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Original Research

Effects of pulmonary rehabilitation on the perception of happiness in individuals with COPD: A randomized clinical trial

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ABSTRACT

Background: Individuals with chronic obstructive pulmonary disease (COPD) demonstrated reduced quality of life and a high prevalence of anxiety and depression. Because physical exercise enhances the perception of happiness in healthy individuals, this study hypothesized that pulmonary rehabilitation could improve happiness in individuals with COPD.
Objective: To assess the effects of pulmonary rehabilitation on the perception of happiness in individuals with COPD compared with usual care.
Methods: A randomized clinical trial. Individuals with COPD divided into two groups: control group (CG) and rehabilitation group (RG). Both groups received usual care, and RG also received an eight-week pulmonary rehabilitation program with aerobic and resistance exercises. Assessments were conducted before and immediately after the rehabilitation program. The primary outcomes was Happiness (Subjective Happiness Scale and the Cantril Ladder). The secondary outcomes were Life Satisfaction Scale, six-minute walk test (6MWT), timed up-and-go test, sit-to-stand test, handgrip strength, dyspnea, fatigue, Saint George's Respiratory Questionnaire (SGRQ), and Hospital Anxiety and Depression Scale.
Results: Forty-one individuals participated (68 ± 9 years, 59% male, FEV_1: 59 ± 18% predicted), composing the CG ($n = 20$) and RG ($n = 21$). Significant differences were observed favouring RG in the Subjective Happiness Scale (1 point; 95% CI: 0 – 1; $p < 0,05$), Cantril Ladder (2 points; 95% CI: 2 – 3; $p < 0,05$), and all secondary outcomes.
Conclusion: Individuals with COPD who underwent pulmonary rehabilitation showed a significant increase in perception of happiness compared with usual care.
Trial Registration: Brazilian Clinical Trials Registry (ReBEC). https://ensaiosclinicos.gov.br/rg/RBR-8tv29dc/1. Number RBR-8tv29dc.

Introduction

Chronic obstructive pulmonary disease (COPD) comprehends pulmonary and systemic manifestations that may lead to dyspnea, fatigue, limitations in daily activities, physical inactivity, reduced independence, decreased functional capacity, and impaired exercise tolerance.[1–3] These effects have significant implications, reducing quality of life and increasing symptoms of anxiety and depression.[1,4] Although literature lacks studies on the perception of happiness in individuals with COPD, analysis of general population showed that they experience a lower perception of happiness compared with individuals with other conditions (e.g., cancer, cardiovascular diseases, stroke, systemic hypertension, diabetes, asthma, and arthritis).[5]

Regular physical exercise impacts emotional aspects because it reduces negative feelings, anxiety, and depression while increasing positive emotional sensations, well-being, and self-image.[6–10] In addition, previous studies demonstrated that physical exercise increased the perception of happiness in healthy populations, older adults, children

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1413-3555/© 2026 Associação Brasileira de Pesquisa e Pós-Graduação em Fisioterapia. Published by Elsevier España, S.L.U. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

with obesity, and individuals with cancer.[5,11–16]

Physical exercise is an important component of pulmonary rehabilitation programs and the most effective non-pharmacological therapeutic intervention for dyspnea, fatigue, functional capacity, exercise tolerance, and quality of life in individuals with COPD.[17,18] Besides physical and functional benefits, positive emotional effects were reduced symptoms of depression and anxiety, and increased neuropsychological functioning, including attention, memory, and reasoning.[9,10]

Thus, this study hypothesized that pulmonary rehabilitation increases the perception of happiness in individuals with COPD. This finding would represent an innovative contribution to understanding the benefits of pulmonary rehabilitation, highlighting the broad therapeutic scope. The demonstration of improved happiness could potentially encourage greater engagement, referrals, and adherence to pulmonary rehabilitation. Therefore, this study aimed to assess the effects of pulmonary rehabilitation on the perception of happiness in individuals with COPD compared with usual care.

