Results of a Home-Based Training Program for Patients With COPD*

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Objectives: To have a group of COPD patients undergo a simple program of home-based exercise training, using the shuttle walking test (SWT) to standardize the intensity of training.
Methods: Sixty patients participated, randomly distributed into two groups (rehabilitation and control) of 30 patients each. The following evaluations were carried out at baseline and at 12 weeks: (1) pulmonary function studies; (2) SWT; (3) submaximal intensity resistance test; (4) cycle ergometer test; (5) quality of life; and (6) dyspnea. The rehabilitation group underwent a lower-extremity training program. Walking was selected as the type of exercise. The intensity of training was set at 70% of the maximum speed attained on the SWT. Divided sessions were held, lasting 1 h, 6 days/wk, at home, with a checkup every 2 weeks. The duration of the program was 12 weeks.
Results: The following patients completed the study: 20 patients (66.6%) from the rehabilitation group (mean [± SD]) age, 64.3 ± 8.3 years; mean FEV_1, 41.7 ± 15.6% of predicted); and 17 patients (56.6%) from the control group (mean age, 63.1 ± 6.9 years; mean FEV_1, 40 ± 16.4% of predicted). We found no changes in pulmonary function or effort parameters (SWT or cycle ergometer) in the rehabilitation group at 12 weeks. A twofold increase (1,274 ± 980 to 2,651 ± 2,056 m; p < 0.001) was achieved in the submaximal intensity resistance test, with less dyspnea at the conclusion of the test (p = 0.05). Significant improvement also was achieved in basal dyspnea and, both statistically and clinically, in the quality of life. Significant changes were not achieved in the control group patients.
Conclusions: A simple home-based program of exercise training achieved improvement in exercise tolerance, posteffort dyspnea, basal dyspnea, and quality of life in COPD patients.
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Keys words: COPD; home-based training program; rehabilitation; shuttle walking test

Abbreviations: BDI = basal dyspnea index; CRQ = chronic respiratory disease questionnaire; MCID = minimum clinically important difference; MRC = Medical Research Council; SWT = shuttle walking test; TDI = transitional dyspnea index; $\dot{V}E$ = minute ventilation; $\dot{V}O_2max$ = maximum oxygen uptake

The role of respiratory rehabilitation for patients with COPD is well-established, and it is widely accepted as a therapeutic modality.[1–7] Respiratory rehabilitation programs provide a comprehensive approach to the control and alleviation of symptoms and the optimization of the functional capacity of patients with COPD. An updated definition of pulmonary rehabilitation was developed by the National Institutes of Health Workshop in 1994: "Pulmonary rehabilitation is a multidimensional continuum of services offered to persons with pulmonary disease and their families, usually by an interdisciplinary team of specialists, with the goal of achieving and maintaining the individual's maximum level of independence and functioning in the community."[2]

Rehabilitation programs are usually complex, including distinct components and techniques: education of patients and their families, pharmacologic treatment, oxygen therapy, adequate nutrition, physical exercise, ventilatory muscle training, breathing retraining, occupational therapy, psychosocial support, and home care. Lower-extremity exercise training is the best validated of all the components in terms of effectiveness and resulting benefits. Exercise programs for the muscles of ambulation are a part of virtually every pulmonary rehabilitation program. There is scientific evidence, provided by well-designed, well-conducted, controlled studies with

statistically significant results, that exercise training of the muscles of ambulation improves exercise tolerance and basal dyspnea.[7,8] Regarding the remaining components, there is less reliable evidence, provided by observational studies, controlled trials with less consistent results, or the opinion of experts.[7]

Most pulmonary rehabilitation programs have been carried out on an inpatient or outpatient basis. Inpatient programs are expensive,[9] and in outpatient programs the subject must go to the hospital several days a week, which is often an added difficulty for the patient. Another problem is the long-term maintenance of benefits once the rehabilitation program has been completed, since gains achieved dwindle progressively if training is abandoned. For this reason, home-based rehabilitation programs are significant. They offer the advantage of continuing the program indefinitely. Home-based rehabilitation programs are preferred by patients, since they are able to spend more time with their families and, in addition, can apply their training to their daily life. Therefore, validation of these programs is needed. Currently, home-based rehabilitation programs are scarce[10–16] and sometimes entail an extreme degree of complexity. There are still many questions to resolve. What is the best home-based rehabilitation program? How can we apply the training intensity necessary to achieve benefits? In many cases, it is not possible to provide cycle ergometers or treadmills for the patient's home; and in those programs for which walking freely for a period of time is recommended, it is more difficult even to establish the walking speed necessary to achieve a training effect.[16]

