Effects of 2 Exercise Training Programs on Physical Activity in Daily Life in Patients With COPD

Vanessa S Probst PhD, Demétria Kovelis PT, Nídia A Hernandes MSc, Carlos A Camillo PT, Vinícius Cavalheri MSc, and Fabio Pitta PhD

BACKGROUND: The effects of different exercise training programs on the level of physical activity in daily life in patients with COPD remain to be investigated. OBJECTIVE: In patients with COPD we compared the effects of 2 exercise/training regimens (a high-intensity whole-body endurance-and-strength program, and a low-intensity calisthenics-and-breathing-exercises program) on physical activity in daily life, exercise capacity, muscle force, health-related quality of life, and functional status. METHODS: We randomized 40 patients with COPD to perform either endurance-and-strength training (no. = 20, mean ± SD FEV_1 40 ± 13% of predicted) at 60–75% of maximum capacity, or calisthenics-and-breathing-exercises training (no. = 20, mean ± SD FEV_1 39 ± 14% of predicted). Both groups underwent 3 sessions per week for 12 weeks. Before and after the training programs the patients underwent activity monitoring with motion sensors, incremental cycle-ergometry, 6-min walk test, and peripheral-muscle-force test, and responded to questionnaires on health-related quality of life and functional status (activities of daily living, pulmonary functional status, and dyspnea). RESULTS: Time spent active and energy expenditure in daily life were not significantly altered in either group. Exercise capacity and muscle force significantly improved only in the endurance-and-strength group. Health-related quality of life and functional status improved significantly in both groups. CONCLUSIONS: Neither training program significantly improved time spent active or energy expenditure in daily life. The training regimens similarly improved quality of life and functional status. Exercise capacity and muscle force significantly improved only in the high-intensity endurance-and-strength group. *Key words: COPD; exercise; pulmonary rehabilitation; physical activity in daily life; activities of daily living.* [Respir Care 2011;56(11):1799–1807. © 2011 Daedalus Enterprises]

Introduction

A large body of evidence shows that pulmonary rehabilitation programs benefit patients with COPD by improving exercise capacity, muscle force, symptoms, and health-related quality of life.[1,2] More recently, benefits in improved daily physical activity have also been investigated, and the amount of physical activity in daily life can be improved by a long-lasting pulmonary rehabilitation program.[3] Despite its being an important outcome in a patient's activity behavior, the amount of physical activity in daily life is not the sole aspect of measuring physical activity, because other factors (eg, intensity of activities and energy expenditure) are also important features of physical activity.

The authors are affiliated with Laboratório de Pesquisa em Fisioterapia Pulmonar, Departamento de Fisioterapia, Universidade Estadual de Londrina, Londrina, Paraná, Brazil. Dr Probst and Ms Hernandes are also affiliated with Centro de Pesquisa em Ciências da Saúde, Centro de Ciências Biológicas e da Saúde, Universidade Norte do Paraná, Londrina, Paraná, Brazil.

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Correspondence: Fabio Pitta PhD, Departamento de Fisioterapia, Universidade Estadual de Londrina, Rua Robert Koch, 60 Vila Operaria, Londrina, Paraná, 86038–440 Brazil. E-mail: fabiopitta@uol.com.br.

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Exercise training remains the essential component of rehabilitation programs, and endurance training is commonly used.[2,4] Programs that include high-intensity exercise (such as endurance and strength training) and low-intensity training (such as callisthenic exercises in the sitting and standing position, moving the upper limbs against gravity) improve outcomes that are relevant to patients (eg, overall dyspnea, functional performance, and health status).[2,5-7] On the other hand, high-intensity programs tend to result in deeper physiological improvements, being especially efficient in increasing exercise capacity and muscle force.[2] However, an important issue not yet investigated is whether different exercise training programs result in different post-program effects on the level of physical activity in daily life in this population. In patients with COPD we compared the effects of 2 exercise/training regimens (a high-intensity whole-body endurance-and-strength program, and a low-intensity calisthenics-and-breathing-exercises program) on physical activity in daily life, exercise capacity, muscle force, health-related quality of life, and functional status.

Methods

This study was performed at and approved by the research ethics committee of University Hospital, Universidade Estadual de Londrina, Londrina, Paraná, Brazil, and all subjects gave written informed consent.

Study Design

In this prospective randomized trial, patients were assigned to one of two 3-month training programs: a high-intensity, whole-body endurance and strength training program (endurance-and-strength training), or a low-intensity calisthenics and breathing exercises training program. At baseline and after program completion we assessed physical activity in daily life, pulmonary function, exercise capacity, respiratory and peripheral muscle force, body composition, health-related quality of life, dyspnea, and functional status. Baseline assessment was performed in the week immediately prior to commencing the training program, and final assessment was performed in the week immediately after program completion.

Subjects

Sixty-three consecutive patients who were referred for exercise training were initially included in the study. The inclusion criteria were: COPD diagnosis according to the Global Initiative for Chronic Obstructive Lung Disease criteria[1]; stable condition (no exacerbations or infections in the preceding 3 months); no severe or unstable cardiac disease (eg, left-ventricular failure or atrial fibrillation); no comorbidities that might influence the execution of the tests and/or the exercise training programs; had not attended a pulmonary rehabilitation program in the last year; and able to attend the out-patient clinic 3 times per week. Pharmacologic treatment was not changed during the course of the study. The subjects performed testing at inclusion and after training-program completion. We collected data from July 2006 to July 2009.

Objective Assessment of Physical Activity in Daily Life

Activity monitoring in daily life was performed with 2 brands of motion sensor: DynaPort Activity Monitor (McRoberts, The Hague, The Netherlands) and SenseWear armband multisensor (BodyMedia, Pittsburgh, Pennsylvania). Both of these motion sensors are small, non-intrusive, and validated for patients with COPD.[8,9] Each subject wore the activity monitors simultaneously for 12 hours a day, during 2 weekdays (Tuesday and Wednesday), before and after (never during) the exercise programs. We used the 2-day average for the analysis, as previously described.[10]

The DynaPort activity monitor weighs 350 g and is worn on the patient's waist. It measures time spent per day walking, standing, sitting, and lying. All subjects were carefully instructed on how to position and wear the DynaPort, and received a manual with clear instructions and figures. This activity-measurement method was validated for patients with COPD and is as accurate as video recording.[8] The DynaPort's software (DynaScope) analyzes the data and creates the report.

The SenseWear multisensor is 8.8 × 5.6 × 2.1 cm and 82 g, and is worn on the upper-posterior region of the right arm. It has an accelerometer and multiple physiological sensors, and estimates energy expenditure with algorithms based on the wearer's sex, age, weight, height, and dominant arm. It reports total energy expenditure, energy expenditure in activities that demand more than 3 metabolic equivalents, time spent in activities that demand more than 3 metabolic equivalents, and number of steps per day.[9]

Secondary Outcomes

Lung function was assessed via spirometry,[11] and we used reference values from the Brazilian population.[12] Exercise capacity was evaluated with 3 tests: the 6-min walk test,[13] with the reference values from Troosters et al[14]; incremental symptom-limited cycle ergometry,[15] following a program previously described[16]; and constant-work-cycle ergometry (endurance time). Body composition was assessed with bioelectrical impedance[17] and we used the specific values described by Kyle et al.[18] Respiratory muscle force was measured with the maximum inspiratory and expiratory pressures,[19] with the reference values from Neder et al.[20] Peripheral muscle force was assessed with the one-repetition maximum test. Functional status was assessed with the London Chest Activity of Daily Living (LCADL) scale[21] and the Pulmonary Functional Status and Dyspnea Questionnaire Modified Version (PFSDQ-M).[22,23] Dyspnea during activities of daily living was assessed with the Medical Research Council dyspnea scale.[22,24] Health-Related Quality of Life was assessed with Saint George's Respiratory Questionnaire.[25,26]

Exercise Training Programs

Close supervision was provided during both training programs, with a ratio of one physiotherapist for every 4 patients. Both training programs consisted of 1-hour training sessions, 3 times per week, for 12 weeks.

