

Rehabilitation in a Warm Versus a Colder Climate in Chronic Obstructive Pulmonary Disease

A RANDOMIZED STUDY

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- **PURPOSE:** The primary aim of this study was to evaluate if pulmonary rehabilitation in a subtropical climate during winter had better long-term effects on health-related quality of life and symptoms of anxiety and depression than an equivalent pulmonary rehabilitation program in a colder climate. The secondary aim was to assess short-term differences in the same outcomes.
- **METHODS:** Referred patients with chronic obstructive pulmonary disease were randomized to and completed rehabilitation in a subtropical climate in Spain (n = 60) or in a temperate climate in Norway (n = 36). Health-related quality of life was assessed with St. George's Respiratory Questionnaire, and symptoms of anxiety and depression were assessed with the Hospital Anxiety and Depression Scale at the start of rehabilitation, at discharge, and 8 months later.
- **RESULTS:** There were no significant differences between the 2 groups in mean changes in St George's Respiratory Questionnaire dimensions or total score (−3.0; 97.5% confidence interval [CI], −8.6 to 2.6, *P* = .22) or Hospital Anxiety and Depression Scale anxiety (−1.2; 97.5% CI, −2.7 to 0.3, *P* = .08) or depression (−0.3; 97.5% CI, −1.7 to 1.1, *P* = .62) score from the start of rehabilitation to 9 months thereafter. During rehabilitation, the Spain group improved more than the Norway group in the activity score of the St George's Respiratory Questionnaire (−6.2; 97.5% CI, −12.4 to −0.1, *P* = .02) and in the Hospital Anxiety and Depression Scale anxiety score (−1.7; 97.5% CI, −2.9 to −0.6, *P* = .001).
- **CONCLUSIONS:** No significant long-term differences in improvement in health-related quality of life or psychological well-being was demonstrated after chronic obstructive pulmonary disease rehabilitation in a subtropical versus a temperate climate.

KEY WORDS

anxiety
chronic obstructive pulmonary disease
depression
health-related quality of life
rehabilitation

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Pulmonary rehabilitation improves health-related quality of life (HRQoL) and exercise capacity in patients with chronic obstructive pulmonary disease (COPD).¹ However, the duration of the rehabilitation effect is uncertain.¹ Also, symptoms of anxiety and depression are common among patients with COPD, but information on the effects of rehabilitation on psychological well-being is scarce and diverging.²⁻⁴

Norway enjoys a temperate climate with cold winters, as in large areas of North America. Previous

studies have shown positive health effects of treatment in a warmer climate in patients with rheumatic and skin disorders.^{5,6} Because of this possible climate effect, the Norwegian government pays for travels to and rehabilitation in Southern Europe. Individuals with COPD have anecdotally reported a positive effect of a warm climate on their lung symptoms and, consequently, their HRQoL and psychological well-being. To our knowledge, a potential climate effect has not previously been investigated in COPD. Therefore, we

wanted to assess whether patients with COPD would benefit from pulmonary rehabilitation in a warmer climate.

The primary aim of this study was to evaluate if subjects undergoing pulmonary rehabilitation in a warm climate in the winter will have a better HRQoL and less symptoms of anxiety and depression 8 months after rehabilitation than would subjects completing an equivalent pulmonary rehabilitation program in Norway. A secondary aim was to assess potential short-term differences in effect of rehabilitation on HRQoL and symptoms of anxiety and depression.

METHODS

Subjects and Study Design

Glittrelinikken is a specialized pulmonary rehabilitation clinic located outside Oslo, receiving patients from all over Norway. Only patients who were referred to an inpatient pulmonary rehabilitation program were evaluated for eligibility to the study. Screening, including pulmonary function tests, was conducted in the outpatient clinic. Two chest physicians independently performed evaluation for eligibility. The eligibility criteria included the following: (1) COPD with forced expiratory volume in 1 second less than 80% predicted and forced expiratory volume in 1 second/forced vital capacity less than 70%; (2) age younger than 75 years; (3) no exacerbation, defined as worsening of lung symptoms requiring hospitalization, treatment with antibiotics or more than 20 mg daily of systemic prednisolone, for more than 1 month before randomization and admission; and (4) percutaneous oxygen saturation at rest of 94% or greater without supplemental oxygen.

