



## RESEARCH LETTERS

## Functionality of patients with Chronic Obstructive Pulmonary Disease at 3 months follow-up after elastic resistance training: a randomized clinical trial<sup>☆</sup>



## INTRODUCTION

Patients with Chronic Obstructive Pulmonary Disease (COPD) present musculoskeletal disorders, which result in exercise intolerance, a decline in quality of life (QoL)<sup>1</sup> and poor sleep quality<sup>2</sup>. It is proven that the use of elastic tools in resistance training for patients with COPD is beneficial in improving the functional capacity, QoL and muscle strength<sup>3,4</sup>. However, it is unknown if the benefits achieved with elastic resistance training using elastic bands and tubes, are maintained after the program, in COPD. Considering the advantages (low cost and portability) of these elastic tools, as well as the benefits for these patients<sup>3</sup>, it is necessary to evaluate the functionality, health status, and body composition at the end of the training program.

The objective of this study was to analyze functional capacity, body composition, QoL and Physical Activity (PA) level at 3 months follow-up after 12 weeks of elastic resistance training in patients with COPD.

## METHODS

## Sample

The sample size was defined using the study of Ramos et al. (2014)<sup>3</sup>. In order to evaluate the study parameters a six-minute walk test (6MWT) was carried out by 54 patients divided into three groups. The duration of the study lasted 24 weeks (12 weeks of training and 12 weeks of follow-up). Participants signed the consent form. All the procedures performed were approved by the Research Ethics Committee (approval number of the Ethics Committee: 1.677.874).

## Study design

A total of 81 patients diagnosed with COPD were recruited. Of these, 48 patients were randomized into three groups: Elastic Band Training Group (EBG), Elastic Tube Training Group (ETG) and Training Group with Conventional Weight Machines (CG). The 3 months follow-up sample was composed of 33 patients, and the study was registered in the Brazilian Clinical Trials Registry (REBEC: RBR-6V9SJJ).

An assessment was individually performed before the beginning of the training, after completing the program training (12 weeks) and after 3 months of follow-up (24 weeks), these evaluations were: spirometry (conducted to confirm the diagnosis of COPD)<sup>1</sup>, body composition (assessed using bioimpedance analysis - Octopolar InBody 720, Biospace, Seoul, Korea), functional capacity (6MWT)<sup>1</sup>, QoL (analyzed by COPD Assessment Test- CAT and sleep disorders assessed by the Mini-Sleep Questionnaire - MSQ). To evaluate PA levels the Baecke Questionnaire (BQ) was used.

## Training protocol

The training program was performed for 12 weeks, three times per week, 60 minutes per session. Materials used included elastic bands (EBG) and elastic tubes (ETG) using chairs specially designed with fixed hooks for these groups, as well as conventional equipment (CG). The exercises used during intervention were: knee extension, knee flexion, shoulder flexion, abduction of shoulder and elbow flexion.

Training protocol consisted of a Maximum Number of Repetitions (MNR) in each set. Therefore, the patient was submitted to a load that had only the MNR imposed by the training dynamics; this consisted of twelve weeks with 2x15 (first week) up to 3x15 (last week) repetitions. The increase in the training load was introduced during the execution of the movement, for EBG and ETG were carried out by adding tubes or bands in the fixed-hooks. The thickness of the elastic tubes indicated different resistances; the greater the thickness the greater the resistance. For CG free weights and pulleys were used.

## Statistical analysis

One-way ANOVA was performed to identify the difference between groups at baseline. A 3x3 repeated measures analysis of variance (RMANOVA) with Bonferroni adjustment for

<sup>☆</sup> Please cite this article as: Silva IG, Silva BSdA, Freire APCF, Santos APSd, Lima FFd, Ramos D, et al. Functionality of patients with Chronic Obstructive Pulmonary Disease at 3 months follow-up after elastic resistance training: a randomized clinical trial. <https://doi.org/10.1016/j.pulmoe.2018.09.005>

**Table 1** Anthropometric and spirometric characteristics of the groups. Data expressed as mean and  $\pm$  standard error.

	EBG [n=12 (6 men)]	ETG [n=11 (7 men)]	CG [n=10 (7 men)]	p
<i>Anthropometric variables</i>				
Age	66.7 $\pm$ 2.40	72.82 $\pm$ 1.94	66.40 $\pm$ 3.94	0.1492
Weight (Kg)	74.64 $\pm$ 3.30	59.18 $\pm$ 3.34 <sup>a</sup>	74.70 $\pm$ 3.21	0.0055
Height (m)	1.60 $\pm$ 0.02	1.61 $\pm$ 0.04	1.65 $\pm$ 0.02	0.3537
BMI (Kg/m <sup>2</sup> )	29.30 $\pm$ 1.29	22.97 $\pm$ 1.12 <sup>b</sup>	27.36 $\pm$ 1.05	0.0051
<i>Pulmonary Function</i>				
FEV <sub>1</sub> (L)	1.44 $\pm$ 0.16	1.15 $\pm$ 0.12	1.58 $\pm$ 0.16	0.1650
FEV <sub>1</sub> % pred	54.8 $\pm$ 5.38	43.1 $\pm$ 4.25	54.43 $\pm$ 5.12	0.1880
FVC (L)	2.61 $\pm$ 0.23	2.36 $\pm$ 0.27	2.60 $\pm$ 0.20	0.8610
FEV <sub>1</sub> /FVC (%)	55.15 $\pm$ 3.76	50.56 $\pm$ 3.41	60.44 $\pm$ 3.93	0.1726

EBG: Elastic band group; ETG: Elastic tube group; CG: Training group with conventional weight machines; Kg: Kilogram; m: meters; Kg/m<sup>2</sup>: kilogram per square meter; L: Liters; BMI: Body Mass Index; FEV<sub>1</sub>: Forced expiratory volume in the first second; FEV<sub>1</sub>% predicted: Forced expiratory volume in the first second percentage predicted; FVC: Forced vital capacity; FEV<sub>1</sub>/FVC: Ratio between forced expiratory volume in the first second and forced vital capacity; %: percentage.

<sup>a</sup> : Statistically significant difference compared to EBG and CG in weight.

<sup>b</sup> : Statistically significant difference compared to EBG and CG in BMI.

multiple comparisons was used to compare group (EBG, ETG and CG) and responses of time (baseline, post training and follow-up). For the comparison between groups (delta values: post training minus baseline and follow-up minus post training) Student T test or Mann Witney was used according to data distribution. Statistical significance was set at  $p < 0.05$ . The effect size (eta-squared;  $\eta^2$ ) was calculated across time.

## RESULTS

Anthropometric and spirometric characteristics of the groups are presented in [Table 1](#).

A total of 33 patients with COPD completed the study, divided into: EBG (degree = GOLD I: 2 patients (17%), GOLD II: 4 (33%), GOLD III: 5 (42%), GOLD IV: 1 (8%); ETG (degree = GOLD I: 0 patients (0%), GOLD II: 3 (27%), GOLD III: 7 (64%), GOLD IV: 1 (9%) and CG (degree = GOLD I: 0 patients (0%), GOLD II: 6 (60%), GOLD III: 3 (30%), GOLD IV: 1 (10%). The results of functional capacity, questionnaires (CAT, MSQ, and PA) and body composition are presented in

Within the three groups, only CAT questionnaire presented a significant decrease over the three assessments ( $p < 0.05$ ) however, the *post-hoc* was not significant. Although not a significant one, only among patients from the ETG group was there a decline in their functional capacity after the program. Comparing follow-up with post-program, all three groups reduced their functional capacity but with a similar non-significant amount for EBG and CG, while reaching the Minimum Clinically Important Difference (MCID) on the ETG. The other variables remained stable.

There was a MCID in CAT in EBG and ETG when comparing baseline and after 12 weeks of training (EBG = -2.76 points; ETG = -3.50 points). [Table 2](#)

## DISCUSSION

Patients with COPD maintained their body composition and PA levels at 3 months follow-up using elastic components. However, although not significant, there was a decrease in

functional capacity. The QoL was also maintained, and MCID was observed in EBG and ETG after 12 weeks of intervention.

It is known that the elderly associated to chronic diseases have a predisposition to functional disability<sup>5,6</sup>. The results of the present study showed a decrease in functional capacity at 3 months follow-up when using elastic components, suggesting the importance of the continuity of program performed to maintain functional capacity<sup>6</sup>. This may be explained by age and pulmonary function, that even if these values were not statistically different between groups, the ETG presented higher age and lower pulmonary function values.