Methods

Study design

This study was a parallel-group, controlled, randomized trial with concealed allocation, using a 1:1 ratio and intention-to-treat analysis, designed by independent investigators. The clinical trial was registered in the Brazilian Clinical Trials Registry (ReBEC), (n. RBR-8tv29dc) and followed the Consolidated Standards of Reporting Trials (CONSORT)[19] guidelines and the Consensus on Exercise Reporting Template (CERT)[20] to report the interventions. The study followed the Helsinki Declaration and was approved by the research ethics committee of the University Hospital of Federal University of Juiz de Fora (n. 5.347.408). All individuals signed a written informed consent.

Randomization and blinding

Individuals were randomly assigned to two groups: control group (CG) and rehabilitation group (RG) at a 1:1 ratio using a randomization process from a website (www.randomization.com). An independent researcher who did not participate in the study conducted randomization, enrolled participants, and assigned participants to interventions. Allocation was concealed using sequentially numbered opaque sealed envelopes, opened after the initial individual assessment. Individuals and physical therapists responsible for the intervention remained blinded during the initial assessment and to all outcomes. All other healthcare professionals were unaware of the study. The researcher who conducted outcome measurements was not blinded to individual allocation.

Participants

Individuals were recruited from a general secondary care university hospital in Federal University of Juiz de Fora, beginning in September 2023, with assessments completed in September 2024. Participants included individuals of both sexes, aged 18 years or older, with clinically stable COPD (no exacerbations in the previous 4 weeks) and regular engagement in physical exercise. Exclusion criteria were the presence of acute health complications, COPD exacerbations, cardiovascular, neurological, musculoskeletal, or other respiratory diseases that would hinder assessments and interventions.

The sample size was calculated using G*Power software (Heinrich-Heine-Universität Düsseldorf). An effect size of 1.243 was demonstrated based on a previous study evaluating the effects of a physical training program on the perception of happiness in older individuals.[13] Considering an alpha error of 0.05 and a power of 0.8, a sample of 24 individuals was considered adequate for this study. A dropout rate of 20 % was predicted, and the final sample size was 29 individuals.

Interventions

The interventions were conducted at the Cardiopulmonary Rehabilitation Center of a secondary care University Hospital, in a controlled environment and adequate ventilation. The program was delivered by three physical therapists with clinical experience in therapeutic interventions for individuals with COPD and other pulmonary disorders. All physical therapists completed a standardized training session specific to the study protocol and received a detailed treatment information to ensure consistency in the delivery of the pulmonary rehabilitation program.

Control group (CG)

The control group (CG) received standard medical and clinical treatment, including pharmacological management. Additionally, participants were provided with verbal guidance to engage in regular walking practice in a safe, flat area, at their own pace, for 30 min per day, three times per week, without supervision or structured monitoring. No additional exercise equipment or non-exercise components were provided.

Rehabilitation group (RG)

The rehabilitation group (RG) received the same standard medical and clinical treatment, including recommendations for walking, as the CG, supplemented by a structured pulmonary rehabilitation program adhering to the International Guidelines for Pulmonary Rehabilitation.[17] The program was delivered in person, tailored with individualized supervision by one physical therapist per participant during each session to ensure proper exercise execution and safety. All participants were considered beginners, as they had never participated in pulmonary rehabilitation or engaged in regular physical exercise. The intervention consisted of 24 sessions conducted three times per week over eight weeks, with each session lasting approximately 60 min, including 30 min of aerobic training and 30 min of resistance training. In addition to the recommendations for walking described earlier, no home-based exercise component was included in the program. The intervention was delivered as planned, with no deviations from the protocol.

Aerobic training

Aerobic training involved 30-minute sessions of treadmill walking or stationary cycling, based on participant preference and physical capacity. The starting intensity for treadmill walking was set at 70 % of the average speed achieved during the six-minute walk test (6MWT).[17] For cycling, the initial workload was adjusted to elicit a heart rate (HR) of approximately 70 % of the maximum heart rate (HRmax), calculated as HRmax = 220 - age. Exercise intensity was guided by heart rate (maintained between 60 % and 80 % of HRmax, using the formula: training HR = resting heart rate [RHR] + 0.6 to 0.8 [HRmax - RHR]), perceived dyspnea, and fatigue, assessed using the modified Borg scale,[21] with target levels between 4 and 6 for both dyspnea and fatigue. Progression occurred weekly by increasing treadmill speed or cycling workload, provided dyspnea and fatigue remained within the target Borg range and HR did not exceed 80 % of HRmax. If dyspnea, fatigue, or HR exceeded these thresholds, the intensity was reduced to ensure participant safety.

