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Effects of empowerment model–based telenursing interventions on empowerment in individuals with COPD

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Abstract

Background Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide. Although empowerment-based interventions delivered through telenursing are suggested to enhance patients' self-management and health outcomes, evidence regarding their effectiveness in COPD patients remains limited.

Objective This study aimed to evaluate the effects of empowerment model-based telenursing interventions on patient empowerment and health outcomes in individuals with COPD.

Methods This single-blind randomized controlled trial included 90 patients with COPD (45 in the intervention group and 45 in the control group) recruited from a university hospital in Turkey. Participants were randomly assigned to the intervention and control groups. The intervention group received four face-to-face empowerment sessions followed by three months of structured telephone calls and reminder text messages, while the control group received standard care. Data were collected at T_0 (baseline), T_1 (3 months/post-test), and T_2 (6 months/follow-up) using the COPD Empowerment Scale (COPD-ES), COPD Assessment Test (CAT), Modified Medical Research Council Dyspnea Scale (mMRC), Modified Barthel Index, Inhaler Device Use Skill Scale, and Pulmonary Function Test (PFT). The data obtained in the study were statistically analyzed using SPSS (Statistical Package for the Social Sciences) version 25.0 for Windows. The study adhered to the CONSORT 2010 guidelines.

Results The intervention group demonstrated significant improvements across multiple outcomes compared with the control group. At T_1 and T_2, notable gains were observed in COPD-ES total scores ($p < 0.001$, $\eta^2 = 0.704$), CAT scores ($p < 0.01$, $\eta^2 = 0.501$), mMRC scores ($p < 0.01$, $\eta^2 = 0.072$), inhaler device use skills ($p < 0.001$, $\eta^2 = 0.531$), and pulmonary function test values ($p < 0.05$, $\eta^2 = 0.176$). In addition, hospital admissions and visits related to COPD exacerbations significantly decreased ($p < 0.05$, $\eta^2 = 0.412$ and $\eta^2 = 0.384$, respectively). No significant changes were found in Modified Barthel Index scores ($p > 0.05$, $\eta^2 = 0.004$), indicating stable functional independence throughout the study period.

Conclusion Empowerment model-based telenursing interventions were effective in enhancing patient empowerment, improving symptom control, optimizing pulmonary function, and reducing hospital utilization

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among COPD patients. These findings support the integration of empowerment-focused telenursing strategies into routine COPD management.

Clinical trial registration HYPERLINK "http://ClinicalTrials.gov" ClinicalTrials.gov Identifier: NCT06217718 [Registration date 2024/02/15]

Keywords Chronic obstructive pulmonary disease, Empowerment, Telenursing, Self-management, COPD exacerbation

Background

Chronic obstructive pulmonary disease (COPD) is a prevalent chronic respiratory condition and a major public health concern globally, associated with substantial morbidity, frequent exacerbations, and progressive decline in lung function [1]. Beyond clinical outcomes, COPD significantly impairs quality of life and imposes considerable economic burdens through recurrent hospitalizations, long-term treatment, and productivity loss, accounting for a substantial portion of respiratory disease-related healthcare expenditures in the European Union [2].

Effective COPD management requires not only pharmacological therapy but also structured patient education and empowerment to enhance self-management, adherence, and timely response to exacerbations [3]. Empowered patients are better equipped to make informed decisions, follow prescribed therapies, adopt healthy behaviors, and engage actively with healthcare providers, ultimately improving clinical outcomes and quality of life [4, 5].

Digital health technologies, particularly telenursing, have emerged as promising tools to support patient empowerment. Telenursing allows remote monitoring, ongoing patient guidance, and structured education on disease management, enabling timely interventions and fostering patient engagement [6, 7]. Previous studies suggest that empowerment-focused telenursing interventions can enhance patient knowledge, self-efficacy, and adherence, while providing a sense of support and security [6].

Despite these benefits, few randomized controlled trials have rigorously evaluated empowerment model-based telenursing interventions specifically in COPD patients, and the direct impact on patient empowerment remains insufficiently investigated. Addressing this gap is essential for developing evidence-based, patient-centered interventions [7].

Therefore, this study was designed to examine the effects of empowerment model-based telenursing interventions on patient empowerment and clinical outcomes in individuals with COPD.

Methods

Study design

This was a parallel-group, single-center randomized controlled trial adhering to CONSORT 2010 guidelines.

Study setting and characteristics

The study was conducted at Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital in Istanbul, Turkey, a teaching and research facility and a main referral center for tertiary pulmonary care. The hospital provides comprehensive services, including pulmonary function tests (PFTs), non-invasive mechanical ventilation, bronchoscopy, immunotherapy, and a dedicated sleep laboratory.

Study population and sample

Patients diagnosed with COPD who presented to the hospital were invited to participate, and all provided written informed consent. Sample size was calculated using G*Power 3.1 based on a previous study by Sazak and Olgun [8], which reported an effect size of 0.90 for the mMRC Dyspnea Scale. With a significance level of 0.05 and 80% power, a minimum of 82 participants (41 per group) was required. To account for potential dropouts, 90 participants were recruited (45 per group).

During the study, two participants in the intervention group discontinued (one death, one lost to follow-up), and four in the control group discontinued (one death, one lost to follow-up, and two voluntary withdrawals). Consequently, 43 participants in the intervention group and 41 in the control group completed the study.

Randomization and allocation

Ninety patients with COPD were randomly allocated to the intervention group (n = 45) or the control group (n = 45) through stratified randomization (Fig. 1). Disease stage and smoking status—factors known to influence COPD self-management [9]—were selected as stratification variables. Stratified randomization was performed in SPSS version 25 (IBM Corp., Armonk, NY, USA) using the Data → Select Cases → If condition is satisfied function, in which “disease stage” and “smoking status” were entered as stratification conditions to ensure balanced group distribution. To minimize selection bias,

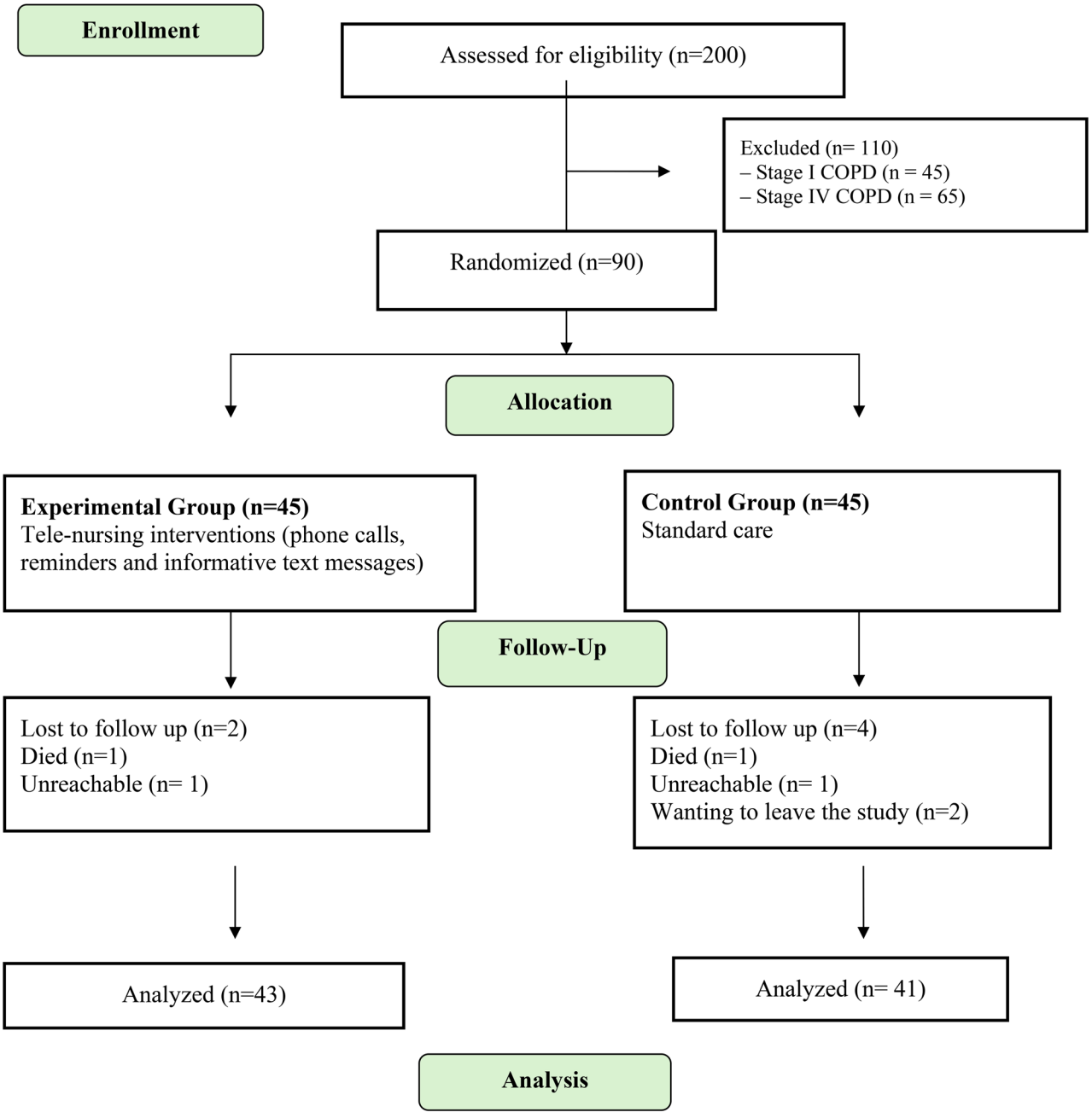

Fig. 1 CONSORT flow diagram shows the participation in this study

group assignments were conducted by an independent researcher blinded to study procedures.

Blinding

Due to the nature of the intervention, neither participants nor intervention providers could be blinded to group allocation. However, the outcome assessors and data analysts were blinded to group assignments throughout the study to minimize detection and analysis bias. Therefore, the study was conducted as an assessor- and analyst-blinded randomized controlled trial [10].

Recruitment

Participants were recruited from a public chest diseases hospital in Turkey between March and November 2024. At the beginning of the study, the investigator physician conducted the staging assessment of COPD. Patients with Stage I COPD were excluded because they generally exhibit minimal symptoms, whereas those with Stage IV COPD were excluded due to severe symptoms and significant functional limitations. To ensure a clinically meaningful and homogeneous sample, only patients with Stage II and Stage III COPD were included in the study.

