Improving physical activity in patients with COPD with urban walking circuits

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KEYWORDS
COPD; Functional capacity; Exercise; Physical activity; Rehabilitation

Summary
Background: Even after a rehabilitation program, levels of physical activity in COPD progressively decrease unless strategies to encourage activity are implemented. We analyzed the effects of the implementation of urban walking circuits on levels of physical activity and exercise capacity of patients with severe and very severe COPD after a rehabilitation program.
Method: A total of 83 patients were randomized to either urban circuits group (UCG) or usual care in the non-circuit group (NCG), after completing a 2-week rehabilitation program. Results were evaluated 9 months after completion of the rehabilitation program and were compared with a control group of 54 patients not enrolled in the rehabilitation program.
Results: At the end of follow-up, UCG patients increased their physical activity by a mean of 32.4 (SE = 5.9) min per day and 1.09 (SE = 0.22) days walked per week; 33.9 (SE = 5.6) min per day and 1.12 (SE = 0.24) days per week more compared to the NCG (p < 0.001). There was a significant positive correlation between the results of the 6-min walking test and minutes walked per day in the UCG (r² = 0.52, p < 0.05) but not in the NCG (r² = 0.094, p > 0.05).

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Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by the presence of chronic and poor reversible airflow obstruction [1] and is associated with systemic effects, including skeletal muscle weakness and wasting, which produce worsening exercise tolerance and impairment of health status [2–4].

Airflow obstruction causes static and dynamic hyperinflation, altering pulmonary and cardiac mechanics [5] and is expressed clinically by progressive worsening dyspnea on exertion. Dyspnea leads patients to become housebound as any physical activity becomes difficult to achieve. This reclusion occurs even in patients who have followed a pulmonary rehabilitation program, as many usually do not continue a program of physical activity after rehabilitation [6].

Pulmonary rehabilitation increases exercise capacity, reduces dyspnea and fatigue, improves quality of life, reduces health-care resource utilization, increases peripheral muscle strength and reduces anxiety and depression. However, maintaining these benefits after a pulmonary rehabilitation program is still a challenge [7].

It is important to increase the levels of physical activity of patients with COPD, because high activity levels are associated with a lower risk of mortality and hospital admission [8,9]. Different strategies have been designed to increase the levels of physical activity after a rehabilitation program, but the results have been disappointing. Moreover, the improvement obtained with programs of physical activity tends to disappear 6 months to 2 years after rehabilitation [10,11]. In a systematic review about the efficacy of maintenance programs of physical activity based on exercise training after rehabilitation, the authors concluded that there was a significant increase in physical activity at 6 months, but the improvement was not sustained at 12 months, and no significant differences were observed between the different interventions [11]. In a systematic review of randomized trails and single-group interventional studies Cindy NG et al. [12] observed that exercise training may confer a small, albeit significant, increase in physical activity.

In order to be successful, a strategy to increase physical activity must be attractive to most patients with COPD and must be easily incorporated into their daily routine. One example is the Nordic walking program that resulted in improvement in walking distance and quality of life in COPD patients [13]. A Tai chi program was also able to improve activity tolerance in a group of COPD patients [14]. However, regular walking is the most common activity in COPD patients and can be performed all year long in Mediterranean areas such as ours. To encourage daily walking, we designed and implemented a series of urban walking circuits adapted to the patient’s characteristics.

The aim of this study was to assess the effectiveness of the implementation of urban walking circuits in increasing the level of physical activity and exercise capacity in severe and very severe COPD patients after completing a pulmonary rehabilitation program compared with a control group receiving usual care. Secondary variables were respiratory muscular strength assessed with maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) and the BODE index.

