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The Effect of Telehealth Based on Symptom Control and Rational Medication Use on Self-Efficacy, Anxiety-Depression, and Symptoms in Male Patients with COPD: A Quasi-Experimental Study

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Abstract

Introduction. Chronic obstructive pulmonary disease (COPD) is a critical global public health issue, imposing substantial physical, social, and economic burdens due to its symptoms and exacerbations. Telehealth has the potential to be applied for symptom management, monitoring medication adherence, and providing psychological support.

This study was carried out to determine the effect of telehealth based on symptom control and rational medication use on self-efficacy, anxiety-depression, symptoms, walking, and healthcare use outcomes in male patients with COPD.

Methods. A quasi-experimental design was used. The study examined 41 patients with COPD (the intervention group = 20, the control group = 21) treated at the Department of Chest Diseases, Buldan Chest Diseases State Hospital, Denizli, Türkiye. Data were collected at baseline and three months post-intervention using the COPD Self-Efficacy Scale, the COPD Assessment Test, the Hospital Anxiety Depression Scale, and the Six-Minute Walk Test. All participants received routine care. The patients in the intervention group were provided with a nurse-led program and telehealth for three months.

Results. A comparison of the baseline data for the two groups revealed a statistically significant difference in the incidence of respiratory hospitalizations ($p = 0.009$). Analysis of covariance adjusted for baseline results revealed statistically significant differences for the weather/environmental effect ($p = 0.011$) and behavioral risk factors subscales ($p = 0.017$) of the COPD Self-Efficacy Scale, as well as dyspnea score after the Six-Minute Walk Test ($p = 0.034$) in the intervention group compared to the control group. No significant differences were observed between the groups in anxiety-depression, symptoms, and healthcare use ($p > 0.05$).

Conclusions. This study demonstrated that telehealth based on symptom control and rational medication use significantly affected post-walking dyspnea and partially improved COPD self-efficacy in male patients with COPD. Incorporating teamwork and device-based monitoring is recommended to enhance the effectiveness of telehealth interventions based on education and monitoring.

Keywords

Anxiety-Depression; Chronic Obstructive Pulmonary Disease; Rational Drug Use; Self-Efficacy; Symptom Control; Telehealth

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Introduction

Chronic obstructive pulmonary disease (COPD) is a critical global public health issue, imposing substantial physical, social, and economic burdens due to frequent exacerbations, recurrent hospitalizations, and the progressive nature of its symptoms, with dyspnea being particularly prominent [1]. COPD is the fourth leading cause of death [2]. The burden of COPD is expected to increase due to the influence of risk factors, population growth, and aging [3]. This trend highlights the need for healthcare professionals to focus on COPD management.

COPD management is a multi-component process that emphasizes medication adherence, symptom management, and physical activity promotion [4]. Patients and families need to be involved and educated in COPD management. However, many healthcare institutions have yet to incorporate practices that promote effective COPD self-management into their healthcare services [5].

Medication adherence is one of the most effective

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ways to facilitate COPD management [6]. The rational use of medicines in all chronic diseases can increase treatment adherence and reduce mortality and morbidity [7]. Inhalers, the cornerstone of COPD treatment, are preferred because they have fewer systemic side effects and provide a high therapeutic effect at low doses. Studies show that most patients with COPD make significant errors when using inhalers [8, 9]. Furthermore, patients who are unable to use inhalers correctly tend to experience more severe symptoms [10]. Improving adherence to inhaler medications and symptom control in COPD patients can improve disease management and reduce the number of exacerbations and emergency healthcare visits [10].

Chronic symptoms, coupled with limitations in physical activity and social engagement among individuals with COPD, often contribute to low self-efficacy, which, in turn, increases the risk of anxiety and depression [11]. Self-efficacy in COPD is an individual's belief in their ability to perform actions with specific outcomes, such as symptom management [12]. In addition, high levels of anxiety lead to unnecessary use of emergency departments, while depression is associated with delays in seeking healthcare and initiating treatment for COPD exacerbations [11, 13].

Behavioral strategies and innovative approaches should support educating COPD patients on medication adherence and symptom control [4]. One such innovative method is telehealth [14]. Telehealth involves exchanging information and delivering healthcare services using information and communication technologies as an integral component of disease management [15]. Telehealth facilitates comprehensive support by reinforcing patient education through phone calls, monitoring patients, and providing feedback [4]. Its content is broad, reflecting the multicomponent nature of COPD management. Telehealth content for COPD includes symptom management, physical activity, and mental health [4]. Symptom management emphasizes the need for behavioral changes, such as adherence to medical treatment, symptom monitoring, and improving self-efficacy. An individualized exercise program for physical activity is communicated through instructions or recommendations. This approach contributes to psychological health by communicating with the patient, providing information and feedback, and suggesting relaxation techniques [4, 16].

The literature supports that increased COPD self-efficacy may reduce recurrent hospitalizations through improved symptom management and psychological health [12]. In addition, adherence to medical therapy may similarly reduce the number of COPD exacerbations and emergency department visits [10]. A systematic review and meta-analysis showed that telehealth applied to patients with COPD effectively reduced symptom burden and increased walking distance [15]. A Cochrane systematic review also proved that telehealth reduced hospital admissions when implemented as part of multicomponent care bundles [3].

Telehealth can be effectively applied for symptom control, medication adherence, psychological support, and physical activity promotion, especially in the early post-discharge period [16, 17]. Previous studies have focused less on symptom control and rational drug use [12, 14, 18, 19]. Based on rational medication use and symptom control, telehealth can help COPD patients manage their symptoms through pharmacological and non-pharmacological methods and develop self-efficacy to reinforce their behaviors. Therefore, telehealth applied to COPD patients may improve their physical and psychological health and optimize healthcare service utilization.

This study aimed to examine the effects of telehealth based on symptom control and rational medication use education, first on self-efficacy, anxiety-depression, and symptoms, and second on walking test results and healthcare use.

Materials and Methods

Study Design

This quasi-experimental study was carried out at the Department of Chest Diseases, Buldan Chest Diseases Hospital, Denizli, Türkiye, between August 2018 and April 2019, with a pretest performed before the intervention and a post-test conducted three months afterward.

Sample Size

The sample size was calculated based on the data from a survey by Kara and Aşti, which examined the effect of education on COPD self-efficacy levels in 60 COPD patients (30 experimental, 30 control) using an experimental design [20]. Assuming a strong effect size (Cohen's d = 0.8) between the two groups, a sample of 56 participants (28 from each group) was calculated to be sufficient to achieve a power of 90% and a confidence interval of 95%. At the end of the follow-up phase, it was determined that each group should include 35 participants to compensate for a 25% attrition rate. During the study period, 234 patients with COPD were evaluated for eligibility, and 70 patients who met the inclusion criteria were included in the study (Fig. 1).

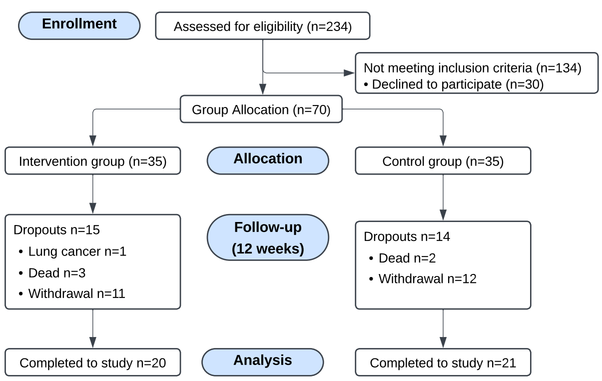

Figure 1. Study flow chart.

Eligibility Criteria and Group Allocation

The inclusion criteria were hospitalization to the Chest Diseases State Hospital with a diagnosis of COPD, literacy, no hearing, speech, or vision impairments, the ability to use a phone, and voluntary participation in the study. The exclusion criteria included respiratory comorbidity (lung cancer, interstitial lung disease, or pulmonary tuberculosis) or psychiatric illness. Patients were divided into two groups: control and intervention. Patients who did not complete the post-tests or were lost to follow-up were excluded from the study.

Data Collection

The study data were collected using a Patient Information Form, the COPD Self-Efficacy Scale (CSES), the COPD Assessment Test (CAT), the Hospital Anxiety Depression Scale (HADS), and the Six-Minute Walk Test (6MWT). The CSES, CAT, HADS, and 6MWT were used in the post-test. In addition, the patients were asked about healthcare use (hospitalizations, emergency room visits, and Chest Disease Outpatient Clinic visits) for the last three months.

Patient Information Form.

This form includes questions about sociodemographic and disease-related characteristics, including age, gender, body mass index, education level, living status, smoking habits, COPD duration and stage, comorbid conditions, forced expiratory volume, and respiratory-related healthcare use.

The COPD Self-Efficacy Scale (CSES).

This scale was developed by Wigal *et al.* to evaluate self-efficacy and the management of respiratory distress in COPD patients [21]. It comprises five subscales: negative effect (12 items), emotional state (8 items), physical effort (5 items), weather/environmental impact (6 items), and behavioral risk factors (3 items). The original scale demonstrated excellent internal consistency (Cronbach's α = 0.95) and good test-retest validity (r = 0.77). The Turkish adaptation study of the scale was conducted by Kara & Mirici [22]. The scale reliability coefficients (Cronbach's α) were 0.94, 0.89, 0.80, 0.73, 0.75, and 0.64 for the total scale and the negative effect, emotional state, physical effort, weather/environmental impact, and behavioral risk factors subscales, respectively. The consistency coefficients of the total scale and subscales were 0.89, 0.90, 0.85, 0.91, 0.86, and 0.89, respectively. The responses are scored using a five-point Likert-type scale from 5 (very safe) to 1 (not safe at all). The relevant item scores are summed up and then divided by the number of items on each subscale. The total CSES score is obtained by summing the subscale scores. The CSES score is between 1-5 (min-max), and higher scores indicate higher self-efficacy [22].

The COPD Assessment Test (CAT).

This is an eight-item test developed by Jones *et al.* and adapted to Turkish by Yorgancioğlu *et al.* [23, 24]. It is used to evaluate disease symptoms, including cough, phlegm, chest tightness, and breathlessness, and the disease impact on activity levels, confidence, sleep quality, and energy levels. It reveals disease severity with a score ranging from 0 to 40. The original scale demonstrated excellent internal consistency (Cronbach's α = 0.88) and good test-retest validity (r = 0.80). The reliability (Cronbach's α = 0.91) and internal consistency (r = 0.96) of the adapted test were excellent [24].

The Hospital Anxiety Depression Scale (HADS).

This scale evaluates the degree of anxiety and depression and was adapted to Turkish by Aydemir [25]. The 14-item HADS scale uses a four-point Likert-type scoring system, with items rated from 0 to 3. The odd-numbered items assess anxiety (HADS-A) and are scored as 3, 2, 1, and 0. The even-numbered items assess depression (HADS-D) and are scored as 0, 1, 2, and 3. HADS-A and HADS-D are scored between 0-21 (min-max). The internal consistency of the adapted test was good for HADS-A (Cronbach α = 0.85) and HADS-D (Cronbach α = 0.77). The cut-off score was ten for the HADS-A and seven for the HADS-D for Turkish samples [25].

The Six-Minute Walk Test (6MWT).

The 6MWT was administered according to the recommendation of the American Thoracic Society [26]. This scale includes a 6-minute walking distance (6MWD), oxygen saturation after 6MWT, and Borg dyspnea score.

Interventions

Intervention Group

The intervention group was given symptom control and rational drug use training, and the first researcher carried out telehealth practice. Before discharge, the first researcher administered the CSES, CAT, HADS, and 6MWT to the intervention group patients. The same assessments were conducted in the post-test, along with questions about healthcare utilization over the last three months.

The interventions implemented in the study are described below:

- *COPD Symptom Control and Rational Drug Use Education.* The symptom control education covered the following topics: the definition, causes, and symptoms of COPD; basic recommendations for living with COPD, including smoking cessation, walking, nutrition, vaccination, regular doctor checkups, infection prevention, and infection symptoms; controlled breathing techniques such as pursed-lip breathing and deep breathing exercises, as well as coughing exercises; and the causes and management strategies for dyspnea, cough, sputum, fatigue, sleep disturbances, and nutrition-related problems. The topics on rational drug use included the importance of regular medication adherence, an overview of pharmacological treatments for COPD, potential side effects, and strategies for their management. The education also covered instructions on the correct administration of inhaler medications, proper storage of medicines, dose monitoring, and checking expiration dates.

  At the end of the education session, patients were provided with the booklet "Living with COPD", which contained all the educational content. The researchers developed the booklet based on existing literature and designed it following patient education recommendations [27–33]. It featured a concise and straightforward style, a large font size (14 pt.), double-spacing, and a colorful design to enhance readability and engagement [32]. The booklet was presented to seven experts with a content validity form based on the DISCERN Handbook [34]. The content validity of the booklet was good (85.71%), and the readability level was specified as "very easily readable" (90%) [35].

- *Telehealth Practice.* The researcher conducted a telehealth program to provide motivation and patient counseling via phone calls. Telehealth interviews covered topics such as adherence to pharmacological treatment, symptom evaluation, breathing exercises, walking plans, smoking cessation, vaccination, and encouraging and acknowledging the patients' progress (Suppl. Table 1). The telehealth program consisted of four phone calls within three months after discharge. Each phone call lasted for approximately ten minutes (Fig. 2).

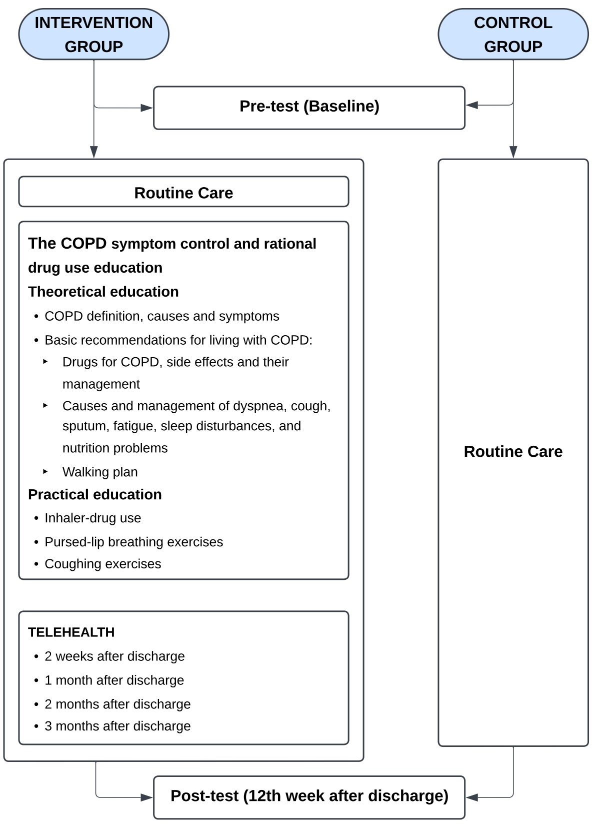

Figure 2. The study protocol.

Control Group

The control group received only routine care; no additional intervention was implemented. Routine care included pharmacological treatments, oxygen therapy, education on inhaler and nebulizer medication (provided during admission and discharge), and individualized follow-up by a physician (after discharge). Before discharge, the first researcher administered the CSES, CAT, HADS, and 6MWT to the control group patients. The same assessments were conducted in the post-test, along with questions about healthcare utilization over the last three months (Fig. 2).

Statistical Analysis

Statistical data analysis was conducted using the SPSS statistical software package version 25.0 (IBM Corp; Armonk, New York). Continuous variables are presented as the mean, standard deviation, standard error, median, and quartile. Categorical variables are reported as numbers and percentages. The Shapiro-Wilk test assessed whether the data conformed to a normal distribution. The Student's t-test was applied to normally distributed variables for inter-group comparisons, while the Mann-Whitney U test was used for non-normally distributed variables. The Chi-square test analyzed the differences between the categorical variables. Analysis of covariance was used to adjust for the effect of potential confounders on baseline outcomes. A p-value < 0.05 was considered statistically significant.

Results

A total of 234 patients were evaluated for eligibility during the study period, and the follow-ups were completed with 41 patients (20 from the intervention group and 21 from the control group) (Fig. 1).

Demographic and Disease Characteristics of the Participants

Table 1 shows participants' demographic and disease characteristics. The mean age was 62.4 ± 9.2 years in the intervention group and 63.1 ± 7.2 years in the control group. Most patients in both groups were elementary school graduates. Seventy percent of the intervention group and 66.7% of the control group patients used to smoke, and more than half of the patients in both groups were in category D according to the GOLD symptom classification. Over half of the control group patients received oxygen and nebulizer therapy at home. Still, there was no statistical difference between the groups regarding regular use of medications and oxygen and nebulizer therapy at home. The mean healthcare use was 1.7 ± 1.1 visits in the intervention group and 2.7 ± 1.5 visits in the control group, with the difference being statistically significant ($p = 0.009$). No statistically significant differences were observed between the groups regarding demographic or other disease-related characteristics ($p > 0.05$).

Distribution of Participants' Self-Efficacy, Anxiety, Depression, and Symptom Scores

Table 2 presents the CSES scores for both groups. No significant differences were observed between the groups in terms of the baseline CSES total and subscale scores ($p > 0.05$). However, at the end of the follow-up, significant differences were found in two CSES subscales: weather/environmental effects ($p = 0.011$) and behavioral risk factors ($p = 0.017$).

Table 1. Demographic and disease characteristics of the groups.