We excluded patients with significant comorbidity that could limit participation or completion of the rehabilitation program. After start of rehabilitation, we excluded participants with intercurrent disease episodes or injuries that made them unable to participate in the rehabilitation program for more than 1 week.

Initially, randomization to 2 equally sized groups was planned. Because the recruitment of participants was too slow to use the available capacity of the rehabilitation facilities in Spain and because of a time constraint, the procedure was changed to a 2:1 randomization. Hence, eligible participants were allocated to 2 treatment arms through block randomization, with 6 participants per block: 4 to rehabilitation in Spain and 2 in Norway. From packs of 6 sealed envelopes, the subjects randomly picked an envelope containing the allocation number. To avoid predictability, for every second patient, 2 new envelopes from the next pack of 6 envelopes were randomly taken to supplement the first one, that is, the pack constantly contained 5 or 6 envelopes.

Written informed consent was obtained from each subject. The Regional Committee for Medical Research Ethics, Health Region East (Oslo, Norway), approved the study.

The Rehabilitation Program

Both allocation groups had pulmonary rehabilitation between October and April and in parallel time periods ± 2 weeks. Before departing Norway, participants allocated to rehabilitation in Spain stayed for 24 hours at Glittrelinikken for clinical evaluation to reveal exacerbations or recent severe comorbidity. Groups of 18 to 23 participants traveled by plane to the island of Gran Canaria, escorted by a chest physician and a nurse on the 5-hour 40-minute flight.⁷ The rehabilitation took place in a Norwegian-owned recreation center in Arguineguin, supervised by personnel from Glittrelinikken. The standard of accommodation was comparable in Norway and Spain.

The climate in Gran Canaria is subtropical, with a mean temperature of 19°C in Las Palmas in October to April, in contrast to the temperate climate in the area of Glittrelinikken, with a mean temperature of -4°C during this period. The center in Arguineguin is located at sea level, whereas Glittrelinikken is located at an altitude of 200 m above sea level.

The inpatient multidisciplinary rehabilitation program was structured 7.5 hours per day, 5 days per week for 4 weeks. It was the same for both groups, with a time schedule developed and managed by experienced professionals. The program consisted of 3 parts, with about the same time allocated to each: disease education and optimization of medical treatment, psychosocial support, and supervised exercises. In addition, the patients were also encouraged to exercise on their own. The exercise facilities were similar for both groups, with fitness center, swimming pool, and walking paths, although in Spain, facilities were mainly outdoors. The participants recorded daily the total exercise time, that is, the sum of exercise during the program and additional exercise outside the program. After completion of rehabilitation, the participants were not systematically referred to any supervised follow-up program as part of the study.

Outcome Assessment

Symptoms of anxiety and depression and HRQoL were assessed at 3 time points: (1) start of rehabilitation, within 3 days of admission to the rehabilitation program; (2) end of rehabilitation, during the last 3 days of the rehabilitation program; and (3) follow-up, at 8 months after completion of rehabilitation, during an outpatient visit at Glittrelinikken. When participants were unable to meet, they could complete the

questionnaires at home with telephone support from project staff. This follow-up was postponed until a participant had been in a stable condition for at least 4 weeks.

The St. George's Respiratory Questionnaire (SGRQ) was used to assess HRQoL.⁸ The SGRQ evaluates symptoms, activities, and the psychosocial impact of respiratory conditions. The SGRQ is self-administered and contains 50 items with 76 weighted responses. It consists of 3 components: (1) symptoms, measuring distress due to respiratory symptoms, originally relating to frequency of symptoms over the last year. For the purpose of this study, we adjusted the time frame of the items on the symptom subscale by replacing "over the last year" with "over the last weeks"; (2) activity, effects of disturbance on mobility and physical activity; and (3) impacts, assessing the psychosocial impact of the disease. The latter 2 components relate to the patient's current health. In addition, all items are aggregated to a total score. Scoring is done on a 0 to 100 scale, with lower scores indicating better health. A change in score of 4 units is considered clinically significant.

