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Research Article

The Effect of Respiratory Exercises on People with Ongoing Dyspnea and Recovered from COVID-19

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Abstract

Objectives: Dyspnea is the most common symptom after having coronavirus disease 2019 (COVID-19). In this study, we evaluated the effect of respiratory exercises on dyspnea in the post-acute period in people who recovered from COVID-19 disease but continued to have dyspnea.

Methods: This research was a randomized controlled, single-blind experimental study. Research data were collected between October 1, 2020 and January 31, 2021, and a total of 50 patients, 24 intervention and 26 control groups, were included in the study. The intervention group received diaphragmatic and lip-contraction breathing exercises for 10 minutes twice a day for a month, while the control group did not receive any exercise in addition to standard treatment. Dyspnea-12 (D-12) and the Numerical Rating Scale (NRS) were used as outcome measurement tools.

Results: There was no difference between initial D-12 and NRS scores in the intervention and control groups, and the groups were normally distributed. After the application, the D-12 and NRS Scale scores of the intervention group were significantly lower than those of the control group ($p<0.05$). Moreover, the last measurements of the intervention group were significantly lower than the D-12and NRS scores than the initial measurements ($p<0.05$).

Conclusion: According to the results obtained, diaphragmatic and pursed lip breathing exercises are effective on post-recovery dyspnea in COVID-19 patients.

Keywords: COVID-19, dyspnea, infection, pulmonary rehabilitation, respiratory exercises, telerehabilitation.

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In the twenty-first century, the seventh type of coronavirus (SARS-CoV-2) with a zoonotic origin similar to the other coronaviruses (HcoV-229E, HcoV-OC43, HKU1, Haven coronavirus, SARS-CoV and MERS-CoV) first emerged in Wuhan, China and caused to declaration of a pandemic by the World Health Organization.[1-4] The disease has been named as COVID-19, is caused by SARS-CoV-2, and is transmitted from human to human via droplet and contact.[4,5]

COVID-19 presents with symptoms of fever, cough, respiratory distress and fatigue. Moreover, diarrhea, pneumonia, hemoptysis, taste and smell dysfunction, acute renal injury, myocarditis, acute respiratory failure, hypoxemia, sepsis, shock and multiple organ failure may develop in moderate and severe cases.[6,7] Coronavirus spike proteins bind to angiotensin converting enzyme 2 (ACE-2) receptors in various parts of the human body such as lung, heart, kidney, gastrointestinal mucosa, small intestine, vascular endothelial cells and epithelial surface. The virus enters the cell

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and causes cell damage. The symptoms observed during the disease process are caused by cell damage due to the cytokine storm and the negative effects of the treatment methods applied.[8-10] It has been suggested that some of these symptoms remain in the post-acute period and become permanent.[11] In studies conducted in this direction, it has been stated that the most common of these symptoms are dyspnea, fatigue, joint and chest pain, cough and permanent loss of taste and smell,[12,13] moreover, dyspnea is the most frequent persistent symptom in the post-acute period.[11]

The respiratory system is more affected by COVID-19 as the nasal mucosa, bronchi and lung parenchyma contain abundant ACE-2 receptors. Histopathological examination showed fibroblastic proliferation foci, alveolar hyperplasia, pulmonary interstitial and alveolar edema, hyaline thrombi in the vessels and interstitial fibrous thickening, causing severe alveolar damage.[14-16] Furthermore, treatment-related complications due to mechanical ventilation, endotracheal intubation, aspiration and tracheostomy may also damage the lung parenchyma in critically ill patients. As a result, the volume, diffusion and functional capacity of the lungs may be adversely affected.[17]

In light of this information, it has been predicted that pulmonary rehabilitation (PR) practice may have an important role in COVID-19 patients to reduce dyspnea, increase and improve the functional capacity of the lungs, prevent complications in the acute and post-acute period, help to reduce anxiety, fear and depression, and to protect and improve physical activity, quality and comfort of life.[18,19] Current guidelines and protocols have emphasized that airway clearance techniques, breathing exercises, the use of assistive devices and training should be included in the PR program.[20,21] However, there is not enough information with a high level of evidence on this subject.[19]

Nurses, physiotherapists and physicians have important responsibilities in PR applications carried out as a multidisciplinary team.[22] Accordingly, nurses can provide support for facilitating daily life activities and living a more comfortable life by teaching respiratory hygiene, hydration, pursed lip, diaphragmatic breathing, postural drainage and coughing exercises to individuals with dyspnea, cough and fatigue.[23] In this study, the effect of pursed lip and diaphragmatic breathing exercises applied in the post-acute period on dyspnea was investigated in individuals whose dyspnea continued after recovery from COVID-19.