Descriptive Characteristics	Intervention Group (n=20) n (%)	Control Group (n=21) n (%)	p
Gender (Male)	20 (100)	21 (100)	N/A
Age, Mean±SD	62.4±9.2	63.1±7.2	0.791[c]
BMI, Mean±SD	26.5±5.5	27.2±5.8	0.714[c]
Education level			
Literate	3 (15)	1 (4.8)	
Elementary	16 (80)	18 (85.7)	0.592[d]
High School	1 (5)	2 (9.5)	
Living status			
Alone	2 (10)	6 (28.6)	0.238[d]
With family	18 (90)	15 (71.4)	
Smoking			
Current smoker	5 (25)	7 (33.3)	
Ex-smoker	14 (70)	14 (66.7)	0.734[d]
Never smoker	1 (5)	0	
Years diagnosed with COPD, Mean±SD	7.8 (6.3)	11.2 (6.6)	0.096[c]
Stage of COPD[a]			
Mild-moderateb	9 (45)	7 (33.3)	
Severe	7 (35)	10 (47.7)	0.781[d]
Very severe	4 (20)	4 (19)	
Comorbid conditions	7 (35)	11 (52.4)	0.262[d]
Regular use of medications	14 (70)	16 (76.2)	0.655[d]
Home oxygen therapy	10 (50)	15 (71.4)	0.238[d]
Home nebulizer therapy	10 (50)	15 (71.4)	0.160[d]
Number of drugs, Mean±SD	4.25±2.29	5.14±2.57	0.568[c]
FEV_1, Mean±SD	42.70±21.83	40.19±16.56	0.680[e]
Respiratory-related healthcare use (past years, Mean±SD)			
Hospitalizations	1.7±1.1	2.7±1.5	**0.009**[e]
Emergency rooms	2.2±3.4	4.4±8.8	0.399[e]
Chest Diseases Outpatient Clinic visits	2.7±1.6	3.0±2.8	0.750[e]

Notes: [a] – Stage of COPD classified based on the Global Initiative for Chronic Obstructive Lung Disease guidelines. [b] – One control group person with mild COPD; [c] – Mann-Whitney U test; [d] – Chi-square test or Fisher's exact test; [e] – Student's t-test.

SD – Standard Deviation; COPD – Chronic Obstructive Pulmonary Disease; FEV_1 – Forced Expiratory Volume; N/A – not applicable.

Table 2. Comparison of CSES scores between groups: unadjusted and adjusted analysis.

	Group	Unadjusted			Adjusted		
		Intervention (n=20)	Control (n=21)		Intervention (n=20)	Control (n=21)	
CSES	Time	Median (Q1-Q3)	Median (Q1-Q3)	p	Mean±SE	Mean±SE	p[c]
Negative effect	Baseline	4.8 (3.5-4.8)	4.8 (3.7-4.6)	0.979[a]	3.9±0.1	4.1±0.17	0.616
	3 months	4.2 (3.6-4.7)	4.2 (3.8-4.7)	0.958[a]	3.9±0.2	4.2±0.2	0.404
Emotional state	Baseline	4.5 (3.5-4.8)	4.3 (3.8-4.5)	0.456[a]	4.1±0.2	4.1±0.9	0.913
	3 months	4.4 (4.0-4.7)	4.1 (3.8-4.6)	0.469[b]	4.2±0.1	4.1±0.1	0.732
Physical exertion	Baseline	4.4 (4.0-4.8)	4.2 (3.9-4.4)	0.581[a]	4.3±0.1	4.6±0.1	0.404
	3 months	4.4 (4.0-4.8)	4.2 (3.9-4.4)	0.137[a]	4.3±0.1	4.1±0.1	0.404
Weather/environmental effect	Baseline	3.8 (3.0-4.3)	3.2 (2.8-3.8)	0.133[a]	3.6±0.2	3.3±0.2	0.172
	3 months	3.8 (3.2-4.1)	3.3 (2.9-3.5)	**0.002**[b]	3.7±0.1	3.2±0.1	**0.011**
Behavioral risk factors	Baseline	4.3 (3.8-4.3)	4.3 (4.0-5.0)	0.174[a]	4.2±0.2	4.4±0.2	0.422
	3 months	4.3 (4.1-5.0)	4.0 (3.5-4.5)	**0.030**[a]	4.4±0.1	3.9±0.1	**0.017**
Total	Baseline	4.0 (3.6-4.6)	3.9 (3.9-4.2)	0.754[a]	3.9±0.1	3.9±0.1	0.944
	3 months	4.2 (3.9-4.5)	3.9 (3.8-4.3)	0.110[b]	4.1±0.1	3.9±0.1	0.284

Notes: [a] – Mann-Whitney U test; [b] – Student's t-test; [c] – ANCOVA, analysis of covariance (covariate variable: respiratory-related hospitalizations).
CSES – Chronic Obstructive Pulmonary Disease Self-Efficacy Scale; Q – Quartile; SD – Standard Deviation; SE – Standard Error.

Table 3 presents the HADS and CAT scores for both groups. No significant differences were observed between the groups in the baseline CAT, HADS-A, and HADS-D scores ($p > 0.05$). Similarly, there were no significant differences in the HADS-A and HADS-D scores between the groups at the end of the follow-up ($p > 0.05$). Although the CAT score of the intervention group was statistically significantly lower compared to the control group after the follow-up ($p = 0.025$), the difference was insignificant after adjustment ($p > 0.05$).