Method

Population

Patients were recruited from the Physical Medicine and Rehabilitation Department of the Hospital of Mataró (Barcelona, Spain) from February 2008 to December 2011 and were included if they fulfilled the following inclusion criteria: severe or very severe COPD (post-bronchodilator FEV₁/FVC <0.7 and FEV₁ <50%, respectively) and stable disease defined as no exacerbation, hospital admission or change in treatment in the previous three months. The exclusion criteria were: other significant respiratory disease (bronchiectasis, lung fibrosis, asthma, etc.), active smoking, severe cardiovascular, neurological, musculoskeletal and/or metabolic pathology that could interfere with the results, alcoholism (>80 g/day) or severe malnutrition (BMI <19 kg/m²).

The study was approved by the Research and Ethics Committee of the Hospital of Mataró and all patients provided written informed consent. The trial is registered at ClinicalTrials.gov, Identifier NCT01854008.

Study design

This was a randomized clinical trial designed to assess the impact of the implementation of urban walking circuits on the level of physical activity and in the improvement in functional capacity in severe and very severe COPD patients after a pulmonary rehabilitation program.

Patients that fulfilled the inclusion criteria were informed about the characteristics of the study and written informed consent was obtained. They were first included in
a standard rehabilitation program as described below. At the end of the program, participants were randomly assigned following simple randomization procedures (computerized random numbers) to 1 of 2 treatment groups. One group, the urban circuit group (UCG), received a leaflet that included urban walking circuits and the remaining patients formed the non-circuit group (NCG). All the patients received general recommendations on physical activity and lifestyle and were visited every two months to encourage them to continue physical activity. The total duration of the study was one year: 3 months of rehabilitation program and 9 months of follow-up (Fig. 1).

Patients who were referred to our institution for evaluation and fulfilled all the inclusion criteria but could not be included in the study because they lived in other cities were also invited to participate and formed the control group (CG). This group received the same general recommendations on physical activity and lifestyle and was requested to attend medical visits for clinical control and encouragement of physical activity every two months for the one year duration of the study, similar to the intervention group (Fig. 1).

All the patients followed their regular pharmacological treatment. Those presenting an exacerbation during the course of the study, which could interfere with the results, defined as worsening of symptoms requiring treatment with systemic corticosteroids and/or antibiotics, were excluded from the analysis.

Interventions

The pulmonary rehabilitation program in our hospital has been previously described [16] and consisted in a moderate intensity program, with a frequency of 3 sessions per week for 12 weeks. The exercise intensity was controlled by the patient using the modified Borg scale (from 0 to 10) [15]. Patients were informed as to the correct use of the scale to ensure that the mean value was not exceeded during exercise training. Basal oxygen flow was increased by one liter in oxygen carrier patients.

Each training session consisted of warm-up exercises of the upper and lower limbs and spine for 10 min, followed by continuous aerobic exercise by cycling for 25 min. The initial intensity of training was 50 W, increasing progressively with tolerance to the exercise. This was followed by strengthening exercises of the upper limb muscles during 15 min, initially without resistance, and increasing progressively with the increase in tolerance, 10 min of stretching exercises and 10 min of relaxation exercises.

A total of 32 urban walking circuits were developed jointly with the town hall of Mataró (124,000 inhabitants) and were included in a leaflet called “A PEU, FEM SALUT! Itineraris Urbans per Mataró” (On foot, keep healthy! Urban itineraries around Mataró). Each circuit includes a map marked with the route and a description of the beginning and end, cultural attractions on the itinerary such as buildings, museums, churches, and other places of interest, comments such as the amplitude of the crossings, lighting or the presence of commercial areas in the surroundings. They include information about the approximate duration, the distance in kilometers, the percent of slope, and the difficulty of the circuits (low, mild, moderate, and high), also shown with a colored circle (green = low, blue = light, orange = moderate and red = high). In addition, bus connections at the beginning and end of the tour are included. These circuits can be obtained on the website http://www.mataro.cat/web/portal/ca/salut/salut_publica/itineraris/index. All patients received individualized information about

![Figure 1](image-url)  The study design consisted of two phases. In the first phase the patients were divided into the rehabilitation group (RG) and the control group (CG). The RG performed a pulmonary rehabilitation program for 12 weeks, 3 times per week. In the second phase the patients in the RG were randomized into two groups, the urban circuits group (UCG) and non-circuits group (NCG).
the content of the leaflet, the meaning of the symbols and interpretation of the maps. This information was reviewed at each bimonthly visit. Patients in the NCG and controls were also visited bimonthly to check proper data collection and encourage physical activity.