The Hospital Anxiety and Depression (HAD) Scale was used to assess symptoms of anxiety and depression.⁹

The HAD Scale is reliable and valid in screening for clinical anxiety and depression. It is self-administered and has 14 items scored on a 0 to 3 scale. Seven of the item scores are summed to give the anxiety subscale score, and the remaining 7 item scores are summed to give the depression subscale score. Hence, scores on both scales range from 0 to 21, with higher scores indicating more symptoms of anxiety or depression. For both subscales, a score of 7 and less is interpreted as normal, 8 to 10 is considered borderline, and 11 or more corresponds to a clinical diagnosis of anxiety or depression.

Exercise capacity was assessed using the 6-minute walking distance at 3 time points: within 3 days of start of rehabilitation, during the last 3 days of rehabilitation, and at follow-up 8 months after rehabilitation. The procedure and encouragement were standardized, but the test was administered outdoors in Spain.

Pulmonary function testing was performed using a Jaeger MasterLab (Jaeger Toennies, Würzburg, Germany) and included measures of flow rates, lung volumes (plethysmography), and diffusing capacity. We used accepted reference values.¹⁰ Oxygen saturation at rest

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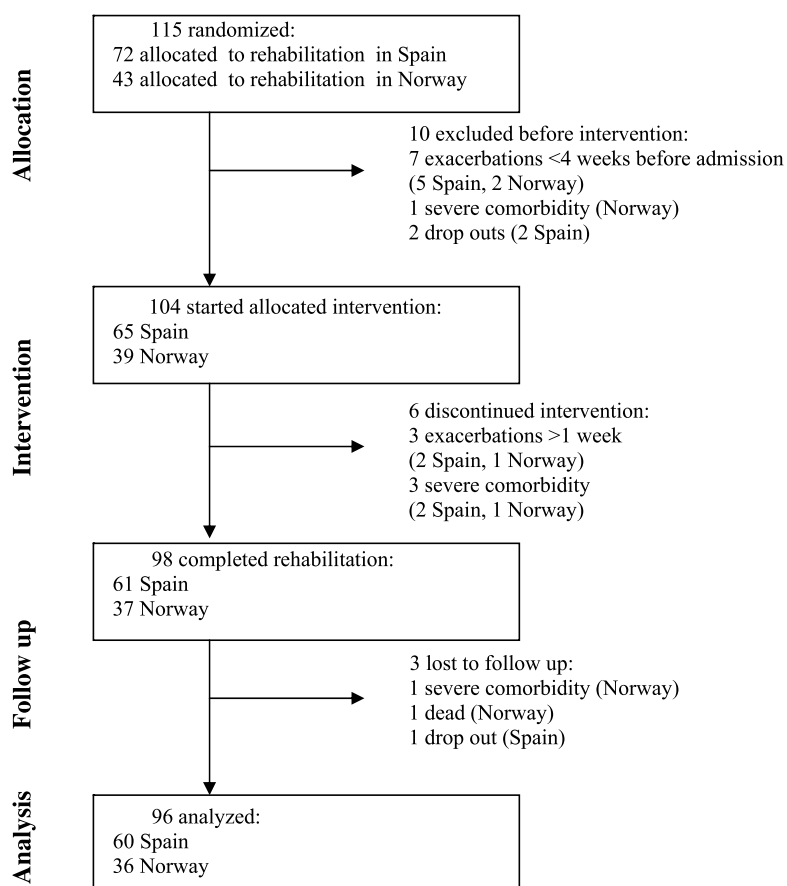


Figure 1. Study plan.

was measured with pulse oximetry (Pulsox-3i, Minolta, Osaka, Japan).

Data on exacerbations, hospitalizations, and physician visits between rehabilitation and follow-up were retrospectively recorded, based on interviews with the participants.

Statistical Analysis

Data are presented as means \pm standard deviations (SD), unless stated otherwise. Initial sample size calculations using the *t* test, aimed at detecting a difference of ± 0.5 SD in the SGRQ total score between the intervention groups, suggested 2 equally sized groups of 63 patients, with a power of .8 and a 5% significance level. Group comparisons in changes in outcomes over time (last – first value) were assessed using the *t* test. Proportions were compared using the χ^2 test. Data on exacerbations, hospitalizations, and physician visits were analyzed using the Mann-Whitney *U* test. We chose a 5% significance level using 2-tailed tests. However, because of multiple comparisons, we chose a 2.5% significance level and 97.5% confidence intervals in the assessment of the study's primary and secondary outcomes.

