Received: 21 March 2018 | Revised: 13 June 2018 | Accepted: 11 July 2018

DOI: 10.1002/pri.1740

RESEARCH ARTICLE

WILEY

Effectiveness of a community-based exercise training programme to increase physical activity level in patients with chronic obstructive pulmonary disease: A randomized controlled trial

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Abstract

Background and Purpose: The exercise training included in pulmonary rehabilitation (PR) programmes improves exercise capacity and quality of life in patients with chronic obstructive pulmonary disease (COPD). Nevertheless, the duration of these effects is limited, and the implementation of PR is still insufficient. Moreover, the physical activity level of COPD patients is low, and it is not modified with the classic PR programmes. The purpose of this study was to assess the effects of a community-based PR programme designed to increase physical activity in COPD patients.

Methods: Stable COPD patients were assigned to either an experimental group (EG, $n = 17$) who followed a community-based 8-week programme consisting of exercise training through walking and a plan to increase activity, using a pedometer for feedback; or a control group ($n = 16$), who followed general recommendations to walk more every day. The following were evaluated postintervention, after 3 months, and after 12 months: exercise capacity (endurance shuttle test [EST]), physical activity (steps/day and modified Baecke questionnaire), quality of life (St. George's Respiratory Questionnaire [SGRQ]), dyspnoea (modified Medical Research Council scale), and exacerbations.

Results: Postintervention, the EG showed significant improvements in EST times (7.6 min [4.4, 10.7]), distance (549 m [282, 815]; $p < 0.01$, both), number of steps (3,361 [1,553, 5,118]), and Baecke scores (1.6 [0.2, 3.1], $p < 0.01$). SGRQ scores decreased (−5.4 [−8.6, −2.4], $p < 0.01$). These results remained evident after 3 and 12 months ($p < 0.01$). There were no differences between the groups nor in the exacerbations or dyspnoea. A significant association was found between increase in physical activity level, improvement in exercise capacity, and quality of life during the period monitored.

Conclusions: A community-based programme of exercise training through walking and increased physical activity, using pedometers as feedback, produces short- and long-term improvements in exercise capacity, physical activity level, and quality of life in COPD patients.

KEYWORDS

exercise, pulmonary disease, chronic obstructive, self-management, walking

1 | INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterized by chronic airflow obstruction, multisystem affectation, and exercise intolerance GOLD (2017) (Global Strategy for the Diagnosis, Management, and Prevention of COPD); the last characteristic can be improved through pulmonary rehabilitation (PR). Nevertheless, despite the well-known benefits provided by PR programmes (McCarthy et al., 2015; Spruit et al., 2013), their implementation is limited (Rochester et al., 2015). Self-administered programmes are an interesting option to increase PR coverage, offering similar benefits to supervised modalities (Vieira, Maltais, & Bourbeau, 2010). Programmes of this type, which use walking as a system of training, have been described in the medical literature (de Sousa Pinto, Martín-Nogueras, Calvo-Arenillas, & Ramos-González, 2014; Dias et al., 2013; Liu et al., 2008; Mitchell et al., 2014; Pradella et al., 2015).

Moreover, the duration of the effects of PR is limited, with decline beginning after 6–12 months (Spruit et al., 2013). For this reason, maintenance interventions are necessary, but there are few studies that have been conducted, and they are heterogeneous and show modest results (Busby, Reese, & Simon, 2014).

On the other hand, physical activity level (PAL) of COPD patients is generally low (Pitta, Troosters, Spruit, Decramer, & Gosselink, 2005). Because inactivity has a negative influence on evolution of COPD (Hill, Gardiner, Cavalheri, Jenkins, & Healy, 2015), it is necessary to identify strategies to modify patients' habits (Spruit et al., 2013; Watz et al., 2014). Furthermore, it has not been demonstrated that classic PR has any effect on patients' PALs (Mantoani, Rubio, McKinstry, MacNee, & Rabinovich, 2016; Spruit, Pitta, McAuley, ZuWallack, & Nici, 2015), whereas a combination of training and behavioural interventions does appear effective (Hill et al., 2015; Lahham, McDonald, & Holland, 2016; Mantoani et al., 2016), especially in programmes that establish sequential objectives and formal feedback systems (Leidy et al., 2014).

Pedometers are portable and easy to use and have been shown to be effective monitoring systems in other programmes that aimed at increasing PAL in different populations (Bravata et al., 2007; Vaes et al., 2013). They are known to help increase PAL in people with COPD (Mantoani et al., 2016; Spruit et al., 2013), although there are no unified criteria for their utilization and there is little evidence regarding duration of the effects of these programmes (Mantoani et al., 2016).

Therefore, given the need to develop effective and lasting interventions making PR more available and increasing PALs in the COPD community, we have proposed this study. We hypothesized that a simple, community-based exercise training programme based on walking, associated with a plan to increase PAL and using a pedometer as feedback, would be more effective than general recommendations to walk more every day and that those effects would be maintained for longer periods. The primary objective was to assess the short-, medium-, and long-term effects of this programme on exercise capacity and PAL in people with COPD. Secondary objectives included the following: (a) assessing the programme's effects on quality of life, dyspnoea, and exacerbations and (b) analysing the influence of these patients' modified PALs on their functional status.

2 | METHODS

2.1 | Study design and subjects

This study consisted of a randomized and controlled clinical trial with a monitoring period of 12 months, comparing a community-based exercise training programme associated with a plan to increase PAL to general recommendations of walking. It was conducted at the *Escuela Universitaria de Fisioterapia de la ONCE* (*Universidad Autónoma de Madrid*), after approval by the ethics and clinical research committees of the hospitals that collaborated in the recruitment process.

COPD patients diagnosed according to the Global Obstructive Lung Disease Initiative criteria (GOLD 2017 Global Strategy for the Diagnosis, Management and Prevention of COPD) were eligible for inclusion, who experienced no exacerbations in the 4 weeks prior to the study, exertional dyspnoea, and low habitual PAL (less than 30 min of moderate exercise per day; Miravitlles et al., 2012). They agreed to participate and signed informed consent forms. We excluded subjects who had difficulty walking, those with cardiovascular diseases (except high blood pressure), and those who had participated in a PR programme over the previous 12 months. Recruitment was conducted by the pulmonology consultants of the aforementioned hospitals, using an intentional system of consecutive series.

Patients were allocated to one of two groups (experimental or control) through simple randomization, using a system of random numbers generated by Microsoft® Excel 2010. Correspondence between numerical codes and study group was only available to researchers in charge of the treatment, not to evaluators. Likewise, participants were not aware of the interventions applied to the other group, and contact between the two groups was avoided at all times.

2.2 | Measurements

Patients were assessed preintervention (Week 0), postintervention (Week 10), and both 3 and 12 months postintervention.