End points

The co-primary end points were the physical activity and the exercise capacity at the end of the study (one year after inclusion or 9 months after completion of the rehabilitation program). Physical activity was measured by the mean of minutes per day walked and the mean of days per week walked. Patients were instructed to write the minutes walked every day in a diary card during the one year of the study and this information was collected at every two-month follow-up visit. The functional capacity was measured with the distance walked in meters in the 6-min walking test (6MWT). The 6MWT was standardized following international recommendations [16]. Oxygen saturation and heart rate were recorded throughout the test using a pulseoximeter (Digit® Finger Oximeter, Smiths Medical PM, USA). Dyspnea was evaluated using the modified Borg scale at the beginning and end of the test [17].

Secondary end points

The same measurements of physical activity and exercise capacity were measured at 3 months to evaluate the effect of the rehabilitation program compared to the control group before the implementation of the urban circuits. Other secondary variables were respiratory muscular strength assessed with maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) and the BODE index.

MIP and MEP were evaluated using a Jaeger MasterScreen (Quebec, Canada) with a pressure transducer connected to the mouth in accordance with guidelines and using recommended reference values [18].

The BODE index (Body mass index, Obstruction, Dyspnea and Exercise) was calculated for all the participants as previously described by the authors [19]. This index scores the risk of patient mortality from 0 to 10, with a higher BODE score reflecting an increase in the risk of mortality.

Statistical analysis

Quantitative variables were expressed as means and standard error (Mean ± SE). The Wilcoxon–Mann–Whitney test was used to compare baseline and post-intervention measurements between CG and Rehabilitation group. To statistically compare the change in each group of patients between pre- and post-intervention treatment responses the Wilcoxon signed rank sum test was performed. To determine the effectiveness of the urban walking circuits, linear regression models were applied to one year measurements as dependent variables, and group (CG, UCG and NCG) and post-rehabilitation measurements as independent variables in an ANCOVA model. The coefficients, 95% confidence intervals and p-values associated with the patient group are reported. Poisson regression was used for Borg and BODE indices analysis. We reported the estimated mean ratio (by exponentiating the Poisson regression coefficients) comparing the UCG and CG with the NCG. The relationship between meters and minutes walked post-intervention by rehabilitation groups was estimated by Pearson correlation, and regression models were used to quantify the correlation. All analyses were performed with the SPSS (version 11.5) for Windows®. Statistical tests of hypotheses were two-tailed with significance set at p < 0.05.

Results

Patients' characteristics

A total of 160 patients were recruited, 73 of whom lived outside the city of Mataró and were included in the control group (CG). A total of 35 patients did not complete the study; 18 did not attend appointments, 12 required hospital admissions for exacerbation, and 5 died, leaving 125 patients valid for analysis (Fig. 1). The mean age was 71 years (standard deviation [SD]: 2.2). All patients were male and the mean FEV1 (%) was 31.7% (SD 0.9%). At baseline, the patients reported an average of 2.9 (SD 0.19) days/week walked and an average of 42.9 (SD 3.5) min/day walked. The general characteristics, BODE index, functional tests, physical activity, 6MWT, and respiratory muscle strength are shown by patient group in Table 1.

Results of the rehabilitation program

After the 12-week rehabilitation program, there was a significant increase in minutes walked per day, days walked per week, and the distance walked in the 6MWT. In contrast, patients in the CG showed a significant decrease in minutes walked per day and distance in the 6MWT, resulting in a mean difference of almost 7 min per day less and 119 m less in the 6MWT compared to rehabilitation group (p < 0.001) (Table 2).