The purpose of the present study was to investigate the effectiveness of a simple home-based program of exercise training of the muscles of ambulation, in which the training intensity was applied in standardized form, using the shuttle walking test (SWT). The SWT fulfills the basic criteria for an exercise test for COPD patients. Unlike cycle ergometry or treadmill walking, it is based on a familiar activity; it is easy to carry out both for the technician and the patient. It requires minimal equipment and has the advantage that it is standardized, incremental, and externally paced.[17]

Materials and Methods

Patients

We studied 60 patients who had COPD diagnosed in accordance with the European Respiratory Society Consensus Statement,[1] which defines this illness as a disorder characterized by decreased maximum expiratory flow and slow forced emptying of the lungs that is slowly progressive, irreversible, and does not change markedly over several months. All patients were in a stable phase of their disease with optimal drug management (ie, bronchodilator therapy and oxygen therapy, if necessary). The criteria for entry into the study were $FEV_1 < 60\%$ of predicted and being an ex-smoker or having been previously included in a smoking-cessation program that resulted in abstinence.[18] Patients with evidence of ischemic heart disease, severe or uncontrolled systemic arterial hypertension, alterations in the thoracic cage, neuromuscular disorders, or intermittent claudication or osteo-articular lesions in the lower extremity that could affect normal ambulation were excluded. Patients suffering an acute exacerbation in the course of the program were excluded.

Study Design

This was a prospective, controlled, and randomized study. The 60 patients were randomly assigned to a 12-week home rehabilitation program (30 patients) or to a control group (30 patients). The following evaluations were carried out at baseline and at 12 weeks in both groups: (1) pulmonary function studies; (2) SWT; (3) resistance test; (4) cycle ergometer test; (5) quality of life; and (6) dyspnea.

Outcome Measures

Pulmonary Function Studies: FVC, FEV_1, FEV_1/FVC ratio, pH, PaO_2, and $PaCO_2$ were measured. Spirometry was performed (Collins Medical; Braintree, MA) that required three similar tracings, with the longest used for calculations. Predicted values were derived from the guidelines of the European Respiratory Society[19] and Sociedad Española de Neurologia y Cirugia Toracica.[20] Arterial gasometry was performed on samples of blood from the radial or humeral artery. Measurements for PaO_2, $PaCO_2$, and pH were performed on a gas analyzer (model AVL-945; Biomedicf; Basilea, Sweden), requiring measurement reproducibility levels of (SD) ± 2 mm Hg, for PaO_2 and $PaCO_2$ and 0.01 for the pH measurement. Sociedad Española de Neurologia y Cirugia Toracica[21] recommendations and reference values for our laboratory, situated at sea level,[22] were followed for the performance of arterial gasometry.

Cycle Ergometer Test: The exercise was carried out on a cardiorespiratory cycle ergometer (CPX/PLUS System; Collins Medical), with a ventilation and inhaled/exhaled gas analyzer. The amount of exercise is controlled automatically by computer. A gas analyzer measures the CO_2 (nondispersive infrared type) and O_2 (zirconium cell) content of each respiration. After a 3-min monitoring period and 1 min of unloaded pedaling, the work rate was increased 10 to 15 W every minute, according to the severity of the obstruction. The patient had to pedal fast enough to maintain 60 to 80 rotations per minute.

At the end of the exercise, we recorded dyspnea and chest and leg discomfort (modified Borg scale).

SWT: We used the modified protocol of Singh et al.[17] This is a maximal, incremental, and externally paced exercise test. Patients were requested to walk between two cones placed 10 m apart. Walking speed increased progressively each minute. The instructions were standardized on a tape recording. The end point was determined when the patient was unable to maintain the required speed.

We recorded heart rate, arterial BP, dyspnea, chest and leg discomfort (modified Borg scale) before and after the SWT.

Prior to the use of the SWT in our training program, we had studied its reproducibility, variability,[23] and correlation with exercise parameters[24] in a group of patients with COPD. Only one test was necessary.

Resistance Test: After performing the SWT, the patients were

subjected to a resistance test (submaximal intensity). It was carried out over 20 m for greater comfort to the patient, with a central mark at 10 m. The walking speed was constant, corresponding to 70% of maximum (*ie*, two levels below the maximum attained in the SWT), and the instructions were standardized on a tape recording. The results were expressed in exercise time (minutes) and distance completed (meters).

We recorded heart rate, dyspnea, chest and leg discomfort (modified Borg scale) before and after the resistance test.

Dyspnea: Basal dyspnea was measured using Mahler's basal dyspnea index (BDI)/transitional dyspnea index (TDI),[25] using magnitude of the task, functional impairment, and magnitude of effort, and the British Medical Research Council (MRC) scale.[26] Posteffort dyspnea was measured using the Borg scale.[27]

Quality of Life: Quality of life was assessed using a specific questionnaire for patients with COPD, which was translated into Spanish and validated, called the chronic respiratory disease questionnaire (CRQ).[28,29] It is divided into four categories: dyspnea or breathing difficulty (questions 4a to 4e); fatigue (questions 7,10,14, and 16); emotional function (questions 5,8,11,13,15,17, and 19); and mastery (questions 6,9,12, and 18). Each question was scored on a 7-point Likert scale.

We used a follow-up questionnaire to evaluate changes in quality of life. The overall effect of treatment was compared with its minimum clinically important difference (MCID), which is defined as the smallest difference perceived as important by the average patient.[30] We considered an increase of at least 0.5 points as being an MCID.[8]

Rehabilitation Program

The rehabilitation program consisted of lower-extremity training. Walking was elected as the type of exercise. Training was performed at home or at a place near home (*eg*, a garden or a park), on a flat track that was 20 m long and that was delimited by a mark at each extreme and another at the midpoint of the track (*ie*, at 10 m). Before the beginning of the exercise-training program, we inspected the place where the training would be carried out. To avoid measurement errors, the patient was given a 20-m tape with a midpoint mark to be placed where the exercise would take place. The patient was supplied with a cassette that indicated the walking speed to him by means of an audible signal. A simple signal indicated that the patient should be at one of the marks situated along the track.

Training intensity was determined individually. Once the resistance test had been performed (at a constant walking speed, two levels below the maximum attained in the SWT), the patient underwent periods of exercise similar to or slightly shorter than the resistance time, alternating with periods of recuperation. Training intensity at the beginning of the program was at least 70% of the maximum speed attained in the SWT. The total duration of the session, including periods of rest, was 1 h. A single session per day, 6 days each week, was held. The total duration of the program was 12 weeks. The patient also went to the hospital every 2 weeks for supervision of his clinical status and his treatment and exercise-training compliance.

The control group patients (standard medical treatment alone) also made visits to the hospital every 2 weeks for a clinical checkup and supervision of treatment.

Statistical Analysis

For data analysis we used computer software (SPSS; SPSS, Inc; Chicago, IL). A Mann-Whitney *U* test was used for intergroup comparison, and a Friedman test was used for intragroup comparison. The changes in each variable in the rehabilitation group compared to the control group were investigated by Mann-Whitney *U* test. The significance level was set at $p < 0.05$.

RESULTS

Ten patients dropped out of the rehabilitation group: 6 left for lack of cooperation (20%), and 4 were excluded due to acute exacerbation of their underlying pathology. Thirteen patients dropped out the control group: 7 did not cooperate with evaluations (23%); 4 had acute exacerbations; 1 had suffered a cerebral vascular accident; and 1 was waiting for prostate cancer surgery. Twenty patients from the rehabilitation group and 17 from the control group completed the study.

Baseline pulmonary function parameters are shown in Table 1. We did not find significant differences between groups.

The (mean ± SD) level achieved by the rehabilitation group in the SWT was 6.7 ± 1.6 (range, 4 to 9), and the distance walked was 418.5 ± 145.9 m (range, 180 to 630 m). In the control group, the level was 7 ± 1.7 (range, 4 to 10), and distance walked was 464.1 ± 172.9 m (range, 210 to 780 m) (Table 2). The time for the submaximal intensity resistance test of the rehabilitation group was 17.1 ± 12.3 min (distance, 1,247 ± 980 m), and in the control group, 24.2 ± 16.7 min (distance, 1,829 ± 1,477.5 m). There were no significant differences between the groups (Table 3).

We also did not find statistically significant differences between the two groups for maximal effort on the cycle ergometer test, for basal dyspnea, and for quality-of-life.

The rehabilitation group began training at 74.3% of the maximal speed attained in the SWT, during an average of 37.8 min the first week (not including rest periods). During successive checkups, there was increasing intensity (average, 81.1% of maximal), training time (average, 48 min), or both. In the last week, five patients had successfully increased intensity, eight had increased time, and six had increased both intensity and time.

Table 1—Baseline Characteristics of the Study Population*

Parameters	Rehabilitation Group	Control Group
Age, yr	64.3 ± 8.3	63.1 ± 6.9
FVC, % predicted	71.1 ± 18.9	74.7 ± 14.7
FEV_1, % predicted	41.7 ± 15.6	40 ± 16.4
FEV_1/FVC ratio	47 ± 9.9	42.3 ± 12
PaO_2, mm Hg	72.6 ± 5.8	67.1 ± 10.9
$PaCO_2$, mm Hg	44.2 ± 5.8	46.3 ± 10

*Values given as mean ± SD.