The main variables consisted of the following: (a) exercise capacity, assessed through the endurance shuttle test (EST; Holland et al., 2014), using as walking speed 80% of the maximum speed in the incremental shuttle test (Holland et al., 2014). Time and distance achieved were measured, as well as functional variables. (b) PAL was assessed through the following:

- Average number of steps/day registered over seven consecutive days, using the OMRON Walking Style X Pocket HJ-320e digital pedometer (Omron Healthcare Inc., Illinois), validated for use with COPD patients (Moy et al., 2010). The patients were required to carry the pedometer attached to their waist, next to their right hip, throughout the entire day, and could only take it off if they were lying down to rest. The pedometer's reliability was assessed for each subject by comparing the number of steps registered by the device to a manual count of steps when walking at the usual speed in a 20-m circuit. Patients whose variability between both measurements was above 10% were excluded (Moy et al., 2010).
- The modified Baecke physical activity questionnaire, which is specifically designed to assess PALs of individuals over 60 years old and is validated for use with Spanish COPD patients (Vilaró et al., 2007).

The secondary variables were as follows: (a) quality of life, measured with the Spanish version of St. George's Respiratory Questionnaire (SGRQ), validated for use with COPD patients (Güell et al., 1998); (b) dyspnoea, assessed through the modified scale of the Medical Research Council (Task group on surveillance for respiratory hazards in the occupational setting & Brooks, 1982); and (c) number of exacerbations over the last 12 months (worsening of at least two of the usual symptoms—dyspnoea, quantity, and colour of the sputum—lasting more than 24 hr; Seemungal, Donaldson, Bhowmik, Jeffries, & Wedzicha, 2000).

2.3 | Intervention

All participants received five group sessions of respiratory physiotherapy. These sessions were run by the same physiotherapist in both groups and included ventilation techniques, bronchial clearance, thoracic mobilization, and education. This initial intervention, considered as "standard care" in a PR programme, has shown no influence in the variables we analysed (Spruit et al., 2013). The specific intervention then began for each group.

The experimental group participated in an 8-week community-based programme combining exercise training and a plan to increase PAL. Exercise training consisted of walking 5 days a week for 30–60 min (in cycles of 15–20 min) at speeds based on the last level completed in a previously conducted incremental shuttle test (Holland et al., 2014; Table 1). The plan to increase activity was based on gradually raising the number of daily steps, inspired by the "Theory of Establishment of Goals or Objectives" (Locke, Lathman, & Smith, 1990). Each week, we aspired to increase the participants' total number of steps by 10–20% in relation to the previous week. Patients used pedometers to control walking speed and number of daily steps; they were taught to note their gait and number of steps/day in an activity diary, which was checked weekly through a phone call. Through these calls, we analysed possible causes of noncompliance, encouraged patients, and set the new objectives for the following week.

At the end of the programme, patients were instructed to maintain the level of activity reached in the final week. Over the next 3 months, a monthly control was made through telephone calls, although it was no longer mandatory to register activity.

The control group received informative sessions about the benefits of exercise. They were given the same pedometer as the subjects in the experimental group, but no specific instructions, only general recommendations to walk more every day.

TABLE 1 Progression of the walking programme applied to the experimental group

Week	Total walking time/day (min)	Walking cycles/day	Number steps/cycle
1	30	2 cycles of 15 min	$0.8 \times n \times t$
2	30	2 cycles of 15 min	$0.9 \times n \times t$
3	30	2 cycles of 15 min	$n \times t$
4	40	2 cycles of 20 min	$n \times t$
5	40	2 cycles of 20 min	$1.1 \times n \times t$
6	50	1 cycle of 20 min + 2 cycles of 15 min	$1.1 \times n \times t$
7	55	2 cycles of 20 min + 1 cycle of 15 min	$1.1 \times n \times t$
8	60	3 cycles of 20 min	$1.1 \times n \times t$

Note. The table shows the weekly progression of the programme in terms of the total daily training time and its distribution in cycles. The goal of number of steps that each subject had to reach in each walking cycle is detailed in the column on the right, where "*n*" is the number of steps taken in 1-min walking at the speed of the last level completed on the incremental shuttle test and "*t*" is the duration of each cycle. Achieving this goal meant that they had walked at optimal speed for most of the time in each walking cycle.

2.4 | Analysis

A descriptive analysis was made of the socio-demographical and clinical characteristics of the subjects at the beginning of the study, and homogeneity between groups was verified. Independent samples *t* tests and Mann–Whitney *U* tests were used to analyse the differences between groups in the result variables postintervention and after follow-up versus preintervention. Moreover, a covariance analysis was made. In the main variables, a sensitivity analysis was applied, as well as an analysis of subgroups in order to determine whether or not the use of long-term oxygen therapy and the season had any influence on the results. Finally, we determined the association between the modification in the PAL and the change in the rest of the variables through the Spearman correlation coefficient, checking for confounding factors. For the analysis of the normality of the variables, we used the Shapiro–Wilk test. In all of the analyses, we assumed a level of confidence ($1 - \alpha$) of 0.95 (level of significance $\alpha = 0.05$). The program used was SPSS® Statistics Version 20.0 (SPSS Inc., Chicago).

3 | RESULTS

A total of 40 subjects were recruited, of whom five dropped out and two were excluded for noncompliance during the intervention phase (17.5% loss). No losses occurred during the follow-up period; therefore, we analysed a total of 33 subjects (17 in the experimental group). Figure 1 shows a participation diagram, and Table 2 lists the characteristics of the sample at the beginning of the study.

3.1 | Effects of the intervention

Postintervention, significant differences were found between the groups in all of the main variables ($p < 0.01$; Table 3). In the experimental group, EST increased by 6.1 ± 5.7 min and 491.4 ± 484.5 m (increases of 103% and 90%, respectively); steps/day increased by 3,158 ± 2,191 or 45%; and total Baecke scores increased by 1.7 ± 2.2. Furthermore, the experimental group showed reduced total SGRQ scores, symptoms, and impact dimensions ($p < 0.01$). No significant differences were observed on the dyspnoea scale ($p > 0.05$).

During the follow-up, significant differences between the groups were also found in relation to the main variables ($p < 0.01$; Table 4). After 3 months of monitoring, the experimental group's EST,

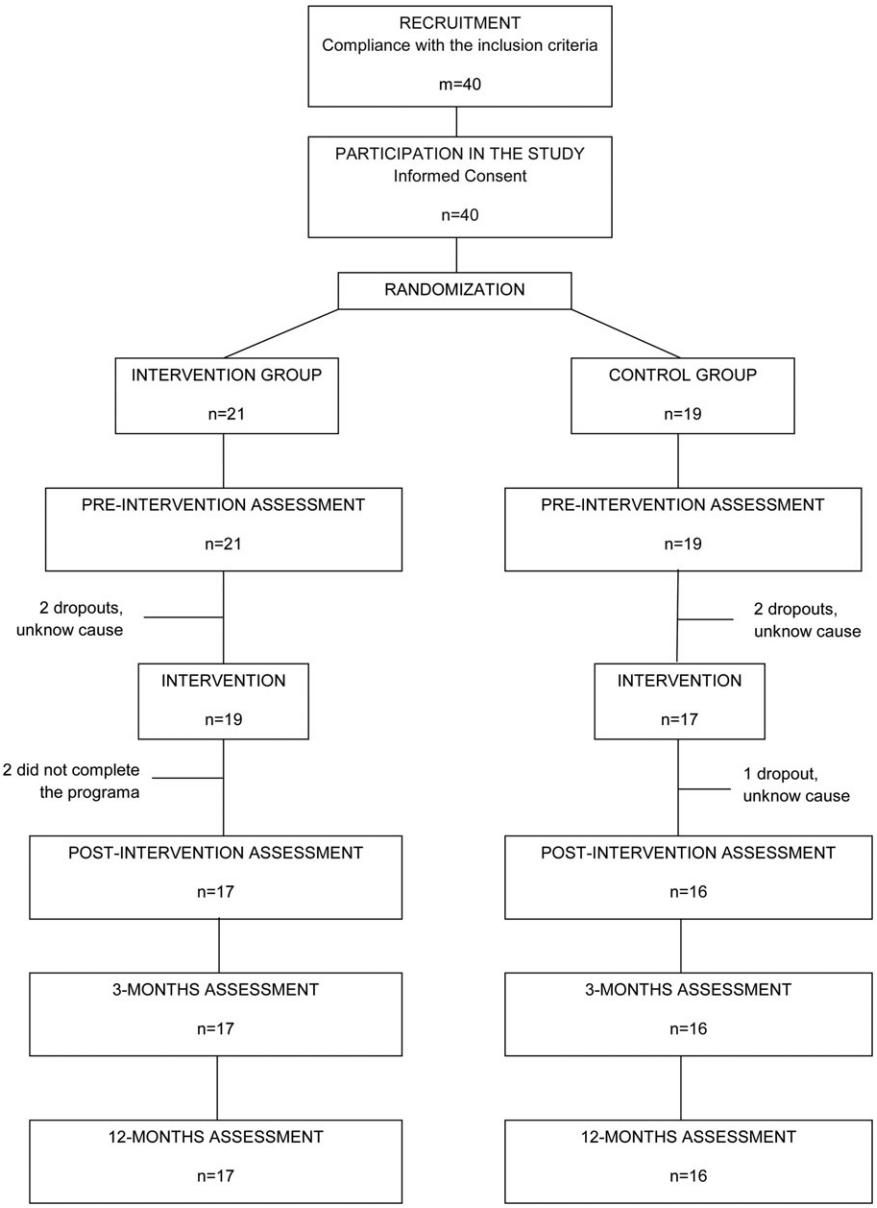

FIGURE 1 Consolidated Standards of Reporting Trials flow diagram of participation

compared with preintervention numbers, had increased by 6.9 ± 6.7 min and 592.6 ± 595.6 m (increases of 112% and 94%, respectively); steps/day had increased by 3,525 ± 2,404 (49%); and total Baecke scores increased by 3.3 ± 3.1. After 12 months, they maintained improvements of 5.5 ± 6.3 min and 472 ± 576.6 m in EST (95% and 81%), as well as of 1,797 ± 2,947 steps/day (25%) and of 2 ± 2.6 in total Baecke score, compared with pre-intervention levels. Furthermore, total SGRQ scores, symptoms, and impact dimensions continued to decrease over 3 months ($p < 0.01$), and this was maintained in total score and impact dimension after 12 months ($p < 0.01$). Nevertheless, no differences were observed in dyspnoea ($p > 0.05$).

The number of exacerbations in the 12 months before the study was similar in both groups (range 0–5) and decreased over the 12 months of monitoring in the experimental group (range 0–2), although not significantly ($p > 0.05$).

Figures 2–4 depict the evolution of the variables with significant results.

3.1.1 | Analysis of sensitivity and subgroups

In the analysis of sensitivity, similar results were maintained to those obtained in the protocol analysis. Moreover, when we separated the groups according to whether or not they used long-term oxygen therapy and the season that the patients completed the programmes (autumn to winter or spring to summer), no differences were found ($p > 0.05$).

3.2 | Associations between modification of PAL and exercise capacity, quality of life, dyspnoea, and exacerbations

In the association analysis controlled by confounding factors, a significant correlation was found between increase in PAL and improved EST results—as well as in quality of life—after both 3 and 12 months ($p < 0.01$) (Table 5). The association was not significant either in the case of dyspnoea or in the exacerbations ($p > 0.05$).

TABLE 2 Demographic characteristics of study participants

Characteristic	Experimental group *n* = 21	Control group *n* = 19
Gender (men), *n* (%)	18 (85.7)	13 (68.4)
Age	69.5 ± 7.4	64.8 ± 9.1
BMI (kg/m^2)	26.3 ± 4.9	26.6 ± 5
FEV_1 (L)	1.44 ± 0.48	1.52 ± 0.6
FEV_1 (%)	45.8 ± 16.5	52.3 ± 15.7
FVC (L)	2.51 ± 0.55	2.57 ± 0.88
FVC (%)	50.7 ± 13.3	55.3 ± 16.9
FEV_1/FVC (%)	55.5 ± 10.6	54.9 ± 15.6
Smoking status		
Nonsmokers, *n* (%)	3 (14.3)	2 (10.5)
Ex-smokers, *n* (%)	17 (81)	15 (78.9)
Smokers, *n* (%)	1 (4.8)	2 (10.5)
Pack/year	38.7 ± 23.3	39.9 ± 29.1
Use of LTOT, *n* (%)	3 (14.3)	3 (15.8)
Season (aut–wint), *n* (%)	15 (71.6)	14 (73.7)
BODE index	2.3 ± 1.4	2 ± 1.2
Charlson index	2.7 ± 2.7	1.5 ± 0.9
IST-Distance (m)	353.8 ± 107.9	397.4 ± 140
EST-Time (min)	7 ± 5.4	7.5 ± 5.4
EST-Distance (m)	657 ± 573.8	678.7 ± 553.7
Steps/day	7,153 ± 3,607	5,888 ± 2,121
Baecke questionnaire		
Domestic	1.3 ± 0.8	1.7 ± 0.6
Leisure	2.3 ± 1.5	1.1 ± 0.6
Sport	3.9 ± 2.9	1.7 ± 2.6
Total	6.5 ± 3.2	4.5 ± 2.8
SGRQ		
Symptoms	38.2 ± 13.2	44.1 ± 21.6
Activity	56.1 ± 20.5	59.8 ± 18.3
Impact	31.5 ± 15.1	36.3 ± 15.5
Total	41.2 ± 13.2	44.6 ± 15.6
Dyspnoea (mMRC)	1.4 ± 0.8	1.5 ± 0.7
Exacerbations	1 ± 1.4	1.6 ± 1.7

Note. Qualitative variables are expressed with their absolute and relative frequencies (%), and the quantitative variables with their mean and the standard deviation. Homogeneity between groups is verified in all of the variables ($p > 0.05$). BMI: body mass index; FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity; FEV_1 (%) and FVC (%): percentage of FEV_1 and of the FVC in relation to the reference value; LTOT: long-term oxygen therapy; Season (autumn–winter): period of participation in the study (from October to March); BODE: Body Mass Index, Obstruction, Dyspnoea and Exercise; IST: incremental shuttle test; EST: endurance shuttle test; SGRQ: St. George's Respiratory Questionnaire; mMRC: modified scale of the Medical Research Council.

4 | DISCUSSION

This study demonstrates that a community-based PR programme in COPD patients improves exercise capacity, PAL, and quality of life over the medium and long term. Results were above the minimum clinically important difference for each variable (Borel, Pepin, Mahler, Nadreau, & Maltais, 2014; Demeyer et al., 2016; Jones, 2002). In the present scientific literature, there are relatively few studies of community-based programmes, which primarily aim to increase PAL in COPD patients and even fewer that combine self-administered exercise training with strategies of increased activity (Mantoani et al., 2016; Watz et al., 2014). In this regard, our study covers a new terrain.

This research has also demonstrated that increased PAL (measured in steps/day and Baecke score) directly affects the increases in time and distance achieved on the EST and the reduction of SGRQ scores. In contrast, there were no changes in dyspnoea or exacerbations.

The benefits obtained in exercise capacity and quality of life indicate that this type of programme both produced a short-term training effect and maintained these benefits over time, suggesting that patients autonomously adopted the regular practice of physical exercise. The programme was based on so-called critical speed, which is the maximum walking speed that can be maintained during a discrete period of time and which corresponds to 90% of VO_2max (Casas et al., 2005). It is a simple and objective system that, employing a pedometer, allows people to control the intensity of their walking; consequently, it is easy to apply, which is a key factor in ensuring that people stick to the programme in the long term. High-speed walking training based on the incremental shuttle test has been used successfully in previous studies (Liu et al., 2008; Mitchell et al., 2014). Moreover, the use of feedback systems—such as a musical programme, which set the pace of the walk (Liu et al., 2008), monitoring heart rate (Pradella et al., 2015) or the level of dyspnoea (de Sousa Pinto, Martín Nogueras, Calvo Arenillas, & Ramos González, 2014)—also obtained good results. In contrast, Dias et al. (2013) found no changes in exercise capacity in a high-speed walking plan with no specific speed control, suggesting that participants may not have trained at the established speed.

Our results regarding the number of steps/day and Baecke scores clearly show changes in the activity habits of the experimental group. These are consistent with results from other researchers who combined, as we did, a plan to increase activity with an exercise training programme (Cruz, Brooks, & Marques, 2016; de Blok et al., 2006). Nevertheless, other studies that applied programmes of increased activity in an isolated manner reported less significant results in terms of steps/day (Altenburg et al., 2015; Hospes, Bossenbroek, Ten Hacken, van Hengel, & de Greef, 2009; Moy, Weston, Wilson, Hess, & Richardson, 2012), which were not maintained over the long term (Altenburg et al., 2015; Moy et al., 2016). This could be due to the fact that reduced symptoms—associated with increased exercise capacity—enable patients to initiate more activity on their own, because fears that dyspnoea might arise are associated with fewer steps/day (Danilack, Weston, Richardson, Mori, & Moy, 2014). This reflection coincides with the conclusions of the recent reviews by Mantoani et al. (2016) and Lahham et al. (2016), who recommend the combination of physical training and behavioural intervention strategies.

Furthermore, physical training through walking may also have been useful in motivating patients to walk more. A recent study found no differences in the number of steps after PR—based on cyclo-ergometer training—between those subjects who also received a plan to increase activity guided through the use of a pedometer

TABLE 3 Short-term effects of intervention

Characteristic	ΔPostintervention − Preintervention		Adjust. diff. (95% CI)	Value of *p*
	Experimental group *n* = 17	Control group *n* = 16		
EST-Time (min)	6.1 ± 5.7	−0.9 ± 2.1	7.6 [4.4, 10.7]	0.000
EST-Distance (m)	491.4 ± 486.5	−70.3 ± 163.4	549 [282, 815]	0.000
Steps/day	3,158 ± 2,191	−16 ± 2,795	3,394 [1,540, 5,248]	0.001[a]
Baecke questionnaire				
Domestic	0.1 ± 0.3	0 ± 0.3	0.1 [−0.1, 0.3]	0.449[a]
Leisure	0 ± 0.7	0 ± 0.5	0 [−0.5, 0.5]	0.857
Sport	0.5 ± 1.1	0.1 ± 1.2	0.4 [−0.4, 1.2]	0.352[a]
Total	1.7 ± 2.2	0 ± 1.4	1.6 [0.2, 3.1]	0.002
SGRQ				
Symptoms	−4 ± 11.1	3.8 ± 7.3	−7.8 [−14.5, −1.1]	0.024[a]
Activity	−2.2 ± 6.6	1.7 ± 7.7	−3.9 [−8.9, 1.2]	0.058
Impact	−5.8 ± 5.2	1.4 ± 5.6	−7.3 [−11.1, −3.4]	0.001[a]
Total	−4.4 ± 3.6	1 ± 4.3	−5.5 [−8.4, −2.6]	0.000[a]
Dyspnoea (mMRC)	−0.2 ± 0.4	0 ± 0.6	−0 [−0.6, 0.1]	0.444

Note. The data are presented as the mean and standard deviation postintervention versus preintervention for each study group. The table lists the average adjusted difference for basal values; confidence intervals = 95% (Adjusted diff. (95% CI)) of the change produced by the application of the experimental programme. EST: endurance shuttle test; SGRQ: St. George's Respiratory Questionnaire; mMRC: modified scale of the Medical Research Council.

[a]Value of "*p*" obtained through covariance analysis (fulfilment of the conditions of applicability of the regression model). The rest of the *p* values were obtained from the corresponding comparison means test.

TABLE 4 Medium- to long-term effects of intervention

Characteristic	Δ3 months − Preintervention				Δ12 months − Preintervention			
	Experimental group *n* = 17	Control group *n* = 16	Adjust. diff. (95% CI)	Value of *p*	Experimental group *n* = 17	Control group *n* = 16	Adjust. diff. (95% CI)	Value of *p*
EST-Time (min)	6.9 ± 6.7	−1.4 ± 2.4	8.9 [5.2, 12.6]	0.000	5.5 ± 6.3	−2 ± 2.2	7.8 [4.2, 11.3]	0.000
EST-Distance (m)	592.6 ± 595.6	−57.3 ± 262	624 [290, 958]	0.000	472 ± 576.6	−152.4 ± 164.9	633 [223, 944]	0.000
Steps/day	3,525 ± 2,404	−316 ± 2,333	3,767 [2,014, 5,520]	0.000[a]	1,797 ± 2,947	−750 ± 1,659	2,457 [675, 4,240]	0.009[a]
Baecke questionnaire								
Domestic	0.2 ± 0.4	0 ± 0.3	0.2 [−0.1, 0.5]	0.154[a]	0.2 ± 0.5	−0.1 ± 0.5	0.3 [−0.1, 0.6]	0.082[a]
Leisure	0.5 ± 0.7	0.1 ± 0.4	0.3 [0, 0.8]	0.074[a]	0 ± 0	0 ± 0	0 ± 0	1.000
Sport	1.4 ± 2	−0.1 ± 1.5	1.5 [0.3, 2.8]	0.006	0.7 ± 1.9	−0.2 ± 0.8	0.9 [−0.1, 2]	0.068[a]
Total	3.3 ± 3.1	−0.1 ± 0.6	3.7 [1.7, 5.5]	0.000	2 ± 2.6	−0.2 ± 0.8	2.8 [1.3, 4.3]	0.000
SGRQ								
Symptoms	−6.3 ± 13.9	3.2 ± 8.4	−9.5 [−17.9, −1.6]	0.025[a]	−4.3 ± 12.4	2.3 ± 8.7	−6.6 [−14.2, −1]	0.087[a]
Activity	−3.9 ± 9.1	0 ± 8	−3.9 [−10.1, 2.1]	0.382	−3.4 ± 9.3	1 ± 6.9	−4.4 [−10.3, 1.4]	0.094
Impact	−6.8 ± 7.8	−6.6 ± 6.8	−10.8 [−15.9, −5.9]	0.000[a]	−4 ± 5.8	5.7 6	−12.3 [−16.9, −7.8]	0.000[a]
Total	−6.7 ± 5.2	−5.4 ± 5	−9 [−12, −5.5]	0.000[a]	−2.3 ± 3.8	3.2 ± 4.1	−8.9 [−12, −5.6]	0.000[a]
Dyspnoea (mMRC)	−0.2 ± 0.4	0 ± 0.4	−0.2 [−0.4, 0.1]	0.423	−0.2 ± 0.4	0.1 ± 0.6	−0.3 [−0.7, 0.1]	0.295
Exacerbations	—	—	—	—	−0.5 ± 0.1	−0.3 ± 1.6	−0.3 [−1.3, 0.7]	0.465

Note. The data are presented as the mean and standard deviation of the postintervention difference (3 months and 12 months) versus preintervention for each study group. The table lists the average difference adjusted for basal values, with the 95% confidence interval (Adjust. diff. (95% CI)) of the change produced by the application of the experimental programme. EST: endurance shuttle test; SGRQ: St. George's Respiratory Questionnaire; mMRC: modified scale of the Medical Research Council.

[a]Value of "*p*" obtained through covariance analysis (fulfilment of the conditions of applicability of the regression model). The rest of the *p* values were obtained from the corresponding comparison means test.

and those who completed the training alone (Nolan et al., 2017). The departure from our results could be explained by the different type of exercise. Walking is a natural activity and can easily be incorporated into daily life.

One factor that we consider to be essential to our results is the type of instructions patients received about their exercise. These were very precise, incorporating a system to control exercise intensity and the use of an activity diary. Providing patients with a pedometer and

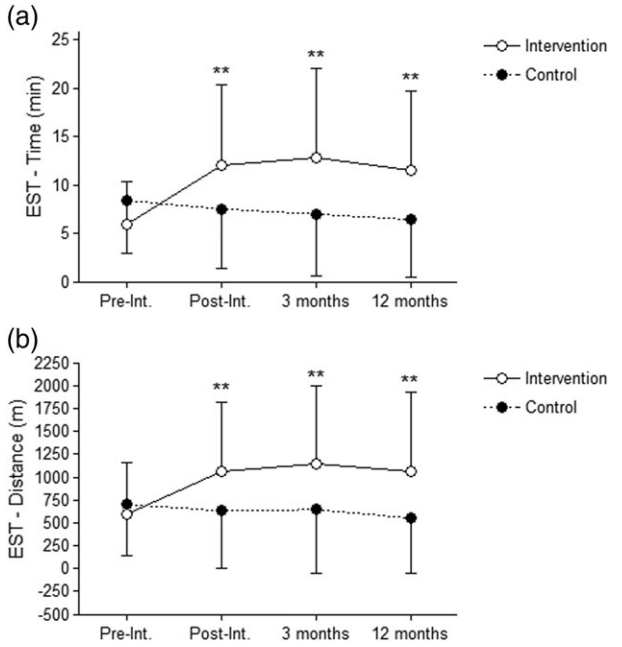

FIGURE 2 (a) The mean and standard deviation of time achieved in the endurance shuttle test (EST) for each study group, in the different periods: Prior to intervention (Pre-Int.), immediately after the end of the intervention (Post-Int.), after 3 months (3 months), and after 12 months (12 months) of the postintervention register. $^{**}p < 0.01$ for the between-group difference postintervention versus preintervention and after 3 and 12 months versus preintervention. (b) The mean and standard deviation of distance achieved in the EST for each study group, in the different periods: prior to intervention (Pre-Int.), immediately after the end of the intervention (Post-Int.), after 3 months (3 months), and after 12 months (12 months) of the postintervention register. $^{**}p < 0.01$ for the between-group difference postintervention versus preintervention and after 3 and 12 months versus preintervention

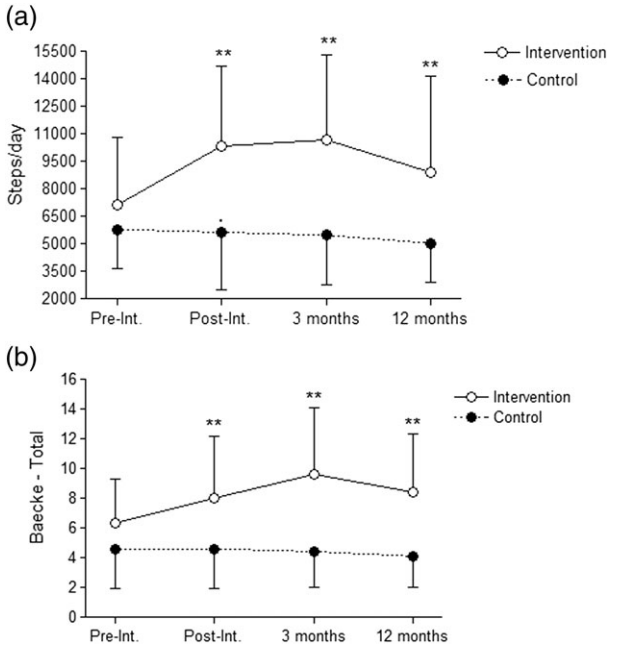

FIGURE 3 (a) The mean and standard deviation of the number of steps per day for each study group, in the different periods: prior to intervention (Pre-Int.), immediately after the end of the intervention (Post-Int.), after 3 months (3 months), and after 12 months (12 months) of the postintervention register. $^{**}p < 0.01$ for the between-group difference postintervention versus preintervention and after 3 and 12 months versus preintervention. (b) This represents the mean and standard deviation of the total score on the modified Baecke questionnaire for each study group, in the different periods: prior to intervention (Pre-Int.), immediately after the end of the intervention (Post-Int.), after 3 months (3 months), and after 12 months (12 months) of the postintervention register. $^{**}p < 0.01$ for the between-group difference postintervention versus preintervention and after 3 and 12 months versus preintervention

a set of general recommendations about walking may not be enough to achieve measurable improvements in PAL, as we observed in the control group of our study and in others' research (de Blok et al., 2006; Hospes et al., 2009). On the other hand, Mendoza et al. (2015) did find a significant increase in activity (3,000 steps/day) when conducting a 3-month programme in which the only difference between the groups was that participants in the experimental group received pedometers and made a note of their daily steps. Nevertheless, the sample analysed in this study showed little ventilatory affectation, and the maintenance of effects in the longer term was not assessed. In any case, more research is needed to determine the influence of the accuracy of the instructions given to patients in community-based PR programmes.

Moreover, the absence of changes in the perception of dyspnoea in our study does not coincide with what has been reported in other studies that analysed community-based PR through walking (de Sousa Pinto et al., 2014; Mitchell et al., 2014). These discrepancies may be due to our choice of dyspnoea scale; the Medical Research Council scale is very simple and depends on activity level (Alonso, 2014). The absence of change in the number of exacerbations after 12 months is consistent with results reported by other authors (van Wetering, Hoogendoorn, Mol, Rutten-van Mölken, & Schols, 2010). They stated that the educational sessions applied to the control group improved their strategies to manage the disease and the early detection of flare-ups, an effect that could be also be attributed to our results.

Therefore, we conclude that the increase in the PAL in our study had an influence on the changes in exercise capacity and quality of life, according with a recent review (Meshe, Claydon, Bungay, & Andrew, 2017). The

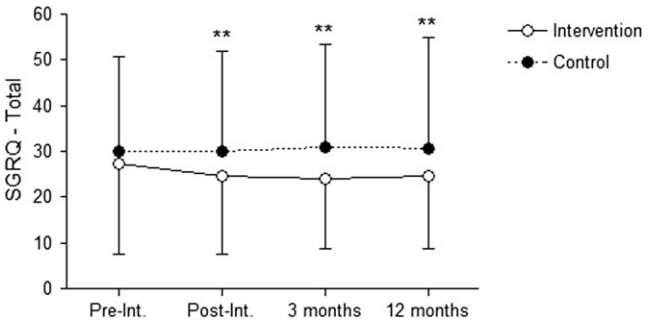

FIGURE 4 The mean and standard deviation of the total score obtained on the St. George's Respiratory Questionnaire (SGRQ) for each study group in the different periods: prior to intervention (Pre-Int.), immediately after the end of the intervention (Post-Int.), after 3 months (3 months), and after 12 months (12 months) of the postintervention register. $^{**}p < 0.01$ for the between-group difference postintervention versus preintervention and after 3 and 12 months versus preintervention

TABLE 5 Association between modification of physical activity level and dyspnoea, quality of life, exercise capacity, and exacerbations

	3 months versus preintervention				12 months versus preintervention			
	ΔSteps/day		ΔBaecke-Total		ΔSteps/day		ΔBaecke-Total	
Characteristic	*r* (95% CI)	*p*	*r* (95% CI)	*p*	*r* (95% CI)	*p*	*r* (95% CI)	*p*
ΔDyspnoea (mMRC)	0.18 [−0.48, 0.17]	0.302	−0.11 [−0.44, −0.3]	0.531	−0.35 [−0.62, 0.21]	0.050	−0.2 [−0.52, 0.15]	0.215
ΔSGRQ-Total	−0.59 [−0.91, −0.19]	0.000	−0.75 [−0.92, −0.48]	0.000	−0.63 [−0.88, −0.31]	0.000	−0.67 [−0.82, −0.44]	0.000
ΔEST-Distance (m)	0.64 [0.33, 0.88]	0.000	0.57 [0.28, 0.76]	0.001	0.70 [0.41, 0.90]	0.000	0.64 [0.35, 0.86]	0.000
ΔEST-Time (min)	0.94 [0.34, 0.90]	0.000	0.62 [0.33, 0.79]	0.000	0.71 [0.43, 0.91]	0.000	0.64 [0.34, 0.86]	0.000
ΔExacerbations	—	—	—	—	−0.35 [−0.62, 0.01]	0.050	−0.07 [−0.34, 0.29]	0.681

Note. Association between modification of the number of steps per day (ΔSteps/day) and of the modified Baecke questionnaire total score (ΔBaecke-Total), after 3 and 12 months versus baseline, and variation in the modified scale of the Medical Research Council score (ΔDyspnoea [mMRC]), the St. George's Respiratory Questionnaire total score (ΔSGRQ-Total), the distance and time achieved on the endurance shuttle test (ΔEST), and the number of exacerbations. Associations between the variables are presented for the complete sample and have been analysed through the Spearman correlation coefficient (*r*) and the 95% confidence interval (95% CI). Analysis checked for confounding factors (aged, FEV_1 [%], Charlson index, and BODE index), as well as for the basal values of the dependent variables.

good results obtained from this intervention seem to magnify this association in relation to other research (Altenburg et al., 2015; Zwerink, van der Palen, van der Valk, Brusse-Keizer, & Effing, 2013). Nevertheless, we have not found any association with exacerbations, which could have been influenced by the sample size or the period of monitoring, because the studies that reported a significant correlation between the modification in the PAL and the exacerbation used larger samples and more prolonged monitoring periods (Durheim et al., 2015; Esteban et al., 2014).

4.1 | Limitations of the study

The scale used to assess dyspnoea may not have been adequately discriminating to show changes. Furthermore, the relatively small sample size and year-long monitoring period may have been insufficient to reveal differences in the number of exacerbations. In addition, the demographic differences between the study sample and other populations could cause a drop in the observed results. Finally, the evaluation of the patient's barriers to exercise would have contributed relevant information to the study.

5 | CONCLUSIONS

A community-based 8-week training programme to increase PAL —based on high-speed walking and using a pedometer for feedback —effectively improves exercise capacity, PAL, and quality of life in COPD patients, and these results are partially maintained for 12 months. Further studies have to explore whether or not these behavioural changes are sustained for more than 12 months and what kind of supervision stimulus could ensure the maintenance.

The change in PAL was significantly correlated with improvements in exercise capacity and quality of life. In order to determine any possible variations in exacerbations, it would be necessary to conduct further studies with more prolonged monitoring periods.

6 | PHYSIOTHERAPY IMPLICATIONS

Simple community-based PR programmes can prolong the duration of the effects of exercise training and improve the adherence of patients for physical activity, as we have showed with our programme. This protocol of exercise training and behavioural change is easily applicable to clinical practice, with a low cost. The following could be interesting: (a) its development in private clinics and primary care centres, as alternative in those patients who cannot access to a rehabilitation centre; (b) the maintenance of the effects after PR; and (c) to promote the practice of exercise and increase the PAL in the patients (in combination with the classic programmes or after them).

Moreover, our results impel us to continue researching in other effective interventions to make PR more available for COPD patients and their applicability in the most severe patients, in comparison with classic PR programmes. In the same way, it would be necessary to know more about the factors that influence the adherence of patients to exercise.