Results of the urban walking circuits

The 83 patients who completed the rehabilitation program were randomized into the UCG and NCG. A total of 12 patients did not complete the study, 9 did not attend appointments, 2 required hospital admission, and 1 died, leaving 34 patients in UCG and 37 in NCG valid for analysis. At the end of follow-up, those included in the UCG increased the time walked 32.44 (standard error [SE]: 5.91) min/day and the days walked by 1.09 (SE: 0.22) days/week compared to baseline; whereas the changes observed in the NCG were an increase of 2.39 (SE: 3.65) min/day and 0.15 (SE: 0.28) days/week respectively (Table 3, Fig. 2).

In a regression analysis with correction for baseline scores, the UCG significantly increased the min/day walked by a mean of 33.97 (95%CI: 22.71–45.23; p < 0.001) and the days walked by week by a mean of 1.12 (95%CI: 0.64–1.61; p < 0.001) compared to the NCG (Table 4), but the patients in the control group walked almost half a day/week less (−0.48 days, 95%CI: −0.92 to −0.05; p = 0.029) than NCG, without significant differences in minutes walked per day (Table 4).
According to the 6MWT, the UCG showed a significant increase of 19.09 m (SE 4.14) compared to baseline, while the NCG and control patients experienced a significant reduction in distance walked (Table 3). The results of the regression analysis showed a significant increase of 43.95 m (95%CI: 30.81–57.08) in 6MWT for the UCG compared to the distance walked by the NCG 9 months after rehabilitation. There were no significant differences in meters walked in the 6MWT at the end of follow-up between the NCG and the control group (3.64 m, 95%CI: 16.40–9.13) (Table 4).

Secondary end points

The MIP and MEP increased in the UCG and decreased in the NCG and CG from the end of the rehabilitation program to the end of the follow-up, with significant differences among groups at the end of the study (Table 3). In regression analysis, the MEP was 12.58 cm² H₂O higher (95%CI: 8.86–16.31) and MIP 5.41 cm² H₂O higher compared to the NCG. Differences in MIP and MEP between the NCG and the control group were smaller (Table 4). No significant differences were observed in the changes of the BODE index between groups (Tables 3 and 4).

Correlation between exercise capacity and physical activity

We found a strong positive correlation between the distance walked in the 6MWT and minutes/day walked in the UCG (r² = 0.502, p < 0.05). However, this correlation was not observed in the NCG (r² = 0.094, p > 0.05) (Fig. 3).
Discussion

The results of our study show an increase in the physical activity of patients with severe and very severe COPD, measured by the mean of minutes walked per day and days walked per week, when the urban walking circuits were offered after a pulmonary rehabilitation program. This increased physical activity was correlated with the maintenance of functional capacity assessed with the 6MWT, even nine months after completion of the rehabilitation program.

There is unanimity about the benefits of pulmonary rehabilitation of COPD. Systematic reviews have shown significant clinical effects in COPD patients, both in a stable state and after an exacerbation [20,21]. Rehabilitation modifies prognostic indicators such as exercise tolerance, activity levels, and dyspnea. The results obtained in our pulmonary rehabilitation program during the first 3 months of the study were consistent with those previously observed regarding improvement in functional capacity [20].

However, rehabilitation programs may not be effective in changing the behavior of patients towards a more active life, and therefore, the benefits of the program will decrease over time and eventually disappear. In a systematic review Cindy NG et al. [12] concluded that exercise training can lead to a significant, but small, increase in physical activity in COPD patients. The authors ratify the need for randomized trials to determine the effect of exercise training in physical activity and in exercise capacity. Beauchamp et al. [11] investigated the efficacy of maintenance programs of physical activity after rehabilitation in a systematic review. Most of the programs were administered in a hospital-based outpatient setting, except for one in which patients were integrated into a local community exercise group. The duration of the programs ranged from 9 to 15 months, and they were based on exercise training including aerobic exercise, and most added lower and/or

### Table 3

Descriptive analysis (mean (SE)) of values obtained at the end of follow-up (one year) and the change (one year compared to 3 months at completion of the respiratory rehabilitation program) in the control group (CG), non-circuit group (NCG) and the urban circuit group (UCG).