Table 2—*Effects of Rehabilitation on Exercise Capacity (SWT and Cycle Ergometer)**

Variables	Rehabilitation Group		Control Group		p Value
	Baseline	12 weeks	Baseline	12 weeks	
SWT	6.7 ± 1.6	6.7 ± 1.6	7 ± 1.7	6.7 ± 1.6	NS†
Level distance, m	418.5 ± 145.9	428 ± 138.6	464.1 ± 172.9	441.2 ± 167.6	NS
HR, beats/min‡	110.8 ± 17.9	104.8 ± 24.3	124.6 ± 14.6	116.4 ± 16.2	NS
Dyspnea‡	7.7 ± 1.8	7.8 ± 2.1	8 ± 1.2	7.6 ± 1.7	NS
Watt-max	65 ± 28.7	62.2 ± 26.1	58 ± 3.4	60.9 ± 28.5	NS
$\dot{V}O_2$max	1.3 ± 0.4	1.4 ± 0.5	1.2 ± 0.5	1.3 ± 0.4	NS
$\dot{V}O_2$, kg	18.4 ± 4.7	18.9 ± 5.6	17.1 ± 4.9	18.6 ± 4.4	NS
$\dot{V}CO_2$	1.3 ± 0.4	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.4	NS
HR, beats/min	116.3 ± 18.6	117 ± 15.5	116.7 ± 17.8	118.6 ± 14.3	NS
$\dot{V}E$	42.9 ± 16.9	42.4 ± 18	38.3 ± 12.2	39.7 ± 10.9	NS
Dyspnea	8.7 ± 0.9	8 ± 1.5	8.1 ± 1.8	7 ± 2.4	NS
Leg discomfort	4.5 ± 3.4	3.5 ± 3.2	3.5 ± 3.7	4.6 ± 3.6	NS

*Values are given as mean ± SD and are measured posteffort. $\dot{V}CO_2$ = carbon dioxide output; Watt-max = maximum workload on the cycle ergometer test; HR = heart rate.
†NS = not significant; $p > 0.05$.
‡Measured during SWT.

Outcome Measures

At 12 weeks, we did not find significant differences in lung function characteristics or arterial blood gas levels in either group.

In the rehabilitation group, we found a slight, though not statistically significant, increase in the distance walked in the SWT and no change in the maximal level of effort. There was a slight increase in dyspnea at the end of the test, but there was a decrease in heart rate and arterial BP and less discomfort in the chest and legs, although none of the parameters reached statistical significance. In the control group, the maximal level of effort and distance walked diminished slightly, without achieving significance. We did not find changes in the remaining parameters. The results are shown in Table 2.

The rehabilitation group showed a significantly increased time in the submaximal intensity resistance test (17.1 ± 12.3 to 36 ± 24.5 min; $p < 0.01$) (Fig 1), resulting in an increase in distance walked (1,274 ± 980 to 2,651 ± 2,056 m; $p < 0.01$)(Fig 2), and they finished with significantly less dyspnea (7 ± 2.3 vs 6.4 ± 2, respectively; $p = 0.05$). There were no significant changes in the control group (Table 3).

There were no significant changes in maximal effort in the cycle ergometer test after 12 weeks in either group (Table 2).

In the rehabilitation group, dyspnea measured by the BDI/TDI improved significantly, and as much globally ($p = 0.03$) as in each of its components (magnitude of task, $p = 0.05$; functional impairment, $p = 0.03$; magnitude of effort, $p = 0.01$). The TDI was 1.4 globally and > 0.4 in each dimension. Dyspnea measured by the MRC scale also improved

significantly ($p = 0.02$). Quality of life (globally and by dimensions) improved and exceeded the MCID. Globally, quality of life increased from 82.6 ± 18.9 to 99.3 ± 21.8 ($p < 0.001$); in relation to clinical significance, the improvement was > 10 points (Fig 3). Confidence interval values suggest that the smallest treatment effect exceeded the MCID for the dyspnea and emotional function dimensions. There were no improvements in basal dyspnea or quality of life in the control group. Only dyspnea in the quality of life score increased very slightly, achieving statistical significance, but not clinical significance (*ie*, deterioration in control of illness). The results are shown in Tables 4 and 5.

DISCUSSION

With our simple home-based program of standardized training for the muscles of ambulation, our group of COPD patients with moderate disease showed improvement in their tolerance of submaximal exercise, in dyspnea, and in quality of life. These results are similar to those found in the literature,[7,8] although the latter were obtained through rather complex rehabilitation programs.