Our analysis was done on a per protocol basis because data on rehabilitation and follow-up were not available for dropouts. Therefore, we could not analyze the data according to the intention-to-treat principle.

The SPSS software version 11.0 (SPSS Inc, Chicago, Ill) was used for all analyses.

RESULTS

Baseline Characteristics

A total of 115 subjects with a diagnosis of COPD and accepted for pulmonary rehabilitation were recruited and randomized; 43 were allocated to the Norway group and 72 to the Spain group (Figure 1).

During the study, 19 subjects were excluded for various reasons: 7 in the Norway group and 12 in the Spain group (Figure 1). Hence, 96 subjects completed the study and were available for per protocol analysis. Subject baseline characteristics at randomization demonstrated no significant group differences, indicating that the groups were well balanced (Table 1). Moreover, there was no difference in the SGRQ and HAD Scale scores between the participants in the 2 groups at the start of rehabilitation (data not shown) nor in the 6-minute walking distance at this time point (Table 1). The time between randomization and admission was similar in the 2 groups (8 \pm 6 weeks in the Spain group vs 7 \pm 3 weeks in the Norway group).

Excluded subjects had lower body mass index than those completing the study (24 \pm 5 kg/m² vs 27 \pm 5 kg/m²,

Table 1 • BASELINE CHARACTERISTICS OF SUBJECTS WHO COMPLETED THE STUDY ACCORDING TO LOCATION OF REHABILITATION

	Norway	Spain
N	36	60
Sex, F:M	12:24	23:37
Age at randomization, y	59 \pm 8	61 \pm 8
Present smokers, n (%)	15 (42)	19 (32)
Oxygen saturation at rest, %	95.4 \pm 1.3	95.8 \pm 1.4
6-Minute walk distance, m*	482 \pm 123	518 \pm 93
FEV ₁ , L	1.5 \pm 0.5	1.4 \pm 0.5
FEV ₁ , % pred	48 \pm 11	49 \pm 14
FVC, L	2.9 \pm 0.8	2.9 \pm 0.8
FVC, % pred	77 \pm 14	79 \pm 17
FEV ₁ /FVC, %	51 \pm 9	50 \pm 10
DL _{CO} , % pred	59 \pm 25	61 \pm 27
DL _{CO} /VA, % pred	71 \pm 31	71 \pm 34
TLC, % pred	118 \pm 21	119 \pm 20
RV, % pred	183 \pm 50	181 \pm 50
Body mass index, kg/m ²	27.6 \pm 5.2	26.5 \pm 5.0
SGRQ total	56.9 \pm 12.0	54.6 \pm 12.7
SGRQ symptoms	59.1 \pm 22.4	53.8 \pm 21.3
SGRQ activity	68.6 \pm 13.5	69.0 \pm 16.2
SGRQ impact	49.5 \pm 12.8	46.6 \pm 13.7
HAD Scale-Anxiety	6.3 \pm 3.5	5.9 \pm 4.0
HAD Scale-Depression	5.4 \pm 3.4	4.9 \pm 3.4

% pred indicates percentage of predicted normal values; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; DL_{CO}, carbon monoxide diffusing capacity; DL_{CO}/VA, carbon monoxide diffusing capacity in relation to alveolar volume; TLC, total lung capacity; RV, residual volume; SGRQ, St. George's Respiratory Questionnaire (10–100 scale); HAD Scale, Hospital Anxiety and Depression Scale (0–21 scale).

Values are mean \pm SD, unless stated otherwise.

*At the start of rehabilitation.

respectively, *P* = .02), whereas there was no difference in the other baseline characteristics (data not shown).

Postrehabilitation Evaluation

The time between completion of rehabilitation and follow-up was not significantly different between the 2 groups (35 \pm 1 weeks in the Spain group vs 36 \pm 1 weeks in the Norway group). At follow-up, 5 subjects in the Spain group and 3 in the Norway group completed the questionnaires at home.