Participants' 6MWT Outcomes and Healthcare Use Results

No significant differences were observed between the groups in their initial 6MWT results ($p > 0.05$) (Table 4). At the end of the follow-up, dyspnea score after 6MWT in the intervention group was lower compared to the control group ($p = 0.009$), and this difference persisted in the adjusted analysis ($p = 0.034$). At the end of the follow-up, no statistically significant differences were observed between the groups in terms of 6MWD or post-6MWT oxygen saturation.

During the three-month follow-up period, healthcare use was assessed in terms of hospitalizations, emergency room visits, and Chest Disease Outpatient Clinic visits. While the intervention group reported fewer emergency visits compared to the control group, there was no statistically significant difference in overall healthcare use between the groups ($p > 0.05$) (Table 4).

Discussion

The primary purpose of this study was to determine the effect of symptom control and rational drug use education and a telehealth program on self-efficacy, anxiety-depression, and symptom control in COPD patients. In addition, 6MWT measurements and healthcare use were evaluated secondarily. The study found an increase in the self-efficacy subscale scores (the weather/environmental impact and behavioral risk factor subscales) and a decrease in dyspnea scores after 6MWT in the intervention group compared to the control group. No significant changes were observed in anxiety-depression, symptoms, and healthcare use.

COPD self-efficacy has been extensively studied in

Table 3. Comparison of HADS and CAT scores between groups: unadjusted and adjusted analysis.

	Group	Unadjusted			Adjusted		
		Intervention (n=20)	Control (n=21)		Intervention (n=20)	Control (n=21)	
	Time	Median (Q1-Q3)	Median (Q1-Q3)	p	Mean±SE	Mean±SE	p^c
HADS anxiety	Baseline	3.0 (1.25-7.25)	2.0 (1.5-5.0)	0.635^a	4.9±1.3	4.5±1.2	0.831
	3 months	3.0 (0.25-5.75)	3.0 (1.0-7.0)	0.626^a	4.2±0.9	3.8±0.9	0.784
HADS anxiety >10, n (%)	Baseline	3 (15)	3 (14.3)	1.000^d			
	3 months	2 (10)	2 (9.5)	1.000^d			
HADS depression	Baseline	4.0 (2.0-6.0)	4.0 (2.0-8.5)	0.802^a	5.3±1.2	5.9±1.2	0.775
	3 months	2.5 (1.0-4.75)	3.0 (1.0-7.5)	0.476^a	3.8±0.9	4.2±0.9	0.783
HADS depression >7, n (%)	Baseline	4 (20)	6 (28.6)	0.523^d			
	3 months	4 (20)	5 (23.8)	1.000^d			
CAT	Baseline	12.5 (8.0-19.0)	14.0 (9.0-20.5)	0.632^b	13.8±1.9	15.5±1.9	0.544
	3 months	9.0 (5.0-14.5)	18.0 (11.5-22.0)	**0.025^a**	10.9±1.9	16.4±1.8	0.052

Notes: [a] – Mann-Whitney U test; [b] – Student's t-test; [c] – ANCOVA, analysis of covariance (covariate variable: respiratory-related hospitalizations); [d] – Fisher's exact test.

HADS – Hospital Anxiety and Depression Scale; CAT – Chronic Obstructive Pulmonary Disease Assessment Test; Q – Quartile; SE – Standard Error.

Table 4. Comparison of 6MWT outcomes and healthcare use between groups: unadjusted and adjusted analysis.

	Group	Unadjusted			Adjusted		
		Intervention (n=20)	Control (n=21)		Intervention (n=20)	Control (n=21)	
6MWT	Time	Median (Q1-Q3)	Median (Q1-Q3)	p	Mean±SE	Mean±SE	p^c
6MWD, m	Baseline	365 (302-447)	360 (211-395)	0.396^a	365±32	321±31	0.338
	3 months	407 (218-487)	350 (132-397)	0.089^b	366.4±36.2	290±35	0.151
Dyspnea post-6MWT	Baseline	3.0 (2.0-4.0)	3.0 (1.5-4.0)	0.695^a	3.2±0.3	2.8±0.3	0.359
	3 months	3.0 (2.0-3.75)	4.0 (3.0-5.5)	**0.009^b**	2.9±0.3	4.0±0.3	0.034
SpO_2% post-6MWT	Baseline	92.5 (85.0-96.75)	92 (80.5-93.5)	0.165^a	89.9±2.1	87.3±2.1	0.409
	3 months	92 (82.5-94.75)	92 (72.5-94)	0.395^a	86.9±3.1	84.4±3	0.567
Respiratory-related healthcare use, 3 months							
Hospitalizations		0.5 (0-1.0)	1.0 (0-2.0)	0.213^a	0.9±0.2	0.9±0.2	0.807
Emergency rooms		0 (0-1.0)	0 (0-2.5)	0.132^a	1.3±1.4	2.3±1.3	0.593
Chest Diseases Outpatient Clinic visits		1.0 (0-2.0)	1.0 (1.0-2.0)	0.258^a	1.2±0.2	1.4±0.2	0.505

Notes: [a] – Mann-Whitney U test; [b] – Student's t-test; [c] – ANCOVA, analysis of covariance (covariate variable: respiratory-related hospitalizations).