Pulmonary Rehabilitation Program (PRP) promotes QoL improvements in patients with COPD<sup>7</sup> while sleep disturbances are detrimental to QoL and can lead to mental and physical illness, increasing health expenditure and mortality<sup>8</sup>. PA is an important protective factor for sleep disorders in the elderly<sup>9</sup>. Maintenance of body composition in patients with COPD is of extreme importance to reduce mortality<sup>10</sup>. Ribeiro et al. found that resistance training does not promote increases in fat-free mass when not associated with nutritional support<sup>11</sup>, which may justify the results found in our study.

In this context, interventions that can promote the maintenance of these variables in patients with COPD are important for functional independence<sup>6</sup>, QoL<sup>7</sup>, decrease in hospitalizations and mortality<sup>8</sup>. In addition, the similar behavior of maintenance of these variables at 3 months follow-up in resistance training using elastic components and conventional training with weight machines is very important, because elastic components have advantages such as low cost, high portability and little demand for space<sup>3</sup> compared with the conventional training. Considering this, it is much easier for patients to use such equipment at home if going to rehabilitation center is not possible. In conclusion, in the present study, at 3 months follow-up of resistance training with elastic components, there was maintenance of body composition, health status and PA levels in patients with COPD. However, there was a decrease in functional capacity, but only with minimum clinically important differences, in the ETG group.

**Table 2** Variables of functional capacity, body composition and questionnaires of quality of life, sleep disturbances and physical activity level expressed as mean  $\pm$  standard error.

		Baseline	12 weeks	$\Delta$ post-pre	Follow-up	$\Delta$ follow-up-post	Effect	p	F	Effect size
<i>Functional capacity</i>										
6MWT (m)	EBG	511.25 $\pm$ 26.36	527.58 $\pm$ 27.01	17.18 $\pm$ 13.25	517.33 $\pm$ 24.43	-10.25 $\pm$ 13.99	Group	0.40	0.96	0.71
	ETG	465.78 $\pm$ 18.98	457.27 $\pm$ 15.13	-8.63 $\pm$ 6.96	431.67 $\pm$ 19.77	-29.20 $\pm$ 12.25	Group x time	0.57	0.74	0.06