Inclusion criteria

- Diagnosed with COPD at least one year prior.
- Able to understand and respond to questions.
- Able to use a mobile phone.
- Classified as stage II or III according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria (30% ≤ FEV1 < 80%).
- Not participating in any other research study.

Exclusion criteria

- Acute COPD exacerbation.
- Severe dyspnea preventing cooperation.
- Sensory impairments affecting vision, hearing, or speech.
- Refusal to complete study forms.
- Patients who were referred to a pulmonary rehabilitation program as part of routine care and had accepted participation or were already attending a program.
- Use of other complementary therapies (e.g., aromatherapy, ozone therapy).
- Presence of malignancies (e.g., lung cancer).
- Amputation or major physical disability limiting participation.
- Neurodegenerative disorders (e.g., dementia).
- Development of COPD-related complications (e.g., pneumonia, pulmonary hypertension).
- Withdrawal from the study.
- Failure to comply with study procedures for more than two consecutive weeks.

Outcomes

Outcomes were measured at three time points: baseline (T_0, before the intervention), post-test (T_1, at the 3rd month), and follow-up (T_2, at the 6th month).

Primary outcome

COPD empowerment scale (COPD-ES)

Patient empowerment was assessed using the COPD Empowerment Scale (COPD-ES), developed by the researchers [11]. During the development phase, a pilot study was conducted with 30 individuals diagnosed with COPD, and the psychometric properties of the scale were subsequently validated in a larger sample of 275 individuals with COPD. The validated scale consists of 24 items grouped into five subscales: awareness, knowledge, cooperation, choice, and self-efficacy. Each item is rated on a five-point Likert scale, with higher scores indicating greater empowerment. The scale has demonstrated high internal consistency, with a Cronbach's alpha of 0.90. The total score of the COPD-ES was considered the primary outcome measure in this study. The full version of the COPD-ES is provided in the appendix.

Secondary outcomes

Healthcare utilization

The number of hospital admissions and hospitalizations due to COPD exacerbations were recorded for each participant throughout the study period. These objective measures served as secondary outcomes reflecting the clinical impact of the intervention.

COPD assessment test (CAT)

COPD symptom burden was evaluated using the COPD Assessment Test (CAT), an eight-item questionnaire that assesses the impact of COPD on patients' health status [12]. Scores range from 0 to 40, with higher scores indicating greater disease burden: 0–10 = low, 11–20 = moderate, 21–30 = high, and 31–40 = very high impact.

Modified medical research council dyspnea scale (mMRC)

Dyspnea was assessed using the mMRC Dyspnea Scale, developed by Fletcher et al. [13]. This five-point scale measures the level of breathlessness experienced during daily activities, with scores ranging from 0 to 4, indicating increasing severity.

Pulmonary function tests (PFTs)

Lung function was evaluated through PFTs, with Forced Expiratory Volume in one second (FEV_1) as the primary pulmonary parameter. Patients took a full, deep breath, and airway and lung volumes were measured during a forced expiratory maneuver. Tests were conducted by the hospital's pulmonary function unit using the ZANPFT device, and results were interpreted based on reference values established by Morris and Polgar [14].

Modified barthel index

Functional independence was measured using the Modified Barthel Index, originally developed by Mahoney and Barthel in 1965 [15]. This 10-item scale evaluates activities of daily living including transfer, ambulation/wheelchair use, stair climbing, feeding, dressing, grooming, bathing, toilet use, and urinary and fecal continence. Total scores range from 0 to 100, with higher scores indicating greater independence. Shah later modified the scoring to a five-point system for increased sensitivity, and a cultural adaptation for Turkey was performed by Küçükdeveci et al. [16].

Inhaler device usage skill scale

Patients' inhaler technique was evaluated using the Inhaler Device Usage Skill Scale, which was developed based on A Guide to Aerosol Delivery Devices for Respiratory Therapists, 2nd Edition [17]. The assessment was

conducted through direct observation by one researcher, following structured steps specific to each inhaler type. Four device types were evaluated: metered-dose inhaler, Diskus, Turbuhaler, and Aerolizer. Each device consisted of 10 steps, scored as 1 for correct performance and 0 for incorrect or incomplete performance, yielding a total score ranging from 0 to 10 for each device.

Control variables

Participants' demographic and clinical characteristics were collected using a Patient Demographic Information Form developed by the researchers based on literature review [4–6]. The same form was administered to both the intervention and control groups at baseline (T_0) to ensure consistency in data collection.

The form included information on age, gender, education level, marital status, occupation, employment status, income source, smoking status, COPD duration, hospital visits and admissions due to COPD in the past six months, presence of other chronic diseases, and patients' self-perceived ability to manage COPD. These variables were considered as covariates to control for potential confounding effects in statistical analyses.

Patient monitoring and follow-up materials

Several materials were used to monitor patients in the intervention group over the three-month period. These tools were not used as outcome measures, but to ensure adherence, support self-management, and document patient progress.

Telenursing follow-up form

The Telenursing Follow-up Form, developed by the researchers, guided bi-weekly phone calls. It was based on literature regarding reinforcement principles, oxygen saturation, pulse monitoring, and symptom control [5, 6, 8], and revised with feedback from four external experts, including a pulmonologist.

COPD empowerment kit

The COPD Empowerment Kit included:

- a pulse oximeter,
- a COPD symptom diary,
- a COPD action plan, and.
- a three-month oxygen saturation/pulse monitoring chart.