Methods

Study Design

This randomized controlled and single-blind study was conducted to determine the effect of diaphragmatic and pursed lip breathing exercises applied to COVID-19 patients for 10 minutes twice a day for 1 month in the post-acute period.

Participants

The study was carried out between 01 October 2020 - 31 January 2021 in a pandemic hospital in the Central Anatolia region of Turkey. Patients who were followed up in the intensive care unit (ICU) with the diagnosis of COVID-19, and who continued to have dyspnea after hospital discharge were included in the sample if they met the inclusion criteria and agreed to participate in the study (n=56). Fifty-six participants were randomly assigned to the groups; twenty-eight for intervention group and twenty-eight for control group. In the intervention group, three participants did not perform breathing exercises regularly and one participant died. Moreover, in the control group, two participants died.

Finally, the study was completed with a total of 50 participants (Fig. 1). The research criteria were prepared in light of the literature and taking expert opinion.[24-27] The study included individuals who were 18 years of age or older, hospitalized in the ICU with a diagnosis of COVID-19, had not participated in the PR program in the previous year, had dyspnea for at least 3 months after discharge, scored 3 or higher on the numerical dyspnea rating scale, agreed to participate in the study, were open to communication and cooperation, and had the skills and technical base to benefit from telehealth services. Exclusion criteria were mental status disorder, chronic obstructive pulmonary disease, asthma, heart failure, previous stroke and neurodegenerative disorders, history of endotracheal intubation and mechanical ventilator support, and being on treatment for dyspnea (such as inhalers). The study was terminated for participants who stated that they could not continue the interviews during the study with or without stating any reason, who had difficulty during the interventions, who could not perform the interventions regularly for any reason, or who died.

Randomization and Blinding

The researcher who collected the data was blinded to the study groups. Random numbers table, which is a simple randomization method, was used to assign the participants to the intervention group or control group.[28]

Determination of Sample Size

Post-hoc analysis was performed with Gpower 3.1 program, with reference to the mean scores of the NRS and The D-12 obtained from 50 patients. The effect size was calculated as 0.95 with a 5% α margin of error and 95% power and it was concluded that the sample size of this study was adequate.