<table>
<thead>
<tr>
<th></th>
<th>CG (n = 54)</th>
<th>NCG (n = 37)</th>
<th>UCG (n = 34)</th>
<th>p-valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One year after</strong></td>
<td></td>
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<tr>
<td><strong>Physical activity</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Minutes/day</td>
<td>40.30 (3.12)</td>
<td>49.05 (2.31)</td>
<td>81.62 (5.35)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Days/week</td>
<td>2.74 (0.14)</td>
<td>3.43 (0.20)</td>
<td>4.44 (0.16)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>6MWT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meters</td>
<td>327.00 (13.78)</td>
<td>406.59 (11.21)</td>
<td>445.41 (10.45)</td>
<td>0.006</td>
</tr>
<tr>
<td>Maximum O₂ desaturation</td>
<td>87.37 (0.83)</td>
<td>87.59 (0.97)</td>
<td>87.26 (1.09)</td>
<td>0.798</td>
</tr>
<tr>
<td>Borg scale</td>
<td>8.56 (0.16)</td>
<td>8.41 (0.16)</td>
<td>7.85 (0.20)</td>
<td>0.012</td>
</tr>
<tr>
<td><strong>Respiratory muscular function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIP (cm² H₂O)</td>
<td>61.32 (1.74)</td>
<td>65.60 (2.00)</td>
<td>76.98 (2.49)</td>
<td>0.001</td>
</tr>
<tr>
<td>MEP (cm² H₂O)</td>
<td>99.15 (3.85)</td>
<td>110.25 (2.52)</td>
<td>122.95 (2.27)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>BODE index</strong></td>
<td>6.02 (0.20)</td>
<td>5.00 (0.15)</td>
<td>4.65 (0.14)</td>
<td>0.067</td>
</tr>
<tr>
<td><strong>Change (one year 3 months)</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Physical activity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minutes/day</td>
<td>–5.43 (3.94)</td>
<td>2.39 (3.65)</td>
<td>32.44 (5.91)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Days/week</td>
<td>–0.39 (0.14)</td>
<td>0.15 (0.28)</td>
<td>1.09 (0.22)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>6MWT</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Meters</td>
<td>–17.20 (4.09)</td>
<td>–25.68 (5.88)</td>
<td>19.09 (4.14)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Maximum O₂ desaturation</td>
<td>–6.46 (0.71)</td>
<td>–7.76 (0.92)</td>
<td>–8.09 (1.03)</td>
<td>0.509</td>
</tr>
<tr>
<td>Borg scale</td>
<td>0.57 (0.13)</td>
<td>0.16 (0.12)</td>
<td>–0.32 (0.08)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Respiratory muscular function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIP (cm² H₂O)</td>
<td>–3.73 (0.57)</td>
<td>–0.95 (0.65)</td>
<td>3.51 (0.93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MEP (cm² H₂O)</td>
<td>–3.32 (1.10)</td>
<td>–12.55 (2.02)</td>
<td>0.00 (1.23)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>BODE index</strong></td>
<td>0.22 (0.07)</td>
<td>0.16 (0.06)</td>
<td>–0.12 (0.09)</td>
<td>0.082</td>
</tr>
</tbody>
</table>

a p-value Kruskal–Wallis test for differences between groups.

Figure 2 Minutes walked per day at the beginning, at the end of the pulmonary rehabilitation program (3 months) and at one year after inclusion in the study.
upper extremity strength training [22–25]. Exercise training was usually supervised by a physiotherapist with frequencies ranging from one session per month [24,26] to three per week [23]. Only in one study was exercise training performed with weekly supervised sessions for 6 months followed by twice monthly sessions for the next 6 months [26]. Patients were encouraged to perform exercise training at home by oral, written and/or telephone support [24–27]. The authors suggested that supervised post-rehabilitation exercise programs were superior to usual care for sustaining benefits in exercise capacity in the medium-term for patients with moderate to severe COPD. However, this effect was not sustained at 12 months and no between-group differences were observed [11]. It is essential to develop strategies to maintain or increase the benefits obtained after respiratory rehabilitation. The prescription of physical activity and the development of strategies for adherence should be considered as a second phase after a pulmonary rehabilitation program.