The low-intensity calisthenics-and-breathing program, which has been used in patients with COPD,[27] consists of 5 sets of exercises: breathing exercises (diaphragmatic breathing and pursed-lips breathing); strengthening of the abdominal muscles (crunches); and calisthenics (trunk rotation and flexion, associated with pursed lips breathing and prolonged expiration). Calisthenics are defined as a form of dynamic exercise consisting of a variety of simple, often rhythmical, movements, generally using minimal equipment or apparatus. Exercises were performed in various body positions: supine, side-lying, sitting, kneeling, and standing. Each set consisted of 12 different exercises, repeated 15 times each. Every 7 sessions each patient began a new set of exercises. Intensity was increased in each new set of exercises by a progression in difficulty regarding the execution of the exercises: set 1 was the easiest, and set 5 the most difficult. As an example, Table 1 shows the first 2 sets of exercises.

The high-intensity whole-body endurance and strength exercise training included cycling; walking; and strength training for the quadriceps, biceps, and triceps muscle groups, based on a program previously described.[28] In the cycling ergometry the training intensity was initially set at 60% of the initial maximum work rate. In the treadmill walking the training intensity was initially set at 75% of the average walking speed during the baseline 6-min walk test. In the strength training the training intensity was initially set at 70% of the baseline one-repetition maximum test. The physiotherapist increased the patient's work rate or duration every week, guided by a pre-determined schedule and driven by the patient's perception of symptoms (measured via Borg dyspnea and fatigue scoring). We used a Borg dyspnea or fatigue score of 4–6 as the target.[29] Oxygen was routinely offered to patients who had S_{pO_2} $< 90\%$ during exertion.

Data Analysis

Statistical analysis was performed with statistics software (Prism 3, GraphPad Software, La Jolla, California). We checked for data-distribution normality with the Kolmogorov-Smirnov test, and used parametric statistics for normally distributed variables. The Medical Research Council dyspnea score data were non-normally distributed and were analyzed with non-parametric statistics. We made between-group and within-group comparisons with the unpaired *t* test, except for the Medical Research Council dyspnea score data, with which we used the Mann-Whitney test for between-group comparisons, and the Wilcoxon test for within-group comparisons. The level of statistical significance was set at $P < .05$ in all analyses.

We performed a post hoc power calculation based on the between-group difference in time spent in activities that demanded more than 3 metabolic equivalents. With an alpha of .05, a before-versus-after training between-group difference of 19.8 min, and a sample size of 20 subjects in each group, the probability is 91% that the study could detect a treatment difference.

Results

Of the initial 63 patients who entered the study, 23 (11 in the calisthenics-and-breathing group and 12 in the endurance-and-strength group) did not complete the training programs. Four of the 11 patients who dropped out in the calisthenics-and-breathing group did so because of COPD exacerbation that led to prolonged hospitalization, and 7 patients withdrew consent for personal reasons (mainly for not being able to attend the program 3 times a week). In the endurance-and-strength group, 4 dropped out because COPD exacerbation that led to prolonged hospitalization, 6 patients withdrew consent for personal reasons (mainly for not being able to attend the program 3 times a week), one patient dropped out after a diagnosis of lumbar disc herniation, and one patient dropped out to undergo cataract surgery. In both groups, the subgroups of patients who dropped-out were not significantly different from the subgroups that completed the exercise programs, except in the 6-min walk test in the calisthenics-and-breathing group. 6-min walk distance was greater in the drop-out group (median 496 m, IQR 460–560 m, vs 420 m, IQR 351–468 m, $P = .006$).

Table 2 describes the baseline characteristics of the 40 patients (20 in each group) who completed the study. There were no significant between-group differences in baseline characteristics, including smoking status: all were ex-smokers (18 in the endurance-and-strength group, and 18 in the calisthenics-and-breathing group), or current smokers (2 in the endurance-and-strength group, and 2 in the calisthenics-and-breathing group).