6MWT – 6-Minute Walk Test; 6MWD – 6-Minute Walking Distance; SpO_2 – Oxygen Saturation; Q – Quartile; SE – Standard Error.

the literature. For example, interventions focusing on rational drug use and inhaler education have demonstrated a significant increase in CSES scores at the end of the follow-up [36, 37]. However, these studies reported notably lower baseline CSES scores compared to the findings of this study [36, 37]. A randomized study investigating telehealth interventions combined with written action plans or education for COPD patients, excluding those with comorbidities, found no significant increase in total CSES scores [38]. In the present study, significant differences were observed between the groups in the scores for the weather/environmental effects and behavioral risk factor subscales of the CSES. Ahmed *et al.* found that the multi-component telehealth program, including group education, problem-solving therapy, educational video, booklet, calls, and messages, improved COPD self-efficacy at the end of the three-month follow-up [12]. However, this difference may be attributed to variations in the socio-demographic characteristics (e.g., age, gender, education, etc.) of the participants in this study, as well as differences in the program components used in Ahmed *et al.*' study [12]. Self-efficacy is influenced by performance, physiological, and emotional states [39]. Therefore, the limited improvement in COPD self-efficacy across all sub-dimensions in this study may be attributed to the intervention method, duration, and content. Methods with a proven potential to enhance COPD self-efficacy, such as motivational interviewing could be considered for future telehealth programs [40].

This study found that the intervention did not significantly improve anxiety and depression scores among COPD patients. Similarly, in a study by Chatwin *et al.*, which investigated the effect of telemonitoring on COPD patients, anxiety scores remained unchanged in the telemonitoring group [41]. Although a statistically significant reduction in depression scores was observed, the clinical relevance of this change was minimal. Recently published studies focusing on COPD self-management and telehealth reported that the interventions did not improve the patients' emotional state, similar to the findings of this study [1, 15, 42]. In the present study, the intervention focused on rational medication use and symptom control. Symptoms may act as a trigger for the onset of anxiety and depression in COPD patients [11]. No statistical reduction in symptoms was observed in this study, and the relationship between symptoms and emotional state can explain this result. The duration of anxiety and depression symptoms among the patients in this study is unknown. Research indicates that chronic anxiety is associated with acute anxiety and depression in COPD individuals [11]. Future telehealth studies should incorporate psychosocial methods and consider various factors that may affect anxiety and depression in COPD patients.

The present study used the CAT to evaluate COPD symptom control. At the end of the follow-up, the intervention group showed a significant decrease in the CAT scores, but this improvement disappeared after adjusted analysis. Similarly, in a study by Hegelund, CAT scores of the intervention group who received action plans decreased after the three-month follow-up [1]. In a multidisciplinary study that included only patients with severe COPD, no decrease was observed in total and subscale scores of the CAT at the end of the one-year follow-up in the intervention group [42]. Demeyer *et al.* reported that a 12-week telehealth intervention based on exercise training did not change CAT scores of COPD patients [18]. Additionally, a meta-analysis study indicated that telehealth interventions lasting three months or less did not significantly improve the health outcomes of COPD patients [15]. Individualized education and telehealth can potentially improve COPD symptom control; however, the limitations of this study may have influenced the CAT results.

In the present study, no statistically significant differences were observed between the groups at the end of the follow-up regarding 6MWT outcomes. While walking distances remained unchanged in the intervention group, they decreased by 30 meters in the control group. The minimum clinically significant difference in 6MWT for COPD patients is reported to be 25-35 meters [43]. Telehealth intervention studies also reported a 12-meter difference in 6MWT between the groups, which was statistically insignificant in the study with a smaller sample size [18, 19]. In addition, a study by Song *et al.* reported that walking outcomes were not significantly different from standard care in telehealth interventions lasting three months or less [15]. In the present study, walking plans, encouragement for walking, and symptom control support via telehealth may have effectively maintained the walking distance and reduced dyspnea after walking. In addition, patients were taught hands-on deep breathing exercises, and a specific plan was suggested. Breathing exercises were also discussed during telehealth phone calls. However, as the supplementary material shows, patients reported not doing breathing exercises at home (Suppl. Table 1). While breathing exercises effectively reduce dyspnea in COPD, they are not considered a comprehensive component of COPD management [44]. Kon *et al.* reported an improvement in the isometric walk test after three months of pulmonary rehabilitation, although this improvement was no longer evident after one year [45]. In contrast, this study showed that symptom control and rational medication use based on telehealth can help maintain walking ability in COPD patients. In addition, encouraging breathing exercises through the device can serve as a motivating factor for patients. The effect of individualized walking plans and the use of respiratory devices can be investigated in telehealth studies. In addition, long-term reminders and motivation should be incorporated to ensure sustained patient engagement.