We did not find changes in pulmonary function or in arterial blood gas levels.[13–16] We also did not find significant improvements in maximal effort parameters in the SWT and in the cycle ergometer. That SWT does not improve is in accordance with the fact of this being a maximal incremental exercise test.[17] The size of the study group might, perhaps, be another reason for the lack of improvement of the SWT after training. Although improvements in maximal effort parameters on the cycle ergometer were

Table 3—Effects of Rehabilitation on Submaximum Intensity Exercise Test (Resistance Test)*

Variables	Rehabilitation Group			Control Group		
	Baseline	12 weeks	p Value	Baseline	12 weeks	p Value
Time, min	17.1 ± 12.3	36 ± 24.5†	0.01	24.2 ± 16.7	26.6 ± 16.6	NS
Distance walked, m	1,247 ± 980	2,650 ± 2,056†	0.01	1,829 ± 1,477.5	2,017 ± 1,452	NS
HR, beats/min	95.6 ± 16.7	100.7 ± 19.5	NS	106.5 ± 17.5	108 ± 14.3	NS
Dyspnea	7 ± 2.3	6 ± 2‡	0.05	6.8 ± 2.5	6.5 ± 2.1	0.03
Leg discomfort	4.2 ± 3.3	4.3 ± 3.4	NS	3.6 ± 2.7	4.4 ± 3.3	NS

*Values are given as mean ± SD and are measured posteffort. See Table 2 for abbreviations.
†p < 0.001 between changes in both groups.
‡p > 0.05 (NS) between changes in both groups.

not statistically significant, the following modifications could be beneficial to patients: maximum oxygen uptake ($\dot{V}O_2$max) increased slightly; carbon dioxide output, maximum minute ventilation ($\dot{V}E$), posteffort dyspnea, and chest and leg discomfort diminished.

Time walking and distance walked in the submaximal intensity exercise test improved significantly. This result is more important than improvements in the maximal effort parameters, since the activities of daily life involve resistance rather than force exercises. Similar results are found in the literature, although in some very intensive rehabilitation programs, maximal exercise parameters improve.[11–14,31,32]

Despite the fact that maximal ventilatory parameters did not improve, basal dyspnea and quality of life of the rehabilitation group improved significantly. There were no changes in the control group. In the trained group, the overall effect size exceeded the MCID.

The benefits obtained in terms of exercise tolerance and quality of life cannot be attributed to an improvement in ventilatory parameters (perhaps due to the size of the sample). Only one study shows a reduction of 10% in the maximum $\dot{V}E$.[33] We think that practicing the SWT resistance test daily makes it easier to perform and may, in and of itself, lead to an improvement. This means that the type of training influences results if they are evaluated using the same type of exercise as that used in the training. Because of this task-specific training effect, it seems more sensible to train the COPD patients for their most relevant activities, such as walking or climbing stairs, rather than in bicycling.[9,34] We think that this improvement could be ascribed to better neuromuscular coordination. Training can lead to improved neuromuscular coordination, which by itself can contribute to an improved ability to perform activities, especially in those patients who lead a sedentary life. Our results are in agreement with Sinclair and Ingram,[35] who showed that training for the 12-min walking test daily improves the 12-min walking distance. The contributions of other factors also must be considered (*eg*, psychological factors [greater motivation] and desensitization to dyspnea). In all circumstances in which dyspnea is perceived, respiratory muscle exertion is increased and the perception of this effort explains the intensity of dyspnea.

Table 4—Effects of Rehabilitation on Dyspnea and Quality of Life*

Characteristics	Rehabilitation Group			Control Group		
	Baseline	12 weeks	p Value	Baseline	12 weeks	p Value
Global QL	82.6 ± 18.9	99.3 ± 21.8†	0.001	91.2 ± 21.4	94.1 ± 22.4	NS
Dyspnea	14.7 ± 5.1	20.1 ± 5.7†	0.001	16.1 ± 5.3	17.6 ± 6	0.01
Fatigue	17.4 ± 4.9	21.1 ± 5.8‡	0.001	20.1 ± 3.9	20.2 ± 4.3	NS
EF	30.8 ± 7.9	36.5 ± 8.5†	0.001	34.2 ± 10.5	36.2 ± 9.2	NS
Mastery	19.4 ± 5.1	21.9 ± 5‡	0.001	20.2 ± 6.5	20 ± 6.5	NS
BDI	4.7 ± 2.2	6.3 ± 2.1‡	0.03	5.4 ± 2.9	5.1 ± 2.9	NS
MT	1.8 ± 0.9	2.3 ± 0.7‡	0.05	1.8 ± 0.8	2 ± 0.7	NS
FI	1.5 ± 1	2.08 ± 1‡	0.03	1.8 ± 1.1	1.6 ± 0.9	NS
ME	1.5 ± 0.6	2.1 ± 0.6‡	0.01	1.9 ± 0.8	2.1 ± 0.8	NS
MRC score	3.2 ± 0.9	2.6 ± 1‡	0.02	3.4 ± 0.9	3.13 ± 1.1	NS

*Values are given as mean ± SD. MT = magnitude of task; FI = functional impairment; ME = magnitude of effort; QL = quality of life; EF = emotional function. See Table 2 for other abbreviations.
†p < 0.01 between changes in both groups.
‡p < 0.05 between changes in both groups.

Table 5—Clinical Significance (MCID) of Changes in Quality of Life*

Parameter	Rehabilitation Group		Control Group	
	Mean ±/SD	MCID†	Mean ±/SD	MCID
QL	1 ± 1 (0.5–1.5)	Mild	0.2 ± 0.4 (−0.04–0.4)	None
Dyspnea	1 ± 0.7 (0.8–1.4)	Moderate	0.3 ± 0.6 (0.02–0.6)	None
Fatigue	0.9 ± 1 (0.4–1.4)	Mild	0.01 ± 0.6 (−0.3–0.3)	None
EF	0.8 ± 0.7 (0.5–1.2)	Mild	0.3 ± 0.7 (0.08–0.6)	None
Mastery	0.7 ± 0.8 (0.3–1)	Mild	−1.2 ± 0.6 (−0.2–0.4)	None

*Values given as mean ± SD (95% confidence interval). See Table 4 for abbreviations.
†Clinical significance occurs when quality of life improves > 0.5 points per section.

Desensitization to dyspnea can be ascribed to an improvement in respiratory muscle function or to a reduction in the respiratory muscle load. This may be a valid hypothesis, since it seems unlikely that respiratory muscle function may improve after training. We believe that structural and biochemical changes that would be produced specifically in trained muscles[36–38] also could be influenced in this improvement, although this aspect has not been evaluated in our study.

There have been few completed home-based programs of rehabilitation. Wijkstra et al[11–13] found that COPD patients can improve quality of life (as measured by the CRQ) and exercise tolerance (watt maximum and $\dot{V}o_2$max) at home, although changes were not seen in the 6-min walking test distance. The only study in which the results of a home-based program are compared to those of an outpatient program and a control group was carried out by Strijbos et al.[14] The first 3 months of the rehabilitation program were supervised, and the rest of the study was unsupervised. In the outpatient group, there was an increase of 19.8% in the watt maximum at 3 months, but there was deterioration at 12 and 18 months of follow-up. In the home-based rehabilitation program, the watt maximum increased progressively, having risen 20.7% with respect to basal value at 18 months. The distance walked in the 4-min walking test showed the same tendency. In both groups, there was an improvement in well-being, but quality of life was not measured by a specific questionnaire. The results argue in favor of home-based rehabilitation, but they have to do with a very complex, intense, very well-supervised, and not entirely home-based program. Cambach et al[15] compared the effectiveness of a 3-month home-based program completed only by physical therapists to that of a 3-month control program (ie, physical exercise, education, relaxation techniques, respiration training) that was applied to a group of patients with asthma and COPD. They found that there was an improvement in exercise tolerance and in the four dimensions of the CRQ through rehabilitation in the whole group. In the group that underwent rehabilitation in the first 3 months and was monitored in the following 3 months, the improvement was maintained in these parameters except in endurance, which diminished significantly. In this study, a high percentage (25.8%) of the patients dropped out after randomization, and, in addition, the groups studied were mixed.

Wedzicha et al[16] carried out a rehabilitation program in which patients were stratified using the MRC dyspnea scale. Education and exercise programs for the moderately dyspneic patients were carried out in a hospital outpatient setting, while the severely dyspneic patients were treated at home. Those in the exercise group received an individualized training program. There was a significant improvement in the SWT in the group with moderate dyspnea who received exercise training, while there was no improvement in the group with severe dyspnea. Neither group of control patients improved. The health status of the group with moderate dyspnea who received training improved, whereas much smaller changes were seen in the remaining groups. Despite the fact that they conclude that improvements following rehabilitation depend on the initial degree of dyspnea, it must be noted that the group with severe dyspnea who trained at home was not subjected to the same training program as the group with moderate dyspnea. It can be seen that in the majority of home-based programs, improvements are obtained but only through complex and intense programs. Apart from the skewing of selection, the lack of improvement in exercise capacity or global increase in health status in the severe group after exercise training could be due to inadequate training intensity (ie, the exercise program carried out at home was not sufficient to produce an improvement in physical performance).