Table 1. The First Two Sets of Exercises in the Calisthenics and Breathing Exercises Training Program*

Position	Exercise Set 1	Exercise Set 2
Dorsal decubitus	Diaphragmatic breathing	Diaphragmatic breathing
Lateral decubitus	Diaphragmatic breathing	Diaphragmatic breathing
Dorsal decubitus	Rectus abdominis: lower limbs in flexion and upper limbs resting along the body. Move scapula from the bed during trunk flexion.	Rectus abdominis: lower limbs in flexion and upper limbs in extension along the body. Move scapula from the bed during trunk flexion, moving both hands in the direction of the knees.
Dorsal decubitus	Abdominal obliques: lower limbs in flexion and upper limbs resting along the body. Lower limbs move to each side during expiration.	Abdominal obliques: lower limbs in flexion and upper limbs resting along the body. During trunk flexion, move one hand in the direction of the opposite knee.
Sitting	Diaphragmatic breathing	Trunk flexion and rotation: lower limbs in extension. One upper arm in extension on the bed and the other arm moves toward the opposite side, performing trunk flexion and rotation.
Sitting	Trunk rotation: lower limbs in extension. One upper arm in extension on the bed; the other moves to the opposite side, performing trunk rotation.	Lateral trunk flexion: lower limbs in extension and upper limbs holding a stick above the head. Perform lateral trunk flexion while keeping upper and lower limbs in extension.
		Trunk rotation: lower limbs in extension and abduction and upper limbs in extension holding a stick in front of the chest. Perform trunk rotation while keeping upper and lower limbs in extension.
Hand and knee position	Diaphragmatic breathing	Equilibrium: lift one upper arm during each expiration. Alternate arms.
On the knees	Lateral trunk flexion: upper limbs hold a stick behind the neck while performing trunk flexion.	Lateral trunk flexion: upper limbs holding a stick above the head. Perform lateral trunk flexion while keeping the arms in extension.
On the knees	Trunk rotation: upper limbs hold a stick behind the neck while performing lateral trunk rotation.	Trunk rotation: upper limbs holding a stick in front of the chest. Perform trunk rotation keeping the arms in extension.
Standing	Lateral trunk flexion: lower limbs in extension and abduction. Upper limbs beside the body. Perform lateral trunk flexion while keeping the arms beside the body.	Lateral trunk flexion: lower limbs in extension and abduction. Upper limbs holding a stick above the head. Perform lateral trunk flexion keeping the arms and legs in extension.
Standing	Trunk rotation: lower limbs in extension and abduction. Upper limbs beside the body. Perform trunk rotation by touching one hand to the opposite knee.	Trunk rotation: lower limbs in extension and abduction. Upper limbs holding a stick in front of the chest. Perform trunk rotation while keeping the arms and legs in extension.

* Each set consisted of 12 different exercises, repeated 15 times each.

No patients had hypoxemia at rest, but 10 patients used oxygen during exercise throughout the endurance-and-strength program, due to desaturation during exertion, whereas no patients in the calisthenics-and-breathing group needed supplemental oxygen during the training.

Physical Activity in Daily Life

Time spent standing, sitting, and lying were not significantly altered by either training program. In time spent walking, the endurance-and-strength group had no significant change, whereas a reduction was observed in the calisthenics-and-breathing group (Fig. 1). None of the energy-expenditure measurements nor the number of steps per day were significantly altered by either training program (Fig. 2). There were no significant inter-group differences in any variable recorded by the either of the motion sensors.

Secondary Outcomes

Patients from both groups tolerated well the exercises and targets in the exercise programs. Six-min walk distance, maximum workload during incremental cycle ergometry, endurance time, and muscle force increased significantly after the exercise program in the endurance-and-strength group, whereas those variables did not change significantly in the calisthenics-and-breathing group (Table 3). Inter-group analysis showed that the improvements in maximum workload during incremental cycle ergom-

Table 2. Baseline Characteristics ($n = 40$)*

	Calisthenics and Breathing Exercises Group	Endurance and Strength Training Group	*P*
Male/female, no.	11/9	10/10	NA
Age (y)	65 ± 10	67 ± 7	.62
Body mass index (kg/m^2)	26 ± 15	27 ± 6	.49
Fat-free mass (kg)	44 ± 8	45 ± 9	.77
FEV_1 (% predicted)	39 ± 14	40 ± 13	.88
FEV_1/FVC (%)	47 ± 14	48 ± 14	.79
Maximum inspiratory pressure (% predicted)	79 ± 30	67 ± 23	.37
Maximum expiratory pressure (% predicted)	110 ± 37	113 ± 32	.65
Time Spent in Daily Activities (min)			
Walking	54 ± 28	57 ± 32	.71
Standing	270 ± 139	248 ± 95	.55
Sitting	283 ± 121	296 ± 91	.71
Lying	108 ± 100	113 ± 101	.87
Energy Expenditure (kcal)			
Total	1,331 ± 596	1,295 ± 635	.72
Activities that demand > 3 metabolic equivalents	428 ± 620	408 ± 620	.84
Time spent in activities that demand > 3 metabolic equivalents (min)	4,533 ± 5,968	4,539 ± 5,314	.90
Steps per day	5,002 ± 4,195	4,568 ± 3,381	.88