In this context, we included patients with severe or very severe COPD in an urban circuits program after completing pulmonary rehabilitation. At baseline, our patients walked a mean of 43 min per day and a mean of 3 days per week. Our findings are similar to those obtained by Pitta et al. [28] and Hernandes et al. [29] who reported an average of 44 and 55 min per day walked, respectively. A correlation has been demonstrated between increased regular physical activity in COPD and a lower risk of hospital readmission and mortality [8], and more recently Waschki et al. [30] showed that a low level of physical activity was the strongest predictor of all-cause mortality in COPD. It is therefore essential to develop strategies to increase physical activity in COPD patients.

Data correlating pulmonary rehabilitation programs with increased physical activity are controversial [31–33], and it has become evident that strategies to maintain and even increase the long-term benefits obtained after rehabilitation are necessary. In our study, we demonstrated that a simple and inexpensive intervention with urban walking circuits was able to increase physical activity and exercise capacity after a rehabilitation program. In contrast patients in the control group experienced a decrease in their physical activity and exercise capacity. Similarly, the patients included in the rehabilitation program, but not in the urban circuits group, showed a decrease in exercise capacity, and their physical activity did not increase at the end of the study after the initial improvement observed with rehabilitation. Therefore, our results confirm that the beneficial effects of pulmonary rehabilitation are not long lasting, and that a substantial number of subjects return to a sedentary life, even after the improvement experienced with rehabilitation [10,11].

A previous study in primary care demonstrated that informative talks about the benefits of physical activity and individual 15-min interviews resulted in a significant improvement in the level of physical activity in patients with chronic diseases, with an adjusted difference of 18 min per week after 6 months compared to a control group [34]. In contrast, in our control group there was a small reduction of 5.4 min per day, despite the repeated

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**Table 4** Estimated effect of urban circuits (results of regression analysis with correction for baseline scores).

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>p-value</th>
<th>Urban circuits group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef</td>
<td>95% C.I.</td>
<td>Coef</td>
<td>95% C.I.</td>
</tr>
<tr>
<td>Physical activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minutes/day</td>
<td>−7.42</td>
<td>−17.53 to 2.68</td>
<td>0.148</td>
<td>33.97</td>
</tr>
<tr>
<td>Days/week</td>
<td>−0.48</td>
<td>−0.92 to −0.05</td>
<td>0.029</td>
<td>1.12</td>
</tr>
<tr>
<td>6MWT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meters</td>
<td>−3.64</td>
<td>−16.40 to 9.13</td>
<td>0.574</td>
<td>43.95</td>
</tr>
<tr>
<td>Maximum O₂ desaturation</td>
<td>3.15</td>
<td>0.66 to 5.64</td>
<td>0.014</td>
<td>−0.33</td>
</tr>
<tr>
<td>Borg scalea</td>
<td>1.04</td>
<td>0.90 to 1.21</td>
<td>0.556</td>
<td>0.94</td>
</tr>
<tr>
<td>Respiratory muscular function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIP (cm² H₂O)</td>
<td>−2.99</td>
<td>−4.70 to −1.27</td>
<td>0.001</td>
<td>5.41</td>
</tr>
<tr>
<td>MEP (cm² H₂O)</td>
<td>5.23</td>
<td>1.68 to 8.77</td>
<td>0.004</td>
<td>12.58</td>
</tr>
<tr>
<td>BODE indexa</td>
<td>1.02</td>
<td>0.84 to 1.24</td>
<td>0.828</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Reference treatment group: NCG.

*a* Mean ratio was presented.

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**Figure 3** Correlation between minutes walked per day and meters walked in the 6MWT at the end of follow-up (one year) for patients in the urban circuits group (UCG) and the non-circuits group (NCG).
encouragement during follow-up visits every 2 months. This is consistent with the deterioration in exercise capacity observed in severe COPD patients not submitted to any training program [35]. In any case, the improvement demonstrated in the previous study with advice and prescription was clearly lower than that obtained with our urban circuits of a mean of 38 min per day.

Other strategies to improve physical activity in COPD patients have been tested with good results, such as Nordic Walking [13]. Urban walking circuits have the advantage of not requiring any trained support personnel and no specific equipment, but it can be influenced by climatic circumstances in different areas.

An important result of the current study is the demonstration of a good correlation at the end of follow-up between the meters walked in the 6MWT and the mean number of minutes walked per day in the urban circuits group, but with no correlation in the non circuit group. These results suggest that it is not the functional capacity that limits the physical activity [6,36] and highlight the importance of encouraging patients to be physically active after pulmonary rehabilitation programs using effective strategies. Similar results have been reported in a recent study that showed a correlation between change in steps/day and in exercise capacity in patients with COPD submitted to an exercise training program, but with no correlation in the control group [37].

Patients in the urban circuits group also obtained better results in secondary outcomes at the end of the study. However, the magnitude of the changes in MIP and MEP was small and probably not clinically meaningful [18]. These results can be explained by the multifactorial causes of muscular dysfunction in COPD patients, which include those derived from lung disease and peripheral involvement: increased activity and unfavorable geometry of the respiratory muscles, inflammation and oxidative stress, nutritional and gas exchange disturbances, comorbidity and the use of myotoxic drugs among others [2,36].

One of the limitations of our study is the use of a diary card for the measurement of physical activity. Other groups have used pedometers to assess the impact of a lifestyle physical activity counselling program after rehabilitation [38]. However, a pedometer may, in itself, introduce a possible bias by conditioning an increase in physical activity during its use. The compliance with diaries in our patient population was excellent, with all the patients reporting more than 80% of filled diaries at control visits. The consistency of the results of physical activity and the 6MWT, particularly in the patients in the circuits groups, provides consistency to our findings. Furthermore, the self-declared time walked per day has demonstrated to be significantly correlated with quality of life and mortality [39,40] and has been included as a parameter of severity in guidelines on the management of COPD [41,42].

Drop outs have to be considered when interpreting our results. A total of 18 patients were lost to follow-up (11.2%), which may affect the internal validity of the results. The control group was non-randomized. However, the selection criteria did not depend on the patient or the research team and this group was made up of patients fulfilling the same inclusion and exclusion criteria but living outside of the town of Mataró and were therefore not eligible for urban circuits in town. In fact, the demographic and clinical characteristics of the control group and the rehabilitation group were similar. The exclusion of patients experiencing an exacerbation during the study may be debatable; however, we believe that exacerbated patients could have influenced the results because these episodes are associated with a significant decrease in physical activity [43] and with generalised muscle dysfunction that may persist even during recovery [44].

Finally the lack of female patients is another limitation of our study. The gender distribution in our study corresponds to the gender distribution of COPD in Spain where most patients, particularly with severe or very severe COPD, are males [45]. Therefore, extrapolation to women must be made with caution.

In conclusion, patients that were offered the option of urban walking circuits after a rehabilitation program increased their level of physical activity and exercise capacity compared with those not offered this option after rehabilitation. Strategies to encourage physical activity should be established after rehabilitation programs to maintain or even increase the beneficial effects of exercise in COPD.

Conflicts of interest

Marc Miravitlles has received speaker fees from Boehringer Ingelheim, Pfizer, AstraZeneca, Bayer Schering, Novartis, Takeda-Grifols, Takeda-Nycomed, Merck, Sharp & Dohme and Novartis, and consulting fees from Boehringer Ingelheim, Pfizer, GSK, AstraZeneca, Bayer Schering, Novartis, Almirall, Merck, Sharp &Dohme, Takeda-Grifols and Takeda-Nycomed. The remaining authors have no conflicts of interest to disclose.

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