Oxygen saturation–pulse monitoring chart

Patients recorded daily oxygen saturation and pulse measurements using the pulse oximeter over three months.

COPD symptom diary

The diary allowed patients to document daily COPD-related symptoms (e.g., sputum production, cough, shortness of breath), including frequency, timing, and additional notes [4, 6, 18].

COPD action plan

The action plan, developed based on literature guidelines, provided empowerment-based self-management instructions tailored to patient symptoms. It included personal information, vaccination history, and treatment guidance to support informed care decisions [18, 19].

Empowerment model-based telenursing interventions

Development of the empowerment model-based training program

The training program was developed based on the empowerment model, using relevant studies and national and international evidence-based guidelines [3, 4, 20–26]. To accommodate visual difficulties in elderly patients, headings were written in Calibri 18-point and the main text in Calibri 16-point font. The content and feasibility were reviewed by the research team and three faculty members, with adjustments made accordingly. The program comprised four 50-minute sessions aimed at enhancing patient empowerment across awareness, knowledge, collaboration, implementation, choice, and self-efficacy.

Session 1 Focused on awareness and knowledge, providing participants with general information about COPD, including risk factors, symptoms, warning signs, health literacy, critical thinking, autonomous decision-making, access to healthcare services, and health communication.

Session 2 Emphasized collaboration and implementation to ensure active involvement in treatment. Practical training included correct inhaler use, respiratory and cough exercises, and device maintenance.

Session 3 Continued to target collaboration, implementation, choice, and self-efficacy, guiding participants in physical activity, healthy nutrition, hydration, maintenance of daily activities, and social participation.

Session 4 Addressed preventive health behaviors, including smoking cessation, immunization, protection from air pollution, stress management, and sleep hygiene, while supporting participants in developing sustainable healthy lifestyle habits.

Intervention

Before the intervention (T_0), all participants completed self-reported data collection tools and pulmonary

function testing, and inhaler use skills were assessed using the Inhaler Device Use Skills Scale. All participants received a COPD empowerment kit with instructions.

Following randomization, the intervention group attended four face-to-face empowerment training sessions in small groups (5–8 participants) and were remotely monitored via telenursing for three months. Participants measured oxygen saturation and pulse at least three times weekly, recorded symptoms, and participated in biweekly telenursing calls assessing vital signs, medication adherence, exercise, nutrition, symptom control, sleep, daily activities, and healthcare utilization. Informative and reminder text messages were sent twice weekly. Non-responders to two consecutive calls were contacted via a secondary phone number; persistent non-responders were excluded from follow-up.

After three months (T_1), both groups completed the post-test assessments, and the intervention group additionally completed a satisfaction survey. No interventions were provided during the subsequent three-month follow-up period. At six months (T_2), all assessments were repeated. After study completion, the control group received the same empowerment training and telenursing interventions as the intervention group.

All measurement tools, questionnaires, and assessments used in the intervention group were also administered to the control group at the same time points (T_0, T_1, and T_2) to ensure comparability between groups. The only additional assessment applied exclusively to the intervention group was the satisfaction survey conducted after the intervention phase. A flowchart summarizing the study design, interventions, and assessment procedures for both groups is presented in Fig. 2.

Standard care

Participants in the control group received standard care in accordance with national COPD management practices. Standard care includes routine physician follow-up visits every 3 to 6 months depending on the patient's clinical status, as well as periodic spirometry testing to monitor disease progression. As part of routine care, the referral process for pulmonary rehabilitation is carried out for patients who consent to participate in such programs. In addition, nurses provide standard patient education during outpatient visits. No structured empowerment-based education or telenursing support was provided to the control group.

Pilot study

A pilot study was conducted to evaluate the clarity, comprehensibility, and suitability of the data collection tools and the educational material. The data collection forms and the training content were reviewed face-to-face with three individuals diagnosed with COPD to assess their understandability and appropriateness. In addition, the telephone interview procedures planned for the intervention were pilot tested to ensure feasibility. Feedback obtained from the pilot evaluations informed the refinement of both the training content and the data collection tools. The individuals who took part in the pilot study were not included in the main study sample.

Statistical analysis

Data were analyzed using SPSS 25 (IBM Corp, Armonk, NY, USA). Descriptive statistics (frequency, percentage, mean ± SD) summarized the data. Normality was confirmed via skewness and kurtosis. Independent samples t-tests compared two groups, while repeated measures ANOVA with Bonferroni post-hoc tests assessed changes over three time points. Categorical variables were analyzed using Chi-square or Fisher's exact tests. Analyses were performed by a blinded statistician, with significance set at $p < 0.05$.

A post hoc power analysis was performed in consultation with a biostatistician. Based on the final sample size ($n = 84$) and the observed effect sizes, the statistical power of the study was calculated as 97%, indicating adequate power to detect significant differences between groups.

Ethical considerations

Ethical approval for the study was obtained from the Marmara University Clinical Research Ethics Committee (Date: 14.07.2022, Protocol No: 09.2021.713). Institutional permission was also granted by Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital (Date: 11.08.2021, No: E-61952817-044-21669). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written and verbal informed consent was obtained from all participants before data collection. All necessary permissions for the use of the measurement scales were obtained via email from the original authors prior to the commencement of the study.