* All values except male/female are mean ± SD.
NA = not applicable

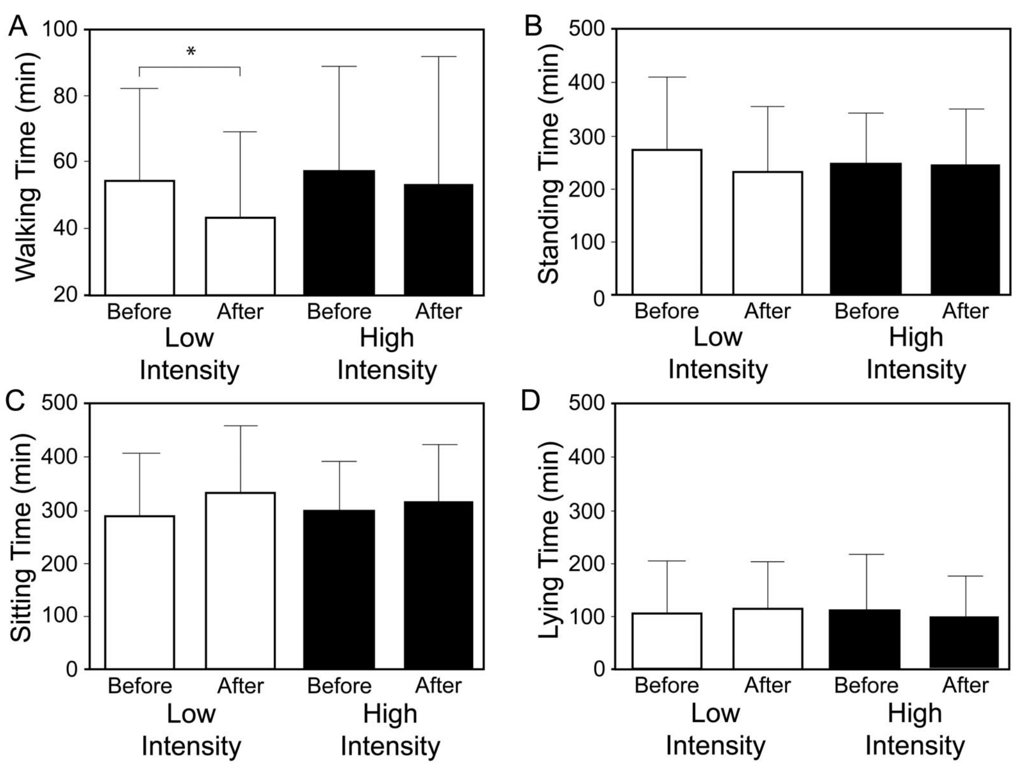

Fig. 1. Mean ± SD time spent per day (A) walking, (B) standing, (C) sitting, and (D) lying, in the lower-intensity calisthenics-and-breathing group and the higher-intensity endurance-and-strength group, before and after their 12-week training programs. * $P = .051$.