This study found no significant difference in healthcare use between the groups during the three-month follow-up, though there was a potential reduction in emergency department visits. Similarly, a telehealth study by Calvo *et al.* reported a significant reduction in emergency department visits and hospital admissions in severe COPD patients after six months [14]. The authors believed that the reduction in healthcare use was related to the content and components of the telehealth program, including the use of monitoring devices during patient follow-up and referral to a pulmonologist after assessment by a nurse [14]. In a study by Fors *et al.*, a nurse-led telehealth intervention reduced mortality and recurrent hospital admissions after six months [17]. Similarly, a meta-analysis study reported weak evidence supporting reducing healthcare use through telehealth in COPD patients [3]. In addition, Metting *et al.* found that a COPD telehealth intervention with educational components positively affected healthcare use [46]. The results of this study, along with those of other studies discussed, highlight the importance of incorporating teamwork, integrating training and devices, and establishing long-term follow-up outcomes in COPD telehealth programs.

Limitations

This study has several limitations. First, it was conducted using a quasi-experimental design, where both the intervention and control groups were admitted to the same hospital ward, potentially leading to interaction between the groups. A second limitation was the relatively small sample, with participants who did not attend the post-test being excluded. Finally, all the study participants were male, as no female patients with COPD met the inclusion criteria during the study period.

Conclusions

This study investigated the effect of telehealth based on symptom control and rational medication use in male patients with COPD. The primary findings revealed a significant improvement in the weather/environmental effects and behavioral risk factors subscales of the CSES in the intervention group. Regarding the 6MWT outcomes, a notable improvement was observed only in dyspnea score after walking. No significant differences were found between the groups in other outcomes, including anxiety-depression, symptom control, and healthcare use.

Ethical Statement

The study was conducted according to the principles of the Declaration of Helsinki, with ethical approval obtained from the Pamukkale University Ethics Committee (Date: January 17, 2018; Number: 60116787-020/4317). The study did not involve any interventional method that could harm the participants.

Informed Consent

The purpose of the study was explained to all participants, and then their written consent was obtained.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Appendix 1

Supplementary Table 1. Telehealth follow-up outcomes of the intervention group.

Monitoring topics	Follow-up after discharge 2 weeks (n=26) n (%)	1 month (n=28) n (%)	2 months (n=27) n (%)	3 months (n=22) n (%)
Regular medication use				
Yes	21 (80.1)	24 (85.7)	24 (88)	18 (81.8)
No	5 (19)	3 (10.7)	3 (12)	3 (13.7)
Partially	-	1 (3.6)	-	1(4.5)
Walking (minute/daily)				
<5	2 (7.7)	2 (7.1)	2 (7.4)	2 (9.1)
05-10	4 (15.3)	8 (28.5)	4 (14.8)	5 (22.7)
>10-30	5 (19.2)	5 (17.8)	8 (29.6)	3 (13.6)
>30-60	7 (26.9)	7 (25)	8 (29.6)	7 (31.8)
>60	7 (26.9)	6 (21.4)	5 (18.5)	5 (22.7)
Breathing exercise				
Yes	9 (34.7)	6 (21.4)	3 (11.1)	2 (9.1)
No	14 (53.8)	16 (57.1)	21 (78.8)	18 (81.8)
Partially	3 (11.5)	6 (21.5)	3 (11.1)	2 (9.1)
Nutrition-fluid intake				
Yes	22 (84.6)	23 (82.1)	21 (77.8)	18 (81.8)
No	4 (15.4)	5 (17.9)	5 (18.5)	4 (18.2)
Partially	-	-	1 (3.7)	-
Symptom control				
Yes	18 (69.2)	18 (64.3)	17 (63)	15 (68.2)
No	8 (30.8)	10 (35.7)	10 (37)	6 (27.3)
Partially	-	-	-	1 (4.5)
Sleep-activity				
Yes	18 (69.2)	23 (82.1)	21 (77.2)	18 (81.8)
No	8 (30.8)	5 (17.9)	6 (22.2)	4 (18.2)
Smoking				
Yes	6 (23.1)	6 (21.4)	6 (22.2)	5 (22.7)
No	20 (76.9)	22 (78.6)	21 (77.8)	17 (77.3)
Vaccination				9 (30)