Resistance training

Resistance training consisted of four exercises performed using handheld dumbbells for upper limb exercises and body weight for lower limb exercises. The exercises performed were: elbow flexion (biceps curl), shoulder abduction (lateral raise), squat, and ankle plantar flexion (calf raise). Details about the physical training program can be found in

the supplementary material.

Each exercise involved three sets of 8–12 repetitions, with a 1-minute rest between sets. The initial load for upper limb exercises was selected to achieve moderate muscle fatigue (4–6 on the Borg scale) after completing the prescribed repetitions. Muscle fatigue was assessed immediately after each exercise using the modified Borg scale.[21] For upper limb exercises, if fatigue was below 4 points, the dumbbell weight was increased by 0.5–1 kg in the subsequent session. For lower limb exercises, progression involved increasing the number of repetitions (up to 15) when fatigue was below 4 points. Exercises were tailored to individual capacity, with adjustments made based on participant feedback.

Adherence and fidelity

Adherence was measured by recording participant attendance at each session using an online attendance log, updated by the supervising physiotherapist immediately after each session. Adherence was defined as attending at least 80 % of the scheduled sessions (19 out of 24 sessions). Fidelity to the intervention was ensured through continuous supervision by trained physiotherapists, who followed the treatment manual and documented any deviations or adjustments in individual participant logs. Motivational strategies were employed, including individualized supervision, discussions about the benefits of physical training, and feedback, which supported participant engagement.

Assessments

All assessments were conducted at the respiratory rehabilitation unit of the university hospital and performed by a single previously trained researcher who followed standardized administration of tests and questionnaires according to international guidelines. Spirometry was conducted according to International Guidelines,[22] and data were expressed using absolute values and percentages of the predicted values.[23] The severity of COPD was classified based on the degree of airway obstruction,[1] and the impact of symptoms was assessed using the COPD Assessment Test (CAT) questionnaire.[24] The economic classes of the individuals were categorized into A1, A2, B1, B2, C, D, and E, according to the Brazilian Economic Classification Criteria.[25]

Primary outcomes

The primary outcomes were assessed using the subjective Happiness Scale (SHS) and the Cantril Ladder scale. The SHS is a questionnaire-based tool designed to assess self-perception of happiness, with four questions, answered on a 7-point Likert scale.[26] Total score ranges from one to seven, with higher scores indicating greater perceived happiness. The scale exhibits good measurement properties, assessed in both the original study[26] and the translated and validated version for the Brazilian population.[27] In addition, The Cantril Ladder is a valid scale that measures individuals' perception of happiness using an image of a ladder with steps numbered from 0 to 10; the first step represents the unhappiest possible life, and the last, the happiest possible life.[28] The Cantril Ladder is among the most widely administered subjective well-being measures; every year, it is collected in 140+ countries in the Gallup World Poll and reported in the World Happiness Report.[29]

Secondary outcomes

Exercise capacity was assessed using the 6MWT. Two tests were performed with a 30-minute rest interval, and the test with the greatest distance was considered for analysis. The outcome was the distance covered and the percentage of the predicted distance.[30,31] Functional capacity was assessed using the timed up-and-go test, composed of standing up from a chair, walking three meters, returning, and sitting down. The test was performed three times, and the fastest time was considered for analysis.[32,33]

Peripheral muscle strength was measured using the handgrip strength with a hydraulic hand dynamometer. Three measurements were taken in the dominant hand, and the best one was used for analysis. The outcome was presented in kilograms-force and as a percentage of the predicted value.[34] The 30-second sit-to-stand test (30s-STS) was also used as a measure correlated with peripheral muscle strength.[35] The primary outcome was the number of repetitions completed and the percentage of the predicted value.[33]

In addition, the Manchester COPD Fatigue Scale assessed fatigue, a scale consisting of 21 questions, ranging from 0 to 54 points, with higher scores indicating greater fatigue.[36] The modified Medical Research Council (mMRC) scale was used to evaluate dyspnea, which consists of five activities, with dyspnea graded from zero to four. Higher scores indicated greater limitations on daily activities due to dyspnea.[37]

Quality of life was measured using the Saint George's Respiratory Questionnaire (SGRQ), which provides a total score in three domains: symptoms, activities, and psychosocial impacts. Results were presented in absolute values and as a percentage of predicted value, with lower scores indicating better quality of life.[38] Additionally, the Satisfaction with Life Scale assessed the life satisfaction of individuals. The questionnaire contains five questions, answered on a 7-point Likert scale, ranging from 5 to 35, with higher scores indicating greater life satisfaction.[39]

Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS), which consists of 14 items divided into anxiety disorder and depressive disorder subscales. Scores range from 0 to 21 points for each domain and from 0 to 42 for the total score, with higher scores indicating greater severity.[40]

Statistical analysis

Statistical analysis was conducted using SPSS for Windows version 20.0 (SPSS, Chicago, Illinois). Shapiro-Wilk test was used to verify data distribution for normality. Sample characterization was presented as mean ± standard deviation, median (interquartile range), or frequency (percentage), depending on the data characteristics and distribution. Comparisons between groups for sample characterization were performed using *t*-test, Mann-Whitney test, and chi-square test.

Primary and secondary outcomes within and between groups were analyzed using generalized linear models with post-hoc testing using the least significant difference, demonstrated by mean ± standard deviation and 95 % confidence interval.[41] Analyses were performed using the intention-to-treat principle. The effect size of the primary outcomes and sample power were assessed using Cohen's d test with G*Power software (Heinrich-Heine-Universität Düsseldorf). A p-value of < 0.05 was considered statistically significant.

Results

A total of 119 individuals met the inclusion criteria and were considered eligible for the study. From those, 78 were excluded, with a final sample of 41 individuals, with 20 in the CG and 21 in the RG (Fig. 1). Only one participant dropped out of the treatment, resulting in an adherence rate of 98 %. The intervention was delivered as planned, with no deviations from the protocol. No adverse events were reported during the interventions. Significant differences were not observed between groups at the initial assessment. The sample characteristics are presented in Table 1.

Happiness scales presented a significant difference between groups. The RG showed a significant improvement in SHS compared with CG, with a difference between groups of 1 (95 % CI: 0 – 1), effect size of 1.11, and sample power of 0.932. Additionally, a significant difference was demonstrated in Cantril Ladder, favoring the RG, with a difference between groups of 2 points (95 % CI: 2 – 3), effect size of 1.783, and sample power of 0.999 (Table 2).

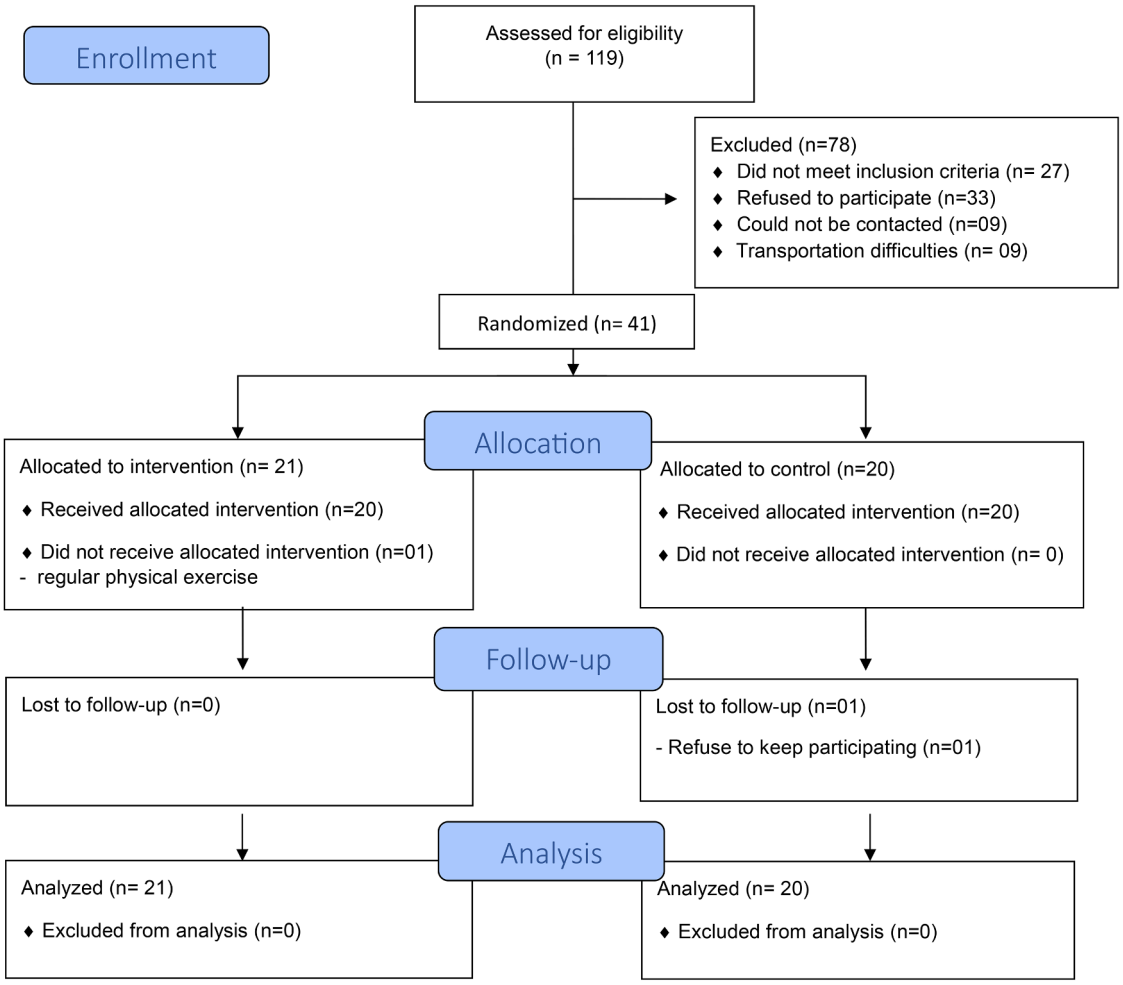

Fig. 1. Flow diagram of participants.

Significant differences favouring RG were also observed for Satisfaction with Life Scale, handgrip strength, 30s-STS, 6MWT, timed up-and-go, mMRC, Manchester COPD Fatigue Scale, SGRQ activities, SGRQ impact, SGRQ total, HADS depression, and HADS total (Table 2).

Significant correlations were found between the difference (final assessment - initial assessment) in happiness perception measured by the SHS and the difference in the 30s- STS ($r = 0.367$), 6MWT ($r = 0.431$), mMRC ($r = -0.402$), MCFS ($r = -0.324$), SGRQ impacts ($r = -0.627$), and SGRQ total ($r = -0.556$). Significant correlations were also found between the difference in happiness measured by the Cantril ladder Scale and the difference in handgrip strength ($r = 0.471$), 30s- STS ($r = 0.636$), 6MWT ($r = 0.576$), timed up and go ($r = -0.368$), mMRC ($r = -0.429$), MCFS ($r = -0.406$), SGRQ activities ($r = -0.358$), SGRQ impacts ($r = -0.597$), and SGRQ total ($r = -0.635$).

Discussion

The present study was the first to evaluate the effects of pulmonary rehabilitation on the perception of happiness in individuals with COPD. Results demonstrated that pulmonary rehabilitation enhanced the perception of happiness and reinforced the well-established benefits of improving physical function and quality of life, confirming the initial hypothesis.

Individuals with COPD have been shown to exhibit lower levels of perceived happiness, as highlighted in a study investigating the association between happiness and mortality.[5] A secondary finding of this study demonstrated a significantly reduced perception of happiness in this population (odds ratio [OR] = 0.668). The perception of happiness was lower than that reported by individuals with cancer (OR: 0.953), systemic arterial hypertension (OR: 0.928), diabetes (OR: 0.863), asthma (OR: 0.848), cardiovascular diseases (OR: 0.784), arthritis (OR: 0.763), and stroke (OR: 0.748), indicating a particular unhappiness in individuals with COPD.[5] Furthermore, individuals with COPD exhibited the lowest indicators of perceived control over their lives, the fewest moments of feeling relaxed, and the highest indicators of feeling stressed compared with individuals with other conditions.[5]

Our study demonstrated a perception of happiness of 4.7 ± 0.9 points, measured using the SHS, indicating a low level of happiness. This result was lower compared with a sample of healthy American adults (5.65 ± 1.0 points)[26] and healthy Brazilian adults (5.12 ± 1.0 points),[27] assessed with the same scale. Although the between-group difference was modest (1 point; 95 % CI: 0 – 1; $p < 0.05$), this result stems from a scale ranging from 0 to 7, in which resulting differences may also seem small. In addition to the statistical difference, this between-group difference is clinically relevant in the context of individuals with COPD, who exhibit a low baseline perception of happiness (4.7 ± 0.9 points on the SHS, lower than healthy populations in Brazil and the USA). This improvement is better understood when considering the large effect size (Cohen's $d = 1.11$), which suggests a significant emotional impact, particularly given the high prevalence of depressive and anxiety symptoms in this population.[4,10]

The Cantril Ladder reported a perception of happiness of 6.170 points, further indicating low happiness levels. This tool is widely used to evaluate the perception of happiness globally. According to the 2025 World Happiness Report, the average perception of happiness was 7.736 points for Finland (highest perception of happiness worldwide), 6.728

Table 1
Baseline characteristics.

	Rehabilitation group ($n = 21$)	Control group ($n = 20$)
Age (y)	69 ± 7	68 ± 11
Male	13 (62)	11 (55)
BMI (kg/m^2)	27 ± 8	29 ± 6
Pulmonary function		
FEV_1. % predicted	58 ± 20	61 ± 15
FVC. % predicted	73 ± 32	75 ± 30
FEV_1/FCV	67 ± 17	69 ± 15
GOLD	2 (2 – 3)	2 (2 – 2)
CAT	17 ± 6	18 ± 4
Smoking status		
Current smoker	1 (5)	1 (5.0)
Does not smoke	20 (95)	19 (95)
Comorbidities		
Hypertension	13 (62)	14 (70)
Diabetes	3 (14)	7 (35)
Cardiovascular disease	5 (24)	1 (5)
Educational level		
Uneducated	1 (5)	1 (5)
Complete middle school	14 (67)	9 (45)
Complete high school	3 (14)	6 (30)
Complete technical education	2 (10)	2 (10)
College graduate	1 (5)	2 (10)
Economic classification		
A	0	1 (5)
B1	0	0
B2	4 (19)	3 (15)
C1	10 (48)	13 (65)
C2	1 (5)	0
D and E	6 (29)	3 (15)

Data are expressed as mean ± standard deviation or frequency (%). BMI, Body Mass Index; CAT, COPD Assessment Test; FEV_1, Forced Expiratory Volume in the first second; FVC, Forced Vital Capacity.

for the United Kingdom (ranked 23th), 6.724 for the United States (ranked 24rd), and 6.494 points for Brazil (ranked 36th).[29]

Physical exercise was demonstrated to increase feelings of happiness and well-being,[5,11–16] but physiological mechanisms underlying these effects on emotional aspects are not completely understood. However, physical exercise stimulates neurotrophic responses, increasing neuroplasticity, neurogenesis, and hippocampal activity. Additionally, exercise stimulates the production and release of neurotransmitters such as serotonin, dopamine, and norepinephrine, endocannabinoids, increases melatonin and β-endorphin, and expands cortical pools of glutamate and gamma-aminobutyric acid. Physical exercise improves cerebral circulation, increases the supply of oxygen and glucose to the brain, and reduces cortisol levels.[42–47] These well-recognized neurophysiological events may help to explain the increased perception of happiness observed in our study.

As expected, RG showed significant improvements in exercise capacity, functional capacity, peripheral muscle strength, dyspnea, fatigue, anxiety, depression, and quality of life. These improvements exceeded the previously defined minimal clinically important differences for individuals with respiratory diseases, which included 6MWT (30 m),[30] mMRC (1 point),[48] Manchester Fatigue Scale (4.9 points),[49] SGRQ (4 points),[38] handgrip strength (6.5 kgf),[50] 30s-STS (2 repetitions),[33] and HADS (1.17 points).[51] These benefits are widely explored in literature, reinforcing that pulmonary rehabilitation is a therapeutic approach capable of improving these outcomes.[1,18]

Physical training enhances performance and also plays an important role in promoting emotional health.[5,11–16] Happier individuals may be more likely to increase their social participation.[52] In addition, they may be more committed and engaged in their treatment, improving adherence and active participation in rehabilitation sessions, which is critical for better clinical outcomes.[17]

Promoting exercise-related behavioral change in rehabilitation remains a persistent challenge, and theoretical models of behavior change offer valuable frameworks to support such efforts.[53] According to the Health Belief Model, perceived benefits—such as the emotional well-being experienced during pulmonary rehabilitation—serve as critical cues to action, increasing the likelihood of adherence to health-promoting behaviors, including physical activity.[53] In this context, the observed improvement in happiness among participants in the rehabilitation group may reflect a perceived emotional benefit of the intervention, which may act as a motivational factor for sustained engagement in the program. Furthermore, from the perspective of Self-Determination Theory, positive emotions such as happiness are closely linked to the satisfaction of basic psychological needs (e.g.,

Table 2
Comparison between the groups for primary and secondary outcomes.
Data are expressed as Mean ± SD; Difference between groups are expressed as Mean (95 % confidence interval).

	Rehabilitation group (RG)		Control group (CG)		Difference RG	Difference CG	Difference between groups
	Baseline	Final	Baseline	Final	Final - Baseline	Final - Baseline	RG – CG
SHS	5 ± 1	6 ± 1	5 ± 1	5 ± 1	1 ± 1*	0 ± 1	1 (0 – 1)*
Cantril ladder	6 ± 2	7 ± 2	7 ± 2	6 ± 2	1 ± 2*	−1 ± 1	2 (2 – 3)*
SWLS	24 ± 8	28 ± 7	22 ± 69	21 ± 7	4 ± 5*	−1 ± 2	5 (3 – 8)*
Handgrip strength, kgf.	28 ± 8	29 ± 9	25 ± 8.9	25 ± 9	1 ± 3	−1 ± 1	2 (1 – 3)*
Handgrip strength, % pred.	102 ± 20	107 ± 22	89 ± 23	88 ± 24	5 ± 8	−1 ± 4	6 (2 – 10)*
30s-STS, repetitions	13 ± 4	15 ± 4	12 ± 3	10 ± 3	3 ± 2*	−1 ± 2	4 (3 – 5)*
30s-STS, % pred.	86 ± 26	102 ± 28	79 ± 21	71 ± 23	17 ± 13*	−8 ± 14	25 (17 – 33)*
6MWT, m	357 ± 127	470 ± 102	349 ± 109	345 ± 111	113 ± 67*	−4 ± 28	117 (86 – 148)*
6MWT, % pred.	68 ± 25	89 ± 22	67 ± 22	66 ± 22	21 ± 13*	−1 ± 5	22 (16 – 29)*
TUG, s.	10 ± 5	9 ± 3	10 ± 4	10 ± 4	−2 ± 3	0 ± 2	−2 (−3 – 0)*
TUG, % pred.	82 ± 26	92 ± 24	84 ± 26	84 ± 28	10 ± 14	0 ± 2	10 (1 – 17)*
mMRC	2 ± 12	1 ± 1	2 ± 1	2 ± 1	−1 ± 1*	0 ± 1	−1 (−2 – −1)*
MCFS	24 ± 12	21 ± 13	27 ± 11	30 ± 12	−4 ± 11	3 ± 4	−6 (−11 – −2)*
SGRQ symptoms	46 ± 16	45 ± 15	47 ± 16	48 ± 17	−2 ± 17	1 ± 8	−3 (−11 – 5)
SGRQ activities	52 ± 28	44 ± 25	61 ± 25	67 ± 25	−9 ± 16	6 ± 14	−15 (−24 – −6)*
SGRQ impacts	47 ± 20	31 ± 20	45 ± 16	49 ± 19	−16 ± 15*	4 ± 8	−20 (−27 – −13)*
SGRQ total	48 ± 17	38 ± 17	50 ± 15	54 ± 16	−10 ± 10*	4 ± 7	−14 (−19– −9)*
HADS Anxiety	5 ± 4	5 ± 5	6 ± 4	7 ± 4	0 ± 2	1 ± 2	−1 (−2 – 0)
HADS Depression	6 ± 5	5 ± 5	6 ± 4	6 ± 4	−1 ± 2	0 ± 2	−1 (−2 – 0)*
HADS total	11 ± 9	10 ± 9	12 ± 6	13 ± 7	−1 ± 3	1 ± 3	−2 (−4 – 0)*

Abbreviations: 30s-STS, 30-Second Sit-to-Stand Test; 6MWT, Six-Minute Walk Test; HADS, Hospital Anxiety and Depression Scale; MCFS, Manchester COPD Fatigue Scale; mMRC, Modified Medical Research Council Dyspnea Scale; SGRQ, Saint George's Respiratory Questionnaire; SHS, Subjective Happiness Scale; SWLS, Satisfaction with Life Scale; TUG, Timed Up and Go Test.
* $p < 0.05$ is considered a statistically significant difference in outcome.

competence, autonomy, and relatedness), which facilitate the internalization of behavior and the development of more autonomous forms of motivation.[53] This suggests that perceived happiness may play a key role in sustaining physical activity in individuals with COPD. Therefore, future interventions may benefit from the intentional incorporation of these theoretical frameworks to not only enhance clinical outcomes but also to optimize emotional engagement and long-term adherence to rehabilitation programs.

The significant correlations observed between changes in happiness perception and improvements in physical and functional outcomes highlight the interconnectedness of emotional and physical well-being in individuals with COPD. These correlations suggest that enhancements in physical function and symptom reduction may contribute to increased happiness. These findings reinforce the benefits of pulmonary rehabilitation, where improvements in exercise capacity, muscle strength, and symptom management likely promote a greater sense of control, reduced physical limitations, and enhanced emotional well-being, aligning with the neurophysiological mechanisms (e.g., increased serotonin and dopamine)[42–47] that support emotional health through physical activity.

This study has some limitations: The sample size may be considered small; however, the sample studied exceeded the pre-calculated sample size requirement. Moreover, large to very large effect sizes were observed for both primary outcomes (effect size > 0.8), coupled with high statistical power (sample power > 0.8). These findings demonstrate that the sample was sufficient to support the study hypothesis. Considering happiness as a complex emotion and influenced by other variables, RG could have increased their perception of happiness due to external factors other than pulmonary rehabilitation, acting as a confounding element. Further studies are needed to minimize the effect of these variables.

Opportunities for further research arise since the construct of happiness has not yet been studied in individuals with respiratory diseases. An example is the need to investigate the perception of happiness in individuals with COPD using qualitative studies and comparing it with a case-controlled sample of healthy individuals, highlighting aspects related to happiness in this population.

Conclusion

Individuals with COPD who underwent pulmonary rehabilitation demonstrated an increased perception of happiness compared with individuals with usual clinical care. This study brings a significant contribution to understanding the benefits of pulmonary rehabilitation beyond physical outcomes and symptom management. Findings highlight the importance of integrated approaches that consider physical, emotional, and psychosocial aspects of COPD.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical

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Trial registration

Brazilian Clinical Trials Registry (ReBEC). https://ensaiosclinicos.gov.br/rg/RBR-8tv29dc/1. Number RBR-8tv29dc. restrictions.

Declarations of competing interest

none

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjpt.2026.101577.

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