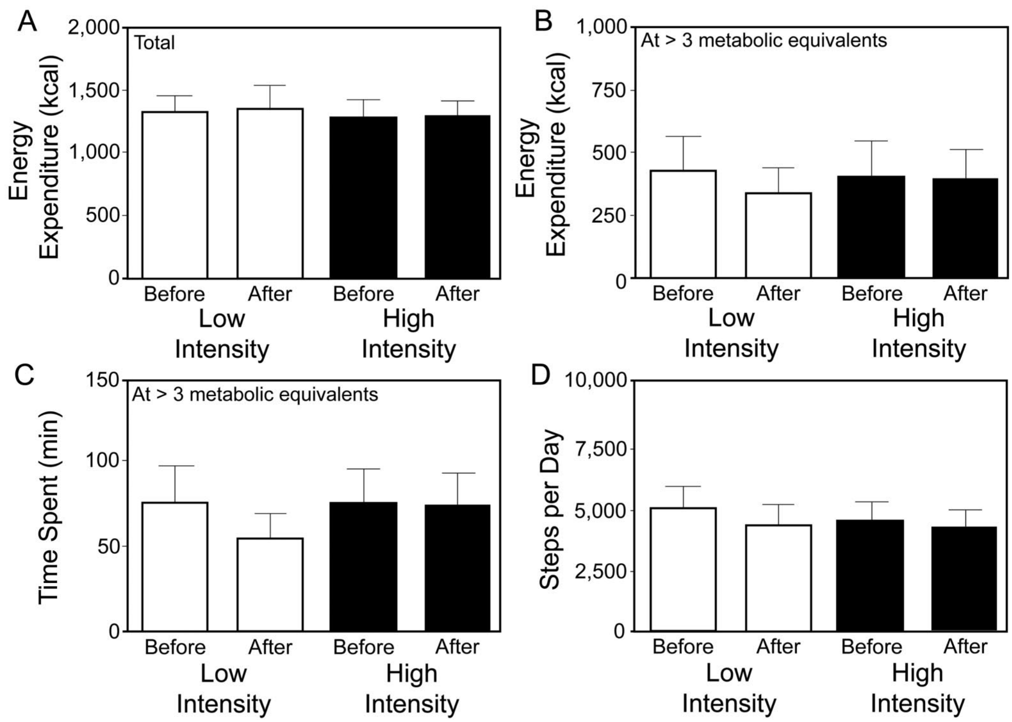

Fig. 2. Mean ± SD (A) total energy expenditure, (B) energy expenditure in activities that demanded > 3 metabolic equivalents, (C) time spent in activities that demanded > 3 metabolic equivalents and (D) number of steps per day, in the lower-intensity calisthenics-and-breathing group and the higher-intensity endurance-and-strength group, before and after their 12-week training programs.

Table 3. Changes in Exercise Capacity and Muscle Force

	Calisthenics and Breathing Exercises Group (no. = 20)		Endurance and Strength Training Group (no. = 20)	
	Before	After	Before	After
Maximum work load (Watts)	30 ± 27	30 ± 30	29 ± 22	48 ± 30*†
Endurance time (min)	6.2 ± 5.5	7.9 ± 7.1	10.7 ± 14.9	17 ± 23.6*
6-min walk distance (m)	392 ± 108	424 ± 114	442 ± 82	483 ± 89*
One-Repetition Maximum Strength Tests				
Quadriceps	10.4 ± 7.2	11.5 ± 6.6	12.4 ± 5.3	16.6 ± 6.1*†
Biceps brachialis	9.2 ± 4.7	10.6 ± 5.1	10.4 ± 3.8	14.7 ± 4*†
Triceps brachialis	10.5 ± 5.1	10.6 ± 5.4	11.5 ± 3.3	16.1 ± 3.8*†

Values are mean ± SD.
* $P = .02$ for before versus after.
† The change in the endurance-and-strength-training group was significantly larger than that in the calisthenics-and-breathing-exercises group ($P = .04$).

etry and muscle force were significantly higher in the endurance-and-strength group, and endurance time showed a similar nonsignificant trend ($P = .08$). There was no intergroup significant difference in improvement in 6-min walk distance ($P = .30$).

Table 4 shows the changes in functional status, dyspnea, and health-related quality of life. Both the calisthenics-and-breathing group and the endurance-and-strength group had significant improvement in Saint George's Respiratory Questionnaire score (mean reductions of 10.8 points and 14.8 points, respectively). The 2 groups, however, did not show significant difference in the degree of improvement ($P = .37$).