ACKNOWLEDGEMENT

This study has been completely funded by the Escuela Universitaria de Fisioterapia de la ONCE.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

Alonso, C. J. L. I. (2014). EPOC: consenso de expertos EXPERT 10. Disnea/síntomas. *Monografías de Archivos de Bronconeumología*, *1*(1). Available in http://separcontenidos.es/revista/index.php/revista/article/view/54

Altenburg, W. A., ten Hacken, N. H. T., Bossenbroek, L., Kerstjens, H. A. M., de Greef, M. H. G., & Wempe, J. B. (2015). Short- and long-term effects of a physical activity counselling programme in COPD: A randomized controlled trial. *Respiratory Medicine*, *109*(1), 112–121.

Borel, B., Pepin, V., Mahler, D. A., Nadreau, É., & Maltais, F. (2014). Prospective validation of the endurance shuttle walking test in the context of bronchodilation in COPD. *The European Respiratory Journal*, *44*(5), 1166–1176.

Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., Lewis, R., … Sirard, J. R. (2007). Using pedometers to increase physical activity and improve health: A systematic review. *JAMA*, *298*(19), 2296–2304. https://doi.org/10.1001/jama.298.19.2296

Busby, A. K., Reese, R. L., & Simon, S. R. (2014). Pulmonary rehabilitation maintenance interventions: A systematic review. *American Journal of Health Behavior*, *38*(3), 321–330.

Casas, A., Vilaro, J., Rabinovich, R., Mayer, A., Barberà, J. A., Rodriguez-Roisin, R., & Roca, J. (2005). Encouraged 6-min walking test indicates maximum sustainable exercise in COPD patients. *Chest*, *128*(1), 55–61.

Cruz, J., Brooks, D., & Marques, A. (2016). Walk2Bactive: A randomised controlled trial of a physical activity-focused behavioural intervention beyond pulmonary rehabilitation in chronic obstructive pulmonary disease. *Chronic Respiratory Disease*, *13*(1), 57–66.

Danilack, V. A., Weston, N. A., Richardson, C. R., Mori, D. L., & Moy, M. L. (2014). Reasons persons with COPD do not walk and relationship with daily step count. *COPD*, *11*(3), 290–299.

de Blok, B. M. J., de Greef, M. H. G., ten Hacken, N. H. T., Sprenger, S. R., Postema, K., & Wempe, J. B. (2006). The effects of a lifestyle physical activity counseling program with feedback of a pedometer during pulmonary rehabilitation in patients with COPD: A pilot study. *Patient Education and Counseling*, *61*(1), 48–55.

de Sousa Pinto, J. M., Martín Nogueras, A. M., Calvo Arenillas, J. I., & Ramos González, J. (2014). Clinical benefits of home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease. *Journal of Cardiopulmonary Rehabilitation and Prevention*, *34*(5), 355–359.

Demeyer, H., Burtin, C., Hornikx, M., Camillo, C. A., Van Remoortel, H., Langer, D., … Troosters, T. (2016). The minimal important difference in physical activity in patients with COPD. *PLoS One*, *11*(4), e0154587.

Dias, F. D., Sampaio, L. M. M., da Silva, G. A., Gomes, É. L. F. D., do Nascimento, E. S. P., Alves, V. L. S., … Costa, D. (2013). Home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: A randomized clinical trial. *International Journal of Chronic Obstructive Pulmonary Disease*, *8*, 537–544.

Durheim, M. T., Smith, P. J., Babyak, M. A., Mabe, S. K., Martinu, T., Welty-Wolf, K. E., … Blumenthal, J. A. (2015). Six-minute-walk distance and accelerometry predict outcomes in chronic obstructive pulmonary disease independent of Global Initiative for Chronic Obstructive Lung Disease 2011 Group. *Annals of the American Thoracic Society*, *12*(3), 349–356.

Esteban, C., Arostegui, I., Aburto, M., Moraza, J., Quintana, J. M., Aizpiri, S., … Capelastegui, A. (2014). Influence of changes in physical activity on frequency of hospitalization in chronic obstructive pulmonary disease. *Respirology (Carlton, Vic.)*, *19*(3), 330–338.

GOLD. (2017). Global Strategy for the Diagnosis, Management and Prevention of COPD. Available in: http://goldcopd.org/gold-2017-global-strategy-diagnosis-management-prevention-copd/

Güell, R., Casan, P., Sangenís, M., Morante, F., Belda, J., & Guyatt, G. H. (1998). Quality of life in patients with chronic respiratory disease: The Spanish version of the Chronic Respiratory Questionnaire (CRQ). *The European Respiratory Journal*, *11*(1), 55–60.

Hill, K., Gardiner, P. A., Cavalheri, V., Jenkins, S. C., & Healy, G. N. (2015). Physical activity and sedentary behaviour: Applying lessons to chronic obstructive pulmonary disease. *Internal Medicine Journal*, *45*(5), 474–482. https://doi.org/10.1111/imj.12570

Holland, A. E., Spruit, M. A., Troosters, T., Puhan, M. A., Pepin, V., Saey, D., … Singh, S. J. (2014). An official European Respiratory Society/American Thoracic Society technical standard: Field walking tests in chronic respiratory disease. *The European Respiratory Journal*, *44*(6), 1428–1446.

Hospes, G., Bossenbroek, L., Ten Hacken, N. H. T., van Hengel, P., & de Greef, M. H. G. (2009). Enhancement of daily physical activity increases physical fitness of outclinic COPD patients: Results of an exercise counseling program. *Patient Education and Counseling*, *75*(2), 274–278.

Jones, P. W. (2002). Interpreting thresholds for a clinically significant change in health status in asthma and COPD. *The European Respiratory Journal*, *19*(3), 398–404.

Lahham, A., McDonald, C. F., & Holland, A. E. (2016). Exercise training alone or with the addition of activity counseling improves physical activity levels in COPD: A systematic review and meta-analysis of randomized controlled trials. *International Journal of Chronic Obstructive Pulmonary Disease*, *11*, 3121–3136.

Leidy, N. K., Kimel, M., Ajagbe, L., Kim, K., Hamilton, A., & Becker, K. (2014). Designing trials of behavioral interventions to increase physical activity in patients with COPD: Insights from the chronic disease literature. *Respiratory Medicine*, *108*(3), 472–481.

Liu, W. T., Wang, C. H., Lin, H. C., Lin, S. M., Lee, K. Y., Lo, Y. L., … Kuo, H. P. (2008). Efficacy of a cell phone-based exercise programme for COPD. *The European Respiratory Journal*, *32*(3), 651–659.

Locke, E. A., Lathman, G. P., & Smith, K. J. (1990). *A theory of goal stting and task performance*. Englewood Clifs N.J: Prentice Hall.

Mantoani, L. C., Rubio, N., McKinstry, B., MacNee, W., & Rabinovich, R. A. (2016). Interventions to modify physical activity in patients with COPD: A systematic review. *The European Respiratory Journal*, *48*(1), 69–81.