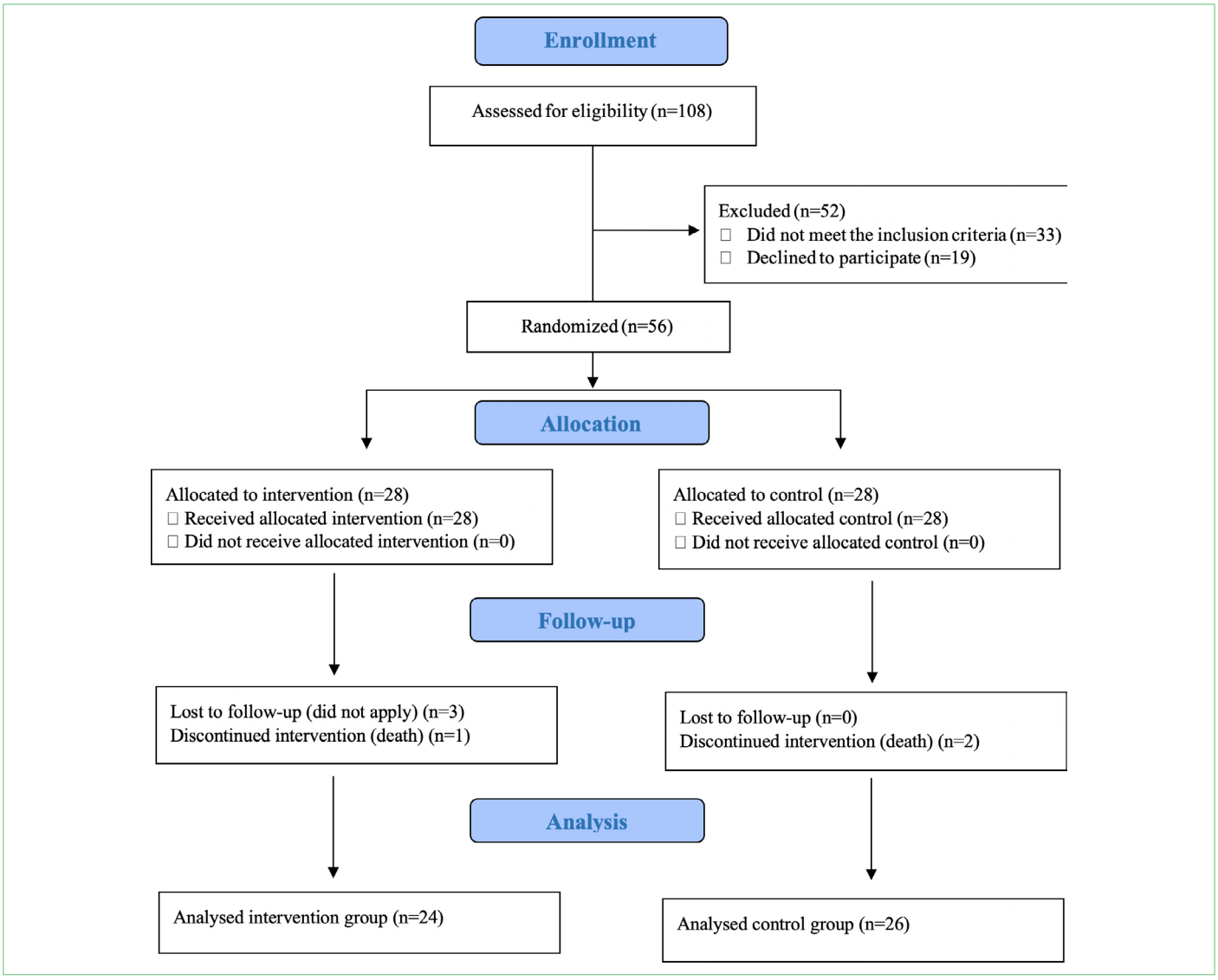

Figure 1. The CONSORT chart of the study.

Outcome Measurement Tools

Personal Information Form

This form, which was prepared by the researchers after reviewing the literature, consists of 9 questions on sociodemographic characteristics of the individual (age, gender, education and marital status, occupation, body mass index), smoking and presence of chronic diseases.[24-26]

Numeric Rating Scale

The numerical rating scale is a one-dimensional scale scored with numbers from 0 to 10 on a horizontal line. This scale, which can be easily applied in the hospital and at home, was developed by Gift and Narsavage in 1998.[29,30] The scale was used at the beginning and end of the study to objectively evaluate the dyspnea experienced by the participants. The severity of dyspnea was scored between 0 (no dyspnea) and 10 (the most severe dyspnea).

The Dyspnea-12 Scale

It is a four-point Likert-type scale which was developed by Yorke et al.[24] in 2010, which measures the severity of dyspnea and consists of a total of 12 items in physical and emotional sub-dimensions. The maximum score that can be obtained from the physical sub-dimension of the scale is 21, and the maximum score that can be obtained from the emotional sub-dimension is 15. The minimum score that can be obtained from the scale is 0, and the maximum score is 36. As the score obtained from the scale increases, the severity of dyspnea increases. In the original study of the scale, the Cronbach's alpha coefficient was reported as 0.90.[24,26] The study for Turkish validity and reliability of the scale was conducted by Gok Metin and Helvacı in 2018, and the Cronbach's alpha coefficient was found as 0.97.[26] This scale was used in the beginning and at the end of our study to objectively analyze the dyspnea experienced by

the participants. In our study, the Cronbach's alpha coefficient was 0.923 in the beