD. J Appl Physiol. 2018 Aug; 125(2): 381-392. doi.org/10.1152/japplphysiol.01078.2017

33. Ramsook A, Molgat Y, Schaeffer M, Wilkie A, Camp P, Reid W. Effects of inspiratory muscle training on respiratory muscle electromyography and dyspnea during exercise in healthy men. J Appl Physiol. 2017 May; 122(5): 1267-75. doi.org/10.1152/japplphysiol.00046.2017

34. Pazzianotto E, Mori T, Zerbetto R, Baruki S, Montebello I. Effects of inspiratory muscle training on respiratory muscle strength, physical fitness and dyspnea in obese women. Eur Respir J. 2019. 54: PA2204.

35. Huang CH, Yang GG, Lee CW. Comparison of inspiratory muscle strength training effects between older subjects with and without chronic obstructive pulmonary disease. J Formos Med Assoc. 2011 Aug; 110(8): 518-26.

36. Karadalli M, Bosnak-Guclu M, Camcloglu B, Kokturk N, Turkyas H. Effects of inspiratory muscle training in subjects with sarcoidosis: a randomized controlled trial. Resp Care. Apr 2016. 61(4): 483-94.

37. Seixas MB, Almeida LB, Trevizan PF, Martinez DG, Laterza MC, Vandelei LCM, et al. Effects of inspiratory muscle training in older adults. Respir Care. 2019 Oct 29. doi: 10.4187/respcare.06945.

Figure legends

Figure 1: Flowchart of participants

Figure 2: HJ Biplot High Intensity Group

Figure 3: HJ Biplot Low Intensity Group