Regarding functional status assessed with the LCADL, only the endurance-and-strength group showed significant improvement. On the other hand, functional status assessed with the PFSDQ-M (dyspnea and fatigue domains) showed significant improvements only in the calisthenics-and-breathing group. The groups had no significant difference in the degree of improvement in LCADL or PFSDQ-M

Table 4. Changes in Functional Status, Dyspnea, and Health-Related Qualify of Life

	Calisthenics and Breathing Exercises Group (no. = 20)		Endurance and Strength Training Group (no. = 20)	
	Before	After	Before	After
London Chest Activity of Daily Living Scale total score	25.5 ± 8.1	23.8 ± 8.7	23.9 ± 10.1	19.8 ± 9.2*
Pulmonary Functional Scale and Dyspnea Questionnaire				
Dyspnea score	31.2 ± 19.5	19.2 ± 9.5*	24.2 ± 22.9	19.1 ± 19.8
Fatigue score	29.1 ± 20.9	16.1 ± 10.9*	25.4 ± 25.7	22.4 ± 22.5
Physical activity score	36.5 ± 21.2	30.7 ± 18	29.9 ± 22.5	24.6 ± 21.5
Medical Research Council dyspnea score, median (IQR)	4 (3–4)	4 (2–4)	3 (2–4)	3 (2–4)
Saint George's Respiratory Questionnaire total score	58.3 ± 11.6	47.4 ± 11.7*	53.4 ± 17.9	38.7 ± 20.7*

± values are mean ± SD.
* $P = .01$ for before versus after.

scores. The Medical Research Council dyspnea score showed no significant improvement in either group.

Discussion

Our 2 training regimens adhered to the current recommendations on frequency and duration of pulmonary rehabilitation (3 times a week for 12 weeks); one program used the currently recommended high-intensity endurance and strength training approach for COPD patients, and the other used low-intensity calisthenics and breathing exercises. Neither exercise program significantly improved the level of physical activity in daily life. In patients with COPD this was the first study to compare the effects of 2 different exercise programs on objectively assessed outcomes of daily physical activity, such as time spent active and energy expenditure.

It was recently found that 12 weeks of high-intensity endurance and strength training do not translate into a more active lifestyle, and significant benefits are achieved only after a longer training period.[3] Therefore, the absence of significant improvement in daily activity level after 12 weeks of high-intensity exercise training[3] were replicated in the present study, so the present results are not surprising and might be explained by the program duration. On the other hand, the objective of the present study was not primarily to evaluate the efficacy of a 12-week high-intensity exercise training by itself in improving daily activity level, but to compare a high-intensity to a low-intensity exercise program's effects on physical activity. Since the high-intensity program did not significantly affect daily physical activity, one could hypothesize that a lower-intensity program of similar duration might yield different results. There are no data in the current literature regarding the impact of an exercise training approach similar to the one followed by our calisthenics-and-breathing group. Our results clearly show that this lower-intensity approach did not improve physical activity in daily life, and was therefore also not capable of making the patients more active after the program, regardless of whether investigating the amount of daily physical activity (with the DynaPort) or the intensity of activities and energy expenditure (with the SenseWear). This reinforces the message that training programs longer than 3 months are indicated to induce a more active lifestyle in such an inactive population as patients with COPD. Future research should focus on investigating daily physical activity behavior after exercise programs longer than 3 months or comprising more than 36 sessions. In addition, future research could also focus on studying the effects of other components of pulmonary rehabilitation (eg, patient education, psychological support, nutritional intervention) on daily physical activity, in both short-term and long-term programs.

Exercise capacity and muscle force improved significantly only in the endurance-and-strength group (see Table 3). These results corroborate other studies that used similar training programs[3,28,30] and reinforce the importance of high-intensity exercise in patients with COPD, and the added benefit of strength training in conjunction with endurance training. Interestingly, despite the observed improvement in exercise capacity and muscle force in the endurance-and-strength group, these patients did not significantly improve their level of physical activity in daily life. This reinforces the fact that these are different domains: tests of exercise capacity and muscle force assess what a patient is able to do, whereas activity monitoring assesses what a patient actually does.[31]

Although the calisthenics-and-breathing group had no significant improvements in muscle force, maximum work load, or endurance time, there was a strong trend toward improvement in functional exercise capacity: 6-min walk distance tended to be better after training ($P = .051$), and there was no significant inter-group difference in 6-min walk distance. Although somewhat unexpected, this improvement was previously observed in patients with COPD who underwent the same type of training.[27] This may have occurred due to the improvement in dyspnea and functional status, as the calisthenics-and-breathing group had improved PFSDQ-M dyspnea and fatigue scores (see Table 4). These patients may have better performance in a functional exercise capacity test such as the 6-min walk test if they are able to perform functional activities with less symptoms, regardless of the training program used.