HRQoL and Psychological Well-being

Between the start of rehabilitation and follow-up 9 months later, there were no differences between the 2 groups in changes in SGRQ scores or HAD Scale scores (Table 2). The activity score of the SGRQ and the

Table 2 • COMPARISONS OF CHANGES IN SGRQ AND HAD SCALE SCORES FROM START OF REHABILITATION TO 8 MONTHS AFTER COMPLETION

	Norway (n = 36) Mean ± SD	Spain (n = 60) Mean ± SD	Difference Mean (97.5% CI)	P
SGRQ				
Total	-0.9 ± 10.1	-3.9 ± 12.4	-3.0 (-8.6 to 2.6)	.22
Symptoms	-7.0 ± 27.5	-9.6 ± 22.2	-2.6 (-14.2 to 9.1)	.62
Activity	-1.0 ± 10.7	-2.5 ± 15.0	-1.4 (-8.0 to 5.1)	.62
Impacts	1.0 ± 11.0	-3.1 ± 13.6	-4.1 (-10.3 to 1.9)	.13
HAD Scale				
Anxiety	-0.1 ± 3.8	-1.3 ± 2.8	-1.2 (-2.7 to 0.3)	.08
Depression	-0.3 ± 3.1	-0.7 ± 3.0	-0.3 (-1.7 to 1.1)	.62

SGRQ indicates St. George's Respiratory Questionnaire; HAD, Hospital Anxiety and Depression; CI, confidence interval.

Change: score 8 months after rehabilitation - score before rehabilitation. Difference: Negative values relate to larger improvement in the Spain group than in the Norway group.

HAD Scale anxiety score improved more during rehabilitation in the Spain group than in the Norway group (Table 3). There were no group differences in changes in the other dimension scores of the SGRQ from the start to the end of rehabilitation.

Exercise Capacity

The mean total exercise time was higher in the Spain group than in the Norway group (3,200 ± 1,250 min vs 2,320 ± 1,270 min, respectively, $P = .001$), as was the number of recording days (26 ± 3 days vs 23 ± 5 days, respectively, $P < .001$), whereas the daily exercise time showed little difference (120 ± 43 min vs 102 ± 48 min, respectively, $P = .06$).

There was no group difference in improvement in the 6-minute walking distance from the start of rehabilitation to the end of rehabilitation (43 ± 42 m for the Spain group vs 39 ± 51 m for the Norway group, $P = .7$) or to follow-up (13 ± 69 m vs 16 ± 72, respectively, $P = .9$).

Exacerbations, Hospitalizations, and Physician Visits

Between the end of rehabilitation and follow-up 8 months later, the Spain group had fewer registered exacerbations than did the Norway group, but there were no differences between the groups in the number of physician visits or hospitalization days (Table 4).

DISCUSSION

The present study showed no long-term advantages of COPD rehabilitation in a subtropical climate on HRQoL or psychological well-being compared with an equivalent program in Norway in the winter. Comparisons of effects immediately after rehabilitation showed improvements in activity and anxiety scores in favor of rehabilitation in a warmer climate.

To our knowledge, a possible climate effect on HRQoL or psychological well-being in patients with

Table 3 • COMPARISONS OF CHANGES IN SGRQ AND HAD SCALE SCORES FROM START TO COMPLETION OF REHABILITATION AFTER 4 WEEKS

	Norway (n = 36) Mean ± SD	Spain (n = 60) Mean ± SD	Difference Mean (97.5% CI)	P
SGRQ				
Total	-5.9 ± 9.2	-10.5 ± 11.6	-4.6 (-9.8 to 0.5)	.04
Symptoms	-18.3 ± 24.6	-19.1 ± 22.1	-0.7 (-11.9 to 10.4)	.88
Activity	-2.0 ± 11.9	-8.3 ± 13.3	-6.2 (-12.4 to -0.1)	.02
Impacts	-4.1 ± 10.0	-9.2 ± 14.2	-5.1 (-10.7 to 0.5)	.04
HAD Scale				
Anxiety	-0.1 ± 1.9	-1.9 ± 2.5	-1.7 (-2.9 to -0.6)	.001
Depression	-1.0 ± 2.2	-1.2 ± 2.7	-0.2 (-1.4 to 1.0)	.72

SGRQ indicates St. George's Respiratory Questionnaire; HAD, Hospital Anxiety and Depression.