McCarthy, B., Casey, D., Devane, D., Murphy, K., Murphy, E., & Lacasse, Y. (2015). Pulmonary rehabilitation for chronic obstructive pulmonary disease. *The Cochrane Database of Systematic Reviews*, *2*, CD003793.

Mendoza, L., Horta, P., Espinoza, J., Aguilera, M., Balmaceda, N., Castro, A., … Hopkinson, N. S. (2015). Pedometers to enhance physical activity in COPD: A randomised controlled trial. *European Respiratory Journal*, *45*(2), 347–354.

Meshe, O. F., Claydon, L. S., Bungay, H., & Andrew, S. (2017). The relationship between physical activity and health status in patients with chronic obstructive pulmonary disease following pulmonary rehabilitation. *Disability and Rehabilitation*, *39*(8), 746–756. https://doi.org/10.3109/09638288.2016.1161842

Miravitlles, M., Soler Cataluña, J. J., Calle, M., Molina, J., Almagro, P., Quintano, J. A., & Ancochea, J. (2012). Guía Española de la EPOC (GesEPOC). Tratamiento farmacológico de la EPOC estable. *Archivos de Bronconeumología*, *48*(7), 247–257.

Mitchell, K. E., Johnson-Warrington, V., Apps, L. D., Bankart, J., Sewell, L., Williams, J. E., … Singh, S. J. (2014). A self-management programme for COPD: A randomised controlled trial. *The European Respiratory Journal*, *44*(6), 1538–1547.

Moy, M. L., Janney, A. W., Nguyen, H. Q., Matthess, K. R., Cohen, M., Garshick, E., & Richardson, C. R. (2010). Use of pedometer and Internet-mediated walking program in patients with chronic obstructive pulmonary disease. *Journal of Rehabilitation Research and Development*, *47*(5), 485–496.

Moy, M. L., Martinez, C. H., Kadri, R., Roman, P., Holleman, R. G., Kim, H. M., … Richardson, C. R. (2016). Long-term effects of an internet-mediated pedometer-based walking program for chronic obstructive pulmonary disease: Randomized controlled trial. *Journal of Medical Internet Research*, *18*(8), e215.

Moy, M. L., Weston, N. A., Wilson, E. J., Hess, M. L., & Richardson, C. R. (2012). A pilot study of an Internet walking program and pedometer in COPD. *Respiratory Medicine*, *106*(9), 1342–1350.

Nolan, C. M., Maddocks, M., Canavan, J. L., Jones, S. E., Delogu, V., Kaliaraju, D., … Man, W. D. C. (2017). Pedometer step count targets during pulmonary rehabilitation in chronic obstructive pulmonary disease. A randomized controlled trial. *American Journal of Respiratory and Critical Care Medicine*, *195*(10), 1344–1352.

Pitta, F., Troosters, T., Spruit, M. A., Decramer, M., & Gosselink, R. (2005). Activity monitoring for assessment of physical activities in daily life in patients with chronic obstructive pulmonary disease. *Archives of Physical Medicine and Rehabilitation*, *86*(10), 1979–1985.

Pradella, C. O., Belmonte, G. M., Maia, M. N., Delgado, C. S., Luise, A. P. T., Nascimento, O. A., … Jardim, J. R. (2015). Home-based pulmonary

rehabilitation for subjects with COPD: A randomized study. *Respiratory Care*, *60*(4), 526–532.

Rochester, C. L., Vogiatzis, I., Holland, A. E., Lareau, S. C., Marciniuk, D. D., Puhan, M. A., … ATS/ERS Task Force on Policy in Pulmonary Rehabilitation (2015). An official American Thoracic Society/European Respiratory Society Policy statement: Enhancing implementation, use, and delivery of pulmonary rehabilitation. *American Journal of Respiratory and Critical Care Medicine*, *192*(11), 1373–1386.

Seemungal, T. A., Donaldson, G. C., Bhowmik, A., Jeffries, D. J., & Wedzicha, J. A. (2000). Time course and recovery of exacerbations in patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*, *161*(5), 1608–1613.

Spruit, M. A., Pitta, F., McAuley, E., ZuWallack, R. L., & Nici, L. (2015). Pulmonary rehabilitation and physical activity in patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*, *192*(8), 924–933.

Spruit, M. A., Singh, S. J., Garvey, C., ZuWallack, R., Nici, L., Rochester, C., … ATS/ERS Task Force on Pulmonary Rehabilitation (2013). An official American Thoracic Society/European Respiratory Society statement: Key concepts and advances in pulmonary rehabilitation. *American Journal of Respiratory and Critical Care Medicine*, *188*(8), e13–e64. https://doi.org/10.1164/rccm.201309-1634ST

Task group on surveillance for respiratory hazards in the occupational setting, & Brooks, S. M. (1982). Surveillance for respiratory hazards. *ATS News*, pp. 12–16.

Vaes, A. W., Cheung, A., Atakhorrami, M., Groenen, M. T. J., Amft, O., Franssen, F. M. E., … Spruit, M. A. (2013). Effect of «activity monitor-based» counseling on physical activity and health-related outcomes in patients with chronic diseases: A systematic review and meta-analysis. *Annals of Medicine*, *45*(5–6), 397–412.

van Wetering, C. R., Hoogendoorn, M., Mol, S. J. M., Rutten-van Mölken, M. P. M. H., & Schols, A. M. (2010). Short- and long-term efficacy of a community-based COPD management programme in less advanced COPD: A randomised controlled trial. *Thorax*, *65*(1), 7–13.

Vieira, D. S. R., Maltais, F., & Bourbeau, J. (2010). Home-based pulmonary rehabilitation in chronic obstructive pulmonary disease patients. *Current Opinion in Pulmonary Medicine*, *16*(2), 134–143.

Vilaró, J., Gimeno, E., Sánchez Férez, N., Hernando, C., Díaz, I., Ferrerc, M., … Alonso, J. (2007). Daily living activity in chronic obstructive pulmonary disease: Validation of the Spanish version and comparative analysis of 2 questionnaires. *Medicina Clinica*, *129*(9), 326–332.

Watz, H., Pitta, F., Rochester, C. L., Garcia-Aymerich, J., ZuWallack, R., Troosters, T., … Spruit, M. A. (2014). An official European Respiratory Society statement on physical activity in COPD. *The European Respiratory Journal*, *44*(6), 1521–1537.

Zwerink, M., van der Palen, J., van der Valk, P., Brusse-Keizer, M., & Effing, T. (2013). Relationship between daily physical activity and exercise capacity in patients with COPD. *Respiratory Medicine*, *107*(2), 242–248.

How to cite this article: Varas AB, Córdoba S, Rodríguez-Andonaegui I, Rueda MR, García-Juez S, Vilaró J. Effectiveness of a community-based exercise training programme to increase physical activity level in patients with chronic obstructive pulmonary disease: A randomized controlled trial. *Physiother Res Int*. 2018;e1740. https://doi.org/10.1002/pri.1740