	CG	497.33 $\pm$ 32.91	509.45 $\pm$ 25.50	3.94 $\pm$ 8.65	499.20 $\pm$ 36.00	-10.25 $\pm$ 18.53	Time	0.23	1.53	0.06
<i>Body Composition</i>										
IWM (Kg)	EBG	20.48 $\pm$ 0.79	20.33 $\pm$ 0.79	-0.17 $\pm$ 0.15	20.69 $\pm$ 0.83	0.37 $\pm$ 0.15	Group	0.20	1.70	0.10
	ETG	18.40 $\pm$ 1.09	18.77 $\pm$ 1.05	0.31 $\pm$ 0.22	18.24 $\pm$ 1.00	1.17 $\pm$ 1.72	Group x time	0.29	1.29	0.08
	CG	20.01 $\pm$ 2.20	22.08 $\pm$ 1.39	2.33 $\pm$ 2.15	21.98 $\pm$ 1.35	-0.10 $\pm$ 0.22	Time	0.24	1.46	0.05
PM (Kg)	EBG	8.86 $\pm$ 0.35	8.79 $\pm$ 0.34	-0.07 $\pm$ 0.06	8.96 $\pm$ 0.36	0.17 $\pm$ 0.07	Group	0.20	1.68	0.10
	ETG	7.95 $\pm$ 0.47	8.12 $\pm$ 0.45	0.15 $\pm$ 0.095	7.87 $\pm$ 0.43	0.49 $\pm$ 0.74	Group x time	0.31	1.23	0.08
	CG	8.66 $\pm$ 0.95	9.55 $\pm$ 0.60	1.01 $\pm$ 0.93	9.46 $\pm$ 0.60	-0.09 $\pm$ 0.09	Time	0.25	1.41	0.05
FFM (Kg)	EBG	45.30 $\pm$ 1.74	44.72 $\pm$ 1.69	-0.64 $\pm$ 0.48	45.81 $\pm$ 1.83	1.09 $\pm$ 0.39	Group	0.25	1.44	0.09
	ETG	41.20 $\pm$ 2.46	42.03 $\pm$ 2.35	0.74 $\pm$ 0.51	40.85 $\pm$ 2.20	2.64 $\pm$ 3.85	Group x time	0.27	1.37	0.09
	CG	44.30 $\pm$ 4.63	48.68 $\pm$ 2.94	4.96 $\pm$ 4.55	48.42 $\pm$ 2.88	-0.26 $\pm$ 0.46	Time	0.25	1.38	0.47
<i>Quality of life</i>										
CAT (score)	EBG	14.18 $\pm$ 2.38	11.42 $\pm$ 2.14	-0.45 $\pm$ 1.80	13.08 $\pm$ 2.30	1.67 $\pm$ 1.06	Group	0.61	0.51	0.04
	ETG	19.40 $\pm$ 2.76	15.90 $\pm$ 3.30	-2.13 $\pm$ 4.70	16 $\pm$ 2.43	0.09 $\pm$ 3.21	Group x time	0.98	0.43	0.07
	CG	15.30 $\pm$ 2.86	14.20 $\pm$ 3.00	-0.78 $\pm$ 2.46	12 $\pm$ 2.80	-2.20 $\pm$ 1.44	Time	0.02*	0.50	0.15
<i>Sleep disturbances</i>										
MSQ (score)	EBG	33.20 $\pm$ 3.28	29.17 $\pm$ 2.17	2.45 $\pm$ 3.51	30.25 $\pm$ 2.07	1.08 $\pm$ 1.20	Group	0.72	0.34	0.02
	ETG	29.67 $\pm$ 3.88	29.90 $\pm$ 2.77	1.00 $\pm$ 1.84	27.36 $\pm$ 2.89	0.18 $\pm$ 3.28	Group x time	0.32	1.20	0.08
	CG	27.5 $\pm$ 2.37	28.4 $\pm$ 2.62	-0.44 $\pm$ 1.56	30.4 $\pm$ 2.44	2.00 $\pm$ 1.83	Time	0.93	0.03	0.001
<i>Physical Activity</i>										
BQ (score)	EBG	4.99 $\pm$ 0.36	4.74 $\pm$ 0.36	0.30 $\pm$ 0.58	5.05 $\pm$ 0.29	0.18 $\pm$ 0.46	Group	0.63	0.47	0.03
	ETG	4.49 $\pm$ 0.73	4.32 $\pm$ 0.65	-0.20 $\pm$ 0.22	4.28 $\pm$ 0.52	0.35 $\pm$ 0.30	Group x time	0.98	0.12	0.01
	CG	5.03 $\pm$ 0.58	4.93 $\pm$ 0.53	-0.24 $\pm$ 0.40	5.28 $\pm$ 0.52	0.35 $\pm$ 0.29	Time	0.50	0.70	0.02