Change: score at the end of rehabilitation - score before rehabilitation. Difference: negative values relate to larger improvement in the Spain group than in the Norway group.

Table 4 • COMPARISONS OF NUMBER OF EXACERBATIONS, PHYSICIAN VISITS, AND DAYS IN HOSPITAL FROM END OF REHABILITATION TO 8 MONTHS AFTER COMPLETION

	Norway (n = 36)	Spain (n = 60)	P
Exacerbations			
0	13	37	
1	12	14	
2	6	2	
≥3	5	7	
Mean rank	56	44	.02
Physician visits			
0	8	21	
1–4	22	35	
5–10	6	3	
≥11	0	1	
Mean rank	53	46	.22
Hospitalization days			
0	28	54	
1–4	2	2	
5–12	4	1	
≥13	2	3	
Mean rank	52	46	.13

COPD undergoing rehabilitation has previously not been investigated in a controlled study. The findings of short-term effects in the present study are in line with previous findings after climate therapy for psoriasis.⁶ The optimal duration for an inpatient pulmonary rehabilitation program has been evaluated in several studies, showing that 4 weeks represent a minimum duration to achieve a lasting clinical important effect.¹ Hence, we cannot exclude long-term effects of rehabilitation programs in a warm climate of longer duration than in the present study.

Exercise is considered to be the main part of a rehabilitation program and is closely related to the achieved improvement in HRQoL.¹ Recently, Brooks et al¹¹ reported that the weather is considered an important reason for not exercising in COPD. In the present study, we do not have a detailed account of exercise time outdoors versus indoors in the 2 groups. The reported longer exercise time in the Spain group may be related to the climate; however, we cannot interpret the larger short-term improvement in the activity dimension of SGRQ in the Spain group during rehabilitation as a climate effect per se. Furthermore, this improvement was only temporary and is therefore of uncertain clinical importance.

After completion of rehabilitation, the SGRQ component and total scores had improved more than 4 points, which is commonly considered the minimally clinical important difference, in both groups. After another 8

months, an improvement in the symptom scale was shown in both groups, suggesting that the rehabilitation program had clinically important short-term and longer-lasting effects in both groups. However, because the present study did not include a control group without rehabilitation, these findings should be interpreted carefully.

Disturbances in psychological well-being are common in patients with COPD, but it is uncertain if rehabilitation improves symptoms of anxiety and depression.^{12,13} In both allocation groups in the present study, the participants scored lower than values considered to represent neurotic disorders, although reported symptoms may represent significant problems for the individuals.^{9,13} Anxiety in patients with COPD is significantly correlated with social support.¹⁴ Hence, it is tempting to speculate that the demonstrated difference in improvement of anxiety symptoms during rehabilitation may be related to stronger social support in a group traveling together, rather than being associated with a genuine climate effect.

In COPD, disability, exacerbations, and reduced HRQoL lead to high costs for the society.^{15–17} In the present study, we found a difference between the groups in exacerbation rates between the end of rehabilitation and follow-up. However, the number of events was small and retrospectively self-reported. Moreover, differences in physician contacts or hospitalization days could not be demonstrated. The study subjects were selected from referred patients with moderate and severe COPD, according to the GOLD guidelines, but patients with pronounced oxygen desaturation were excluded.¹⁷ The number of included subjects was limited, thus restricting the statistical power of the study. Because of the recruitment process in one of the study arms, the study sample size was satisfactory to detect a difference of ±0.6 SD between the groups, with a power of .8 and a 5% significance level. Therefore, these results should be interpreted carefully, and one should not generalize the findings to all patients with COPD.

Recent research has evaluated the value of treatment strategies not commonly included in established multidisciplinary rehabilitation programs, for instance, the use of polyunsaturated fatty acids or creatine.^{18,19} In line with those interventions, our study aimed at improving the effects of rehabilitation in COPD, but the results suggest that there is no beneficial long-term climate effect in rehabilitation programs for COPD. In addition, we have no substantial pathophysiologic rationale for a climate effect on the disease process in COPD.

In conclusion, this comparison of COPD rehabilitation in a temperate and subtropical climate in the wintertime did not demonstrate any significant long-term differences in improvement of HRQoL or psychological well-being.

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