Results

Baseline characteristics

A total of 84 participants were included in the analysis. There were no statistically significant differences between the intervention and control groups regarding sociodemographic or clinical characteristics ($p > 0.05$). The majority of participants were male (83.7% in the intervention group and 73.2% in the control group) and married (88.4% and 87.8%, respectively). Most participants had a primary or middle school education, and nearly all reported income levels below their expenses. Current smokers accounted for 41.9% of the intervention group and 36.6% of the control group. Approximately one-third of participants in both groups had at least one chronic

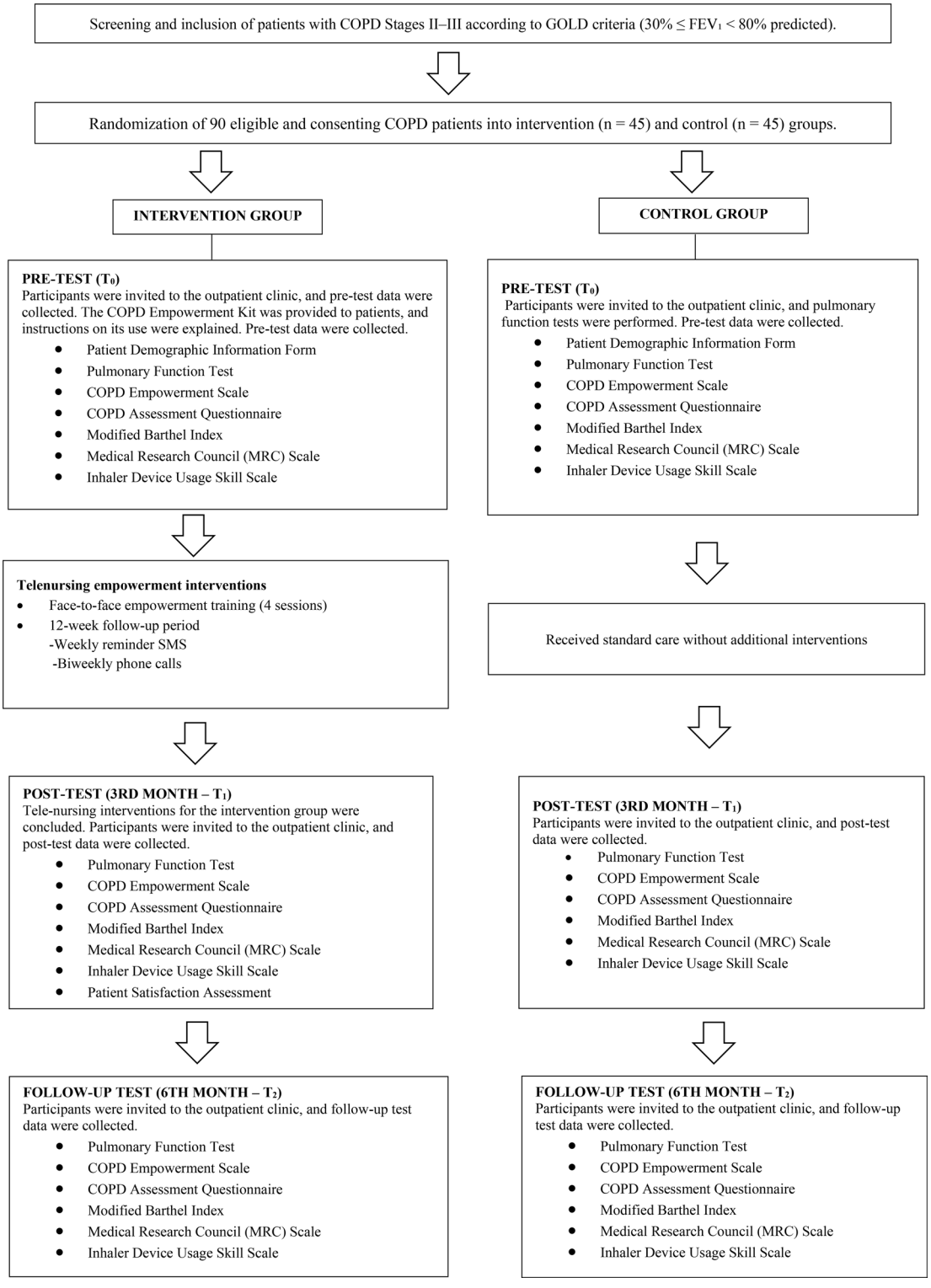

Fig. 2 Study Flowchart

disease other than COPD. The mean age was 62.79 ± 7.91 years in the intervention group and 61.27 ± 9.14 years in the control group, while the mean duration of COPD diagnosis was 9.51 ± 5.88 and 7.71 ± 4.91 years, respectively (Table 1).

Intervention adherence

Each scheduled follow-up call lasted approximately 30 min, and participants were able to contact the researcher whenever needed. Throughout the study, participants made a total of 23 additional unscheduled phone calls and four video calls outside the planned follow-up schedule. These communication records reflect the level of engagement with the intervention during the follow-up period.

Primary outcome

The empowerment model-based telenursing intervention significantly improved patient empowerment. COPD Empowerment Scale (COPD-ES) scores increased in the intervention group from 88.4 ± 18.4 at baseline (T_0) to 113.0 ± 15.3 at post-test (T_1) and 120.6 ± 7.9 at follow-up (T_2), whereas the control group showed minimal change (T0: 81.7 ± 16.6; T1: 79.4 ± 17.0; T2: 77.3 ± 6.9) (Table 2). Effect size analysis demonstrated a large effect of the intervention on COPD-ES scores ($\eta^2 = 0.704$), indicating that the empowerment model-based telenursing intervention substantially increased patient empowerment over six months.