In our study, 20% of patients in the rehabilitation group and 23% in the control group dropped out. The main reason for dropping out among the rehabilitation patients was the difficulty of finding a suitable training site. Although we first checked out the site, sometimes the patient was uncomfortable and decided not to continue. This is the principal drawback of our program. Among subjects in the control group, the lack of cooperation with the 12-week outcome measures was the main reason for them dropping out. Our drop-out rate was higher
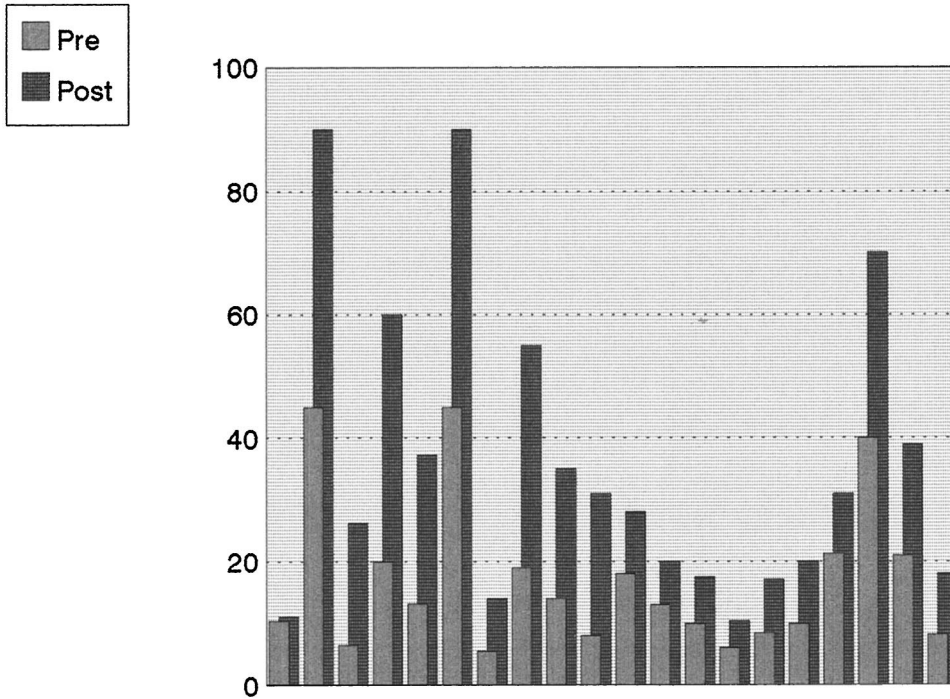
FIGURE 1. Time of resistance before and after rehabilitation.

than that found in some programs[11,14] but was less than in the program of Cambach et al[15] (25.8%). Nonetheless, the drop-out rate was similar in the rehabilitation program to that in the control group.

Additional statistical analysis, including for the patients who dropped out, did not reveal significant differences between the group that dropped out and the group that completed the study, in terms of
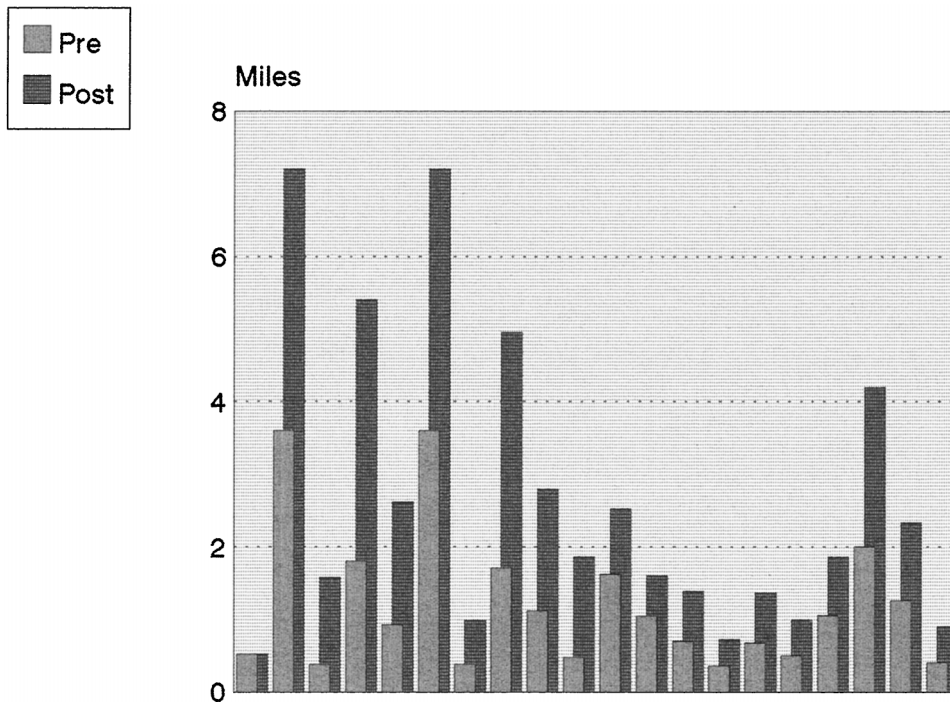