EBG: Elastic band group; ETG: Elastic tube group; CG: Training group with conventional weight machine; 6MWT: Six-minute walk test; IWM: Intracellular water mass; PM: Protein mass; FFM: Fat free mass; CAT: COPD Assessment Test; MSQ: Mini-Sleep Questionnaire; BQ: Baecke Questionnaire; m: meters; Kg: Kilogram;  $\Delta$  post-pre: difference between baseline and 12 weeks evaluations of each group expressed as mean and standard error;  $\Delta$  follow-up-post: difference between 3 months of follow-up and 12 weeks evaluations of each group expressed as mean and standard error; Effect: Comparisons of group (EBG, ETG and CG) and responses of time (Baseline, 12 weeks and 3 months of follow-up);

\*: statistical significance  $p < 0.05$ .

## Acknowledgements

The authors would like to thank all the volunteers, the São Paulo State University (UNESP) for allowing the development of this research and for the funders of this research: São Paulo Research Foundation (FAPESP) (#2017/10925-2 #2017/10145-7), National Council for Scientific and Technological Development (CNPq) (#470742/2014-3) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) 001.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.pulmoe.2018.09.005](https://doi.org/10.1016/j.pulmoe.2018.09.005).

## Referências

- Vogelmeier CF, Criner GJ, Martinez FJ, Anzueto A, Barnes PJ, Bourbeau J, et al. Global Strategy for the Diagnosis Management, and Prevention of Chronic Obstructive Lung Disease 2017 Report. GOLD Executive Summary. *American journal of respiratory and critical care medicine*. 2017;195(5):557–82.
- Scharf SM, Maimon N, Simon-Tuval T, Bernhard-Scharf BJ, Reuveni H, Tarasiuk A. Sleep quality predicts quality of life in chronic obstructive pulmonary disease. *International journal of chronic obstructive pulmonary disease*. 2010;6:1–12.
- Ramos EM, de Toledo-Arruda AC, Fosco LC, Bonfim R, Bertolini GN, Guarnier FA, et al. The effects of elastic tubing-based resistance training compared with conventional resistance training in patients with moderate chronic obstructive pulmonary disease: a randomized clinical trial. *Clinical rehabilitation*. 2014;28(11):1096–106.
- Nyberg A, Lindstrom B, Rickenlund A, Wadell K. Low-load/high-repetition elastic band resistance training in patients with COPD: a randomized, controlled, multicenter trial. *The clinical respiratory journal*. 2015;9(3):278–88.
- Dunlop DD, Manheim LM, Sohn MW, Liu X, Chang RW. Incidence of functional limitation in older adults: the impact of gender, race, and chronic conditions. *Archives of physical medicine and rehabilitation*. 2002;83(7):964–71.
- Mattos IE, do Carmo CN, Santiago LM, Luz LL. Factors associated with functional incapacity in elders living in long stay institutions in Brazil: a cross-sectional study. *BMC geriatrics*. 2014;14:47.
- Troosters T, Gosselink R, Decramer M. Short- and long-term effects of outpatient rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. *The American journal of medicine*. 2000;109(3):207–12.
- Smagula SF, Stone KL, Fabio A, Cauley JA. Risk factors for sleep disturbances in older adults: Evidence from prospective studies. *Sleep medicine reviews*. 2016;25:21–30.
- Inoue S, Yorifuji T, Sugiyama M, Ohta T, Ishikawa-Takata K, Doi H. Does habitual physical activity prevent insomnia? A cross-sectional and longitudinal study of elderly Japanese. *Journal of aging and physical activity*. 2013;21(2):119–39.
- Schols AM, Slangen J, Volovics L, Wouters EF. Weight loss is a reversible factor in the prognosis of chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine*. 1998;157 6 Pt 1:1791–7.
- Ribeiro AS, Avelar A, Schoenfeld BJ, Ritti Dias RM, Altamari LR, Cyrino ES. Resistance training promotes increase in intracellular hydration in men and women. *European journal of sport science*. 2014;14(6):578–85.

Isis Grigoletto Silva<sup>a,\*</sup>, Bruna Spolador de Alencar Silva<sup>b</sup>, Ana Paula Coelho Figueira Freire<sup>a</sup>, Ana Paula Soares dos Santos<sup>a</sup>, Fabiano Francisco de Lima<sup>a</sup>, Dionei Ramos<sup>a</sup>, Ercy Mara Cipulo Ramos<sup>a</sup>

<sup>a</sup> Department of Physical Therapy, São Paulo State University (UNESP), Faculty of Science and Technology, Presidente Prudente, São Paulo, Brazil

<sup>b</sup> Department of Physical Education, São Paulo State University (UNESP), Institute of Biosciences, Rio Claro, São Paulo, Brazil

\*Corresponding author. São Paulo State University (UNESP), Faculty of Science and Technology, Presidente Prudente, Brazil, Department of Physical Therapy, Address: 305, Roberto Simonsen St. Presidente Prudente, SP, Brazil. Zip-code: 19060-900. Tel.: +55 18 32295821  
E-mail address: [isis.grigoletto@hotmail.com](mailto:isis.grigoletto@hotmail.com) (I.G. Silva).

<https://doi.org/10.1016/j.pulmoe.2018.09.005>  
2531-0437/

© 2018 Sociedade Portuguesa de Pneumologia. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Understanding symptoms variability in outpatients with AECOPD



Dear Editor,

Symptoms are the cornerstone for diagnosing acute exacerbations of chronic obstructive pulmonary disease (AECOPD), however little information is available on their variability during these events and on their relationships with objective clinical measures. This study explored changes in patients' symptoms and their relationships with objective clinical measures during AECOPD.

## Methods

A longitudinal observational study was conducted with thirty-six outpatients with AECOPD (24 males; 68.4±9.9 years; forced expiratory volume in one second (FEV<sub>1</sub>) 50.7±20.4%predicted) recruited from the urgent care of a Central hospital. Patients attended to 4 assessments: until 48 hours of the urgent care visit (T1), 8 days (T2), 15 days (T3) and 45 days (T4) after the hospital visit. Patients' prescriptions included only pharmacological treatment and consisted in antibiotics (n=16; 44.4%), beta-adrenergic agonists (n=2; 5.6%), cholinergic antagonists