Secondary outcomes

FEV_1 values increased significantly in the intervention group at T_1 (65.2 ± 13.7) and T_2 (66.9 ± 14.3) compared with baseline (61.0 ± 14.0), while no significant changes were observed in the control group (T_0: 57.8 ± 14.3; T_1: 55.8 ± 13.7; T_2: 54.0 ± 13.9). This improvement was statistically significant ($F = 8.986$, $p < 0.001$) with a moderate effect size ($\eta^2 = 0.176$) (Table 2).

COPD-related hospitalizations decreased in the intervention group from 0.91 ± 0.84 at T0 to 0.23 ± 0.57 at T1 and 0.12 ± 0.32 at T2. Similarly, the total number of hospital admissions declined (T0: 2.26 ± 1.98; T1: 0.61 ± 0.96; T2: 0.42 ± 0.73), whereas the control group showed minimal reductions (hospitalizations T0–T2: 0.71 ± 0.84 → 0.46 ± 0.60; admissions T0–T2: 1.81 ± 1.71 → 1.66 ± 1.37) (Table 2). These reductions were statistically significant (hospitalizations: $F = 29.487$, $p < 0.001$, $\eta^2 = 0.412$; admissions: $F = 26.129$, $p < 0.001$, $\eta^2 = 0.384$), indicating a strong effect of the intervention in reducing healthcare utilization (Table 2).

Symptom severity, as measured by the CAT, significantly decreased in the intervention group from baseline (T_0: 25.70 ± 7.63) to post-test (T_1: 18.63 ± 7.40) and follow-up (T_2: 15.05 ± 4.38), while the control group showed minimal change (T_0: 21.59 ± 8.52; T_1: 22.78 ± 7.96; T_2: 25.81 ± 5.03) ($F = 42.21$, $p < 0.001$, $\eta^2 = 0.501$). This indicates a large effect size, suggesting that the intervention had a substantial impact on symptom reduction. Modified Barthel Index scores, reflecting functional independence, did not significantly differ between groups across the three time points ($F = 0.168$, $p = 0.840$, $\eta^2 = 0.004$) (Table 3).

Table 1 Sociodemographic characteristics of the participants

Variables		Intervention Group		Control Group		Statistics $X^2(p)$
		n	%	*n*	%	
Gender	Female	7	16.3	11	26.8	1.388 (80.181[b])
	Male	36	83.7	30	73.2	
Marital Status	Married	38	88.4	36	87.8	0.006 (0.600[b])
	Single	5	11.6	5	12.2	
Education Level	Primary Education	21	48.8	22	53.7	3.925 (0.270[a])
	Middle School	11	25.6	8	19.5	
	High School	8	18.6	11	26.8	
	Bachelor's Degree and Above	3	7.0	0	0.0	
Income Level	Income Lower Than Expenses	38	88.4	37	90.2	0.077 (0.531[b])
	Income Equal to Expenses	5	11.6	4	9.8	
Smoking Status	Current smoker	18	41.9	15	36.6	0.245 (0.393[b])
	Nonsmoker	25	58.1	26	63.4	
Presence of Chronic Diseases Other Than COPD	Yes	17	39.5	14	34.1	0.262 (0.388[b])
	No	26	60.5	27	65.9	
		Mean	**SD**	**Mean**	**SD**	t/p[c]
Age		62.790	7.906	61.270	9.138	0.818/0.416
COPD Diagnosis Duration		9.512	5.885	7.707	4.910	1.522/0.132

Mean: Average. SD: Standard Deviation. a: Chi-Square Test; b: Fisher's Exact Test; c: Independent Samples t-Test

Table 2 Pulmonary and clinical measures across intervention and control groups at T_0, T_1 and T_2

Measurement/Time	Group	Mean ± SD	t	*p*	F	*P*/ANOVA	Bonferroni	Eta^2
FEV1 Value								
T_0	Intervention	61.000 (13.988)	1.043	0.300	8.986	0.000	1 > 2.3	0.176
	Control	57.781 (14.305)						
T_1	Intervention	65.230 (13.655)	3.158	0.002				
	Control	55.800 (13.703)						
T_2	Intervention	66.880 (14.310)	4.192	0.000				
	Control	53.980 (13.893)						
Number of Hospitalizations								
T_0	Intervention	0.907 ± 0.840	1.087	0.280	29.487	0.000	1 > 2.3	0.412
	Control	0.707 ± 0.844						
T_1	Intervention	0.233 ± 0.571	-2.234	0.029				
	Control	0.537 ± 0.674						
T_2	Intervention	0.116 ± 0.324	-3.338	0.002				
	Control	0.463 ± 0.596						
Number of Hospital Admissions								
T_0	Intervention	2.256 ± 1.977	1.117	0.267	26.129	0.000	1 > 2.3	0.384
	Control	1.805 ± 1.706						
T_1	Intervention	0.605 ± 0.955	-4.227	0.000				
	Control	1.732 ± 1.450						
T_2	Intervention	0.419 ± 0.731	-5.204	0.000				
	Control	1.659 ± 1.371						
COPD-ES								
T_0	Intervention	88.419 ± 18.446	1.741	0.085	99.708	0.000	1 < 2.3; 2 < 3	0.704
	Control	81.732 ± 16.646						
T_1	Intervention	113.000 ± 15.294	9.540	0.000				
	Control	79.366 ± 17.006						
T_2	Intervention	120.628 ± 7.919	26.731	0.000				
	Control	77.268 ± 6.881						