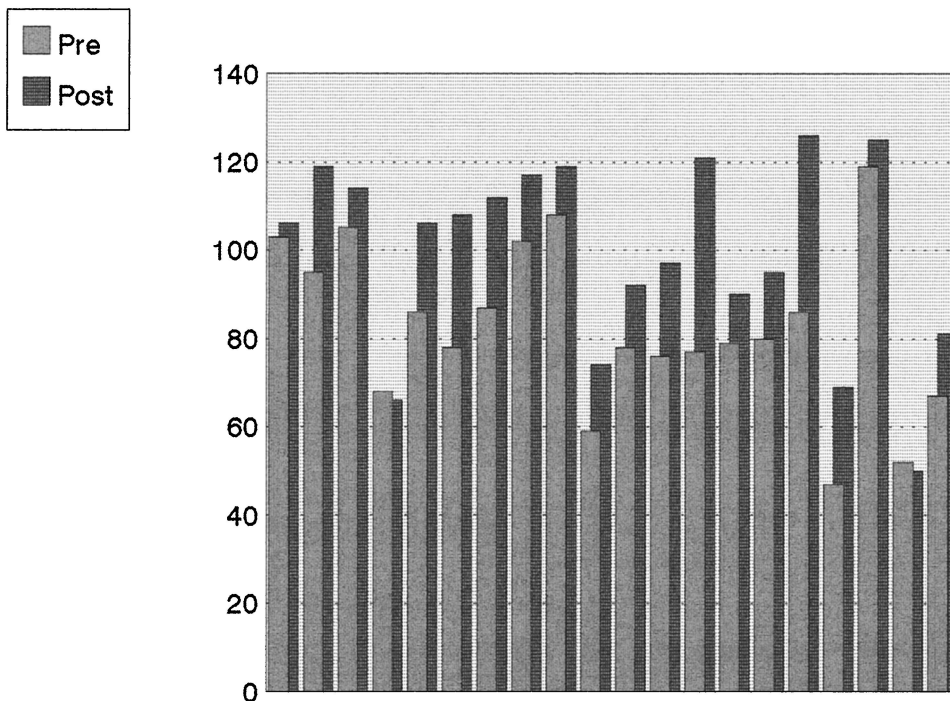FIGURE 2. Distance walked in the resistance test before and after rehabilitation.

FIGURE 3. Quality of life prerehabilitation and postrehabilitation.

FEV_1, exercise tolerance, dyspnea, and quality of life. Eighty percent of the patients finished this simple program, which constitutes an elevated percentage; the fact that it is a low-cost program must be taken into account when it is compared with the other programs.

We used high training intensity, although we knew that training at low intensity as well as at high intensity achieves benefits, provided that the total amount of work per session is equalized. Although there are studies that demonstrate that patients who train at high intensity obtain more benefits,[39,40] Maltais et al[41] found improvement in exercise capacity and various physiologic parameters, despite the fact that their patients did not tolerate high-intensity training. In contrast, Belman[42] recommends a program in which exercise increases gradually, with greater emphasis on time than on intensity of training, since improvement in exercise time allows the patient to become more independent in some daily living activities. We began the training at 70% of the speed reached in the SWT and, by the end of the program, 60% of the training patients had increased their intensity level to 81.1%. Initially, the exercise time during the first week was 37.8 min/d, in divided sessions. At 3 months, exercise time had increased in 70% of the patients, averaging 48 min. Of the 20 patients, both intensity and time increased in 8 (40%). This allowed a large increase in resistance or tolerance in the submaximal exercise test, with the time they could remain walking at 70% of their maximal velocity increasing twofold and with less posteffort dyspnea.

In summary, with our simple program of home-based lower-extremity training and using the SWT to standardize training intensity, COPD patients improved exercise capacity, dyspnea, and quality of life. Our program has the advantage that it is home-based (ie, the patients can have more time with their families and can apply the training in their daily life). The type of exercise is based on a familiar activity such as walking and is easy for the patient to carry out. It is requires minimal equipment, and it has a good cost-effectiveness ratio. We have achieved benefits similar to those obtained in multidisciplinary rehabilitation programs, which are complex and sometimes difficult for the patient to follow.

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