Health-related quality of life and functional status are also important outcomes. Both groups had significant improvement in Saint George's Respiratory Questionnaire score (see Table 4). This is in accordance with previous studies, which also found improved health-related quality of life and dyspnea after either high-intensity[2,28,32] or low-intensity exercise training[5-7,27]. Although the endurance-and-strength group had a greater improvement in Saint George's Respiratory Questionnaire score, this difference was not significant, compared to the improvement in the calisthenics-and-breathing group (see Table 4). Thus, according to the present results, in terms of health-related quality of life, the high-intensity approach cannot be advocated as superior to a lower-intensity training program; this corroborates results from Normandin et al.[6] On the other hand, for optimizing benefits in muscle force and maximum exercise capacity, high-intensity training is indicated.

Regarding functional status, the endurance-and-strength group had improved LCADL score, but not PFSDQ-M score. This might have occurred because the LCADL scale is more responsive to training than the PFSDQ-M.[33] The calisthenics-and-breathing group did not have improved LCADL score, but did improve in the PFSDQ-M's dyspnea and fatigue domains. This might have happened due to the characteristics of the scale and the questionnaire. The LCADL scale is short, comprising only 10 items, and grades limitations on activities of daily living. Although more responsive than the PFSDQ-M,[33] the LCADL might not have been designed with enough depth to detect changes after a simpler exercise program such as our calisthenics-and-breathing program. A more detailed questionnaire, such as the PFSDQ-M, might better detect slight changes. However, we did not find a clear reason why there was no significant improvement in the PFSDQ-M dyspnea and fatigue domains in the endurance-and-strength group, and this remains to be explained. Regarding the PFSDQ-M's physical activity domain, neither group improved, which is in accordance with the physical-activity data from the motion sensors. We believe that 12 weeks of either training regimen would not have been enough to significantly change physical activity in daily life, regardless of the training intensity. On the other hand, the significant improvements in specific domains of functional status underline the fact that patients might not improve the amount of daily physical activity after 3 months of exercise training, but they do report improvements in their self-perceived efficiency on performing their daily tasks.

Patients tolerated well the exercise training programs, and the patients who completed the training were able to follow the scheduled exercise-intensity increase. Twenty-three (37%) of our initial 63 patients dropped out. That drop-out ratio is somewhat higher than that observed by Fischer et al[34] and Pitta et al,[3] but much lower than that observed by Bourbeau et al[35] and Cote and Celli,[36] who had drop-out rates of up to 60%. The drop-out rates did not differ between the 2 groups (35% in the calisthenics-and-breathing group, 38% in the endurance-and-strength group), which conflicts with the expectation that a lower-intensity training program should have a lower drop-out rate and higher adherence than a higher-intensity program.

Limitations

First, this was a relatively small study: 40 patients completed the exercise programs. However, the power calculation based on time spent in activities that demanded more than 3 metabolic equivalents suggested that the sample size was enough to respond adequately to the study's main objective. On the other hand, a larger sample might have avoided the unexpected post-training reduction in time spent walking in daily life in the calisthenics-and-breathing group, since this result was due to 3 markedly negative post-training outliers, all in the calisthenics-and-breathing group, which might be attributable to chance.

Second, we performed only 2 days of physical activity monitoring before and after the exercise programs, and this might underpin the lack of significant differences. However, although not ideal, 2 days of monitoring does provide acceptable reliability in the assessment of physical activity level in patients with COPD.[10]

Third, we were not able to measure maximum oxygen consumption and ventilation during the incremental exercise test, due to lack of adequate equipment. However, we believe that our maximum-work-load data adequately represented what would have been found if those other variables were also assessed.

Conclusions

Regardless of whether the patients performed high-intensity endurance and strength training or low-intensity calisthenics, abdominal muscles strengthening, and breathing exercises, 12 weeks of training had no significant effect on the level of physical activity in daily life in patients with COPD. Conversely, there were improvements in quality of life and functional status after both training regimens, and there was improvement in exercise capacity and muscle force after high-intensity training.

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