SD: standard deviation; T0: Pre-test; T1: Post-test; T2: Follow-up; FEV1: Forced Expiratory Volume in 1 s; COPD-ES: Chronic Obstructive Pulmonary Disease Empowerment Scale; t/p: independent sample t-tests; F/P: repeated measures ANOVA; Bonferroni: post-hoc comparisons; Eta^2: effect size

MMRC dyspnea scores demonstrated a modest improvement in the intervention group (T_0: 2.19 ± 0.80; T_1: 1.79 ± 0.94; T_2: 1.74 ± 1.00) compared with the control group (T_0: 1.78 ± 0.99; T_1: 1.66 ± 0.97; T_2: 1.54 ± 0.93) ($F = 3.28$, $p = 0.043$, $\eta^2 = 0.072$), indicating a small-to-moderate effect on dyspnea severity.

Inhaler device use skills increased markedly in the intervention group, rising from 4.54 ± 1.22 at baseline (T_0) to 6.70 ± 1.81 at post-test (T_1) and 6.98 ± 1.35 at follow-up (T_2), while the control group showed no meaningful improvement (T_0: 4.85 ± 1.35; T_1: 4.71 ± 1.45; T_2: 4.10 ± 1.70) ($F = 47.55$, $p < 0.001$, $\eta^2 = 0.531$) (Table 4). This large effect size indicates that the intervention substantially enhanced participants' inhaler technique over time.

All participants in the intervention group ($n = 43$) reported maximum satisfaction (10/10) with the telenursing program, supporting its feasibility, acceptability, and patient-centered applicability in COPD management.

Discussion

The results of this study indicate that, compared to the control group, the intervention group showed significant improvements in FEV_1, reductions in the number of hospital visits and admissions, and enhanced COPD empowerment as measured by COPD-ES scores. Symptom control, assessed using CAT scores, also improved, reflecting better quality of life, and dyspnea levels decreased as indicated by mMRC scores. In addition, inhaler device usage skills were significantly better in the intervention group. These findings suggest that empowerment model-based telenursing interventions positively affected both clinical outcomes and patient self-management in individuals with COPD.

The intervention group exhibited significantly higher FEV_1 values compared to the control group at both T_1 and T_2, indicating that the empowerment model-based telenursing intervention effectively enhanced pulmonary function in patients with COPD. The eta-squared value ($\eta^2 = 0.176$) indicates a moderate effect size, suggesting that the intervention had a meaningful clinical impact on improving lung function. These findings align with

Table 3 Symptom and functional measures across intervention and control groups at T_0, T_1 and T_2

Measurement/Time	Group	Mean ± SD	t	*p*	F	*P*/ANOVA	Bonferroni	Eta²
CAT								
T_0	Intervention	25.698 ± 7.633	2.333	0.022	42.211	0.000	1 > 2.3; 2 > 3; 1 < 3; 2 < 3	0.501
	Control	21.585 ± 8.515						
T_1	Intervention	18.628 ± 7.403	-2.477	0.015				
	Control	22.781 ± 7.958						
T_2	Intervention	15.047 ± 4.380	-10.472	0.000				
	Control	25.805 ± 5.026						
Modified Barthel Index								
T_0	Intervention	85.209 ± 12.678	0.407	0.685	0.168	0.840		
	Control	84.073 ± 12.927						
T_1	Intervention	85.512 ± 14.370	-0.241	0.810				
	Control	86.244 ± 13.444						
T_2	Intervention	86.674 ± 11.137	0.163	0.871				
	Control	86.268 ± 11.694						
MMRC								
T_0	Intervention	2.186 ± 0.795	2.078	0.041	3.279	0.043	1 > 2.3	0.072
	Control	1.781 ± 0.988						
T_1	Intervention	1.791 ± 0.940	0.636	0.527				
	Control	1.659 ± 0.965						
T_2	Intervention	1.744 ± 1.002	0.985	0.327				
	Control	1.537 ± 0.925						

SD: standard deviation; T_0: Pre-test; T_1: Post-test; T_2: Follow-up; CAT: COPD Assessment Test; MMRC: Modified Medical Research Council Dyspnea Scale; t/p: independent sample t-tests; F/P (ANOVA): repeated measures ANOVA; Bonferroni: post-hoc comparisons; Eta²: effect size

Table 4 Inhaler device use skill across intervention and control groups at T0, T1 and T2

Measurement/Time	Group	Mean ± SD	t	*p*	F	*P*/ANOVA	Bonferroni	Eta²
Inhaler Device Use Skill								
T_0	Intervention	4.535 ± 1.222	-1.135	0.260	47.547	0.000	1 < 2.3; 1 > 3; 2 > 3	0.531
	Control	4.854 ± 1.352						
T_1	Intervention	6.698 ± 1.807	5.547	0.000				
	Control	4.707 ± 1.453						
T_2	Intervention	6.977 ± 1.354	8.607	0.000				
	Control	4.098 ± 1.700						

SD: standard deviation; T_0: Pre-test; T_1: Post-test; T_2: Follow-up; t/p: independent sample t-tests; F/P (ANOVA): repeated measures ANOVA; Bonferroni: post-hoc comparisons; Eta²: effect size

previous research. Gregoriano et al. [25] reported higher FEV_1 values in patients who adhered to inhaler therapy supported by daily reminders and phone calls. Similarly, Liu et al. [23] demonstrated that internet-based self-management interventions improved lung function in COPD patients. Wang et al. [24] observed an increasing trend in FEV_1 among patients receiving individualized nursing interventions based on the health belief model, although the change was not statistically significant. Collectively, these results suggest that the extent of FEV_1 improvement may depend on the specific intervention strategies employed and the baseline disease stage.

Telehealth technologies in COPD aim to reduce the burden on healthcare services, particularly as exacerbations carry a high risk of recurrence within eight weeks and tend to increase in frequency with disease progression [3, 26]. In this study, the intervention group demonstrated a significant reduction in COPD-related hospital visits and admissions at T_1 and T_2 compared to the control group. The eta-squared values ($\eta^2 = 0.412$ for hospitalizations and $\eta^2 = 0.384$ for hospital admissions) indicate large effect sizes, suggesting that the telenursing intervention had a substantial impact on reducing healthcare utilization. These findings are consistent with previous literature; for instance, a meta-analysis reported that individualized action plans significantly reduced at least one hospital visit related to COPD exacerbations [26]. However, Saleh et al. [27] observed no significant difference in hospital readmissions at six months when comparing standard care with telehealth interventions (video and phone consultations), suggesting that discrepancies may be related to differences in intervention type, intensity, or follow-up duration (3–24 months).

The literature indicates that patients who actively monitor their health and maintain communication with a familiar nurse achieve better disease self-management [3]. Telephone calls and text messaging are key components of interventions that promote patient empowerment and self-care [22, 23]. Consistent with these reports, our study found that empowerment model-based telenursing interventions significantly increased COPD-ES scores ($\eta^2 = 0.704$) and improved CAT scores ($\eta^2 = 0.501$) and mMRC grades ($\eta^2 = 0.072$), demonstrating their effectiveness in enhancing symptom control and dyspnea management [23, 28]. The large effect sizes for COPD-ES and CAT indicate a strong practical impact of the intervention, whereas the small effect observed for mMRC reflects a modest but clinically meaningful improvement in dyspnea perception.

In this study, Modified Barthel Index scores remained stable at both T_1 and T_2 in both groups, likely reflecting a ceiling effect due to participants' high baseline functional independence ($\eta^2 = 0.004$). For patients with lower levels of independence, assessment of instrumental activities of daily living may provide more sensitive measures. Differences in COPD stage, comorbidities, and intervention content across studies may also explain inconsistencies in reported outcomes [29].

Correct inhaler use requires multiple sequential steps, and errors can reduce drug delivery, affecting efficacy and safety. Effective inhaler therapy prevents COPD exacerbations, making proper technique crucial. International guidelines recommend device training before starting inhaled medications [18]. In this study, the intervention group received "demonstrate and return demonstration" training along with reminder text messages, resulting in significant improvement in inhaler technique at both T_1 and T_2 ($\eta^2 = 0.531$), whereas no significant improvement was observed in the control group, highlighting the importance of ongoing education and reinforcement. This finding is consistent with previous literature [30].

Limitations

This study was conducted in a single university hospital, and the relatively small sample size may limit the generalizability of the findings to broader populations or different healthcare settings.

Conclusion

Empowerment model–based telenursing interventions significantly increased empowerment levels in patients with COPD, reduced hospital visits and admissions, improved pulmonary function, decreased dyspnea, and strengthened self-management behaviors, yielding clinically meaningful improvements in patient outcomes. Integration of these programs into routine care and extending follow-up durations may optimize long-term self-management and healthcare utilization. Furthermore, targeted nurse training and competency development in telenursing could enhance the scalability and widespread implementation of such interventions.

Abbreviations

CAT	Chronic Obstructive Pulmonary Disease Assessment Test
COPD	Chronic Obstructive Pulmonary Disease
COPD-ES	Chronic Obstructive Pulmonary Disease Empowerment Scale
FEV_1	Forced Expiratory Volume in one second
GOLD	Global Initiative for Chronic Obstructive Lung Disease
mMRC	Modified Medical Research Council Dyspnea Scale
PFTs	Pulmonary Function Tests

Supplementary Information

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Supplementary Material 1

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Author contributions

ZA, SE and ÖO contributed to conception and design of research. ZA contributed to data collection. SE contributed to formal analysis. ZA and SE drafted the manuscript. ZA, SE and ÖO critically revised the manuscript. All authors read and approved the final manuscript.

Data availability

The datasets generated and analysed during the current study are not publicly available due but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This clinical trial was registered at ClinicalTrials.gov (Identifier: NCT06217718; registration date: February 15, 2024). The study was approved by the Clinical Research Ethics Committee of the Faculty of Medicine at Marmara University (protocol code: 09.2021.713, dated July 14, 2022) and conducted in accordance with the principles of the Declaration of Helsinki and Good Clinical Practice (GCP). Institutional permission was obtained from Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital through the Provincial Health Directorate (dated August 11, 2021; reference no: E-61952817-044-21669). Written and verbal informed consent was obtained from all participants prior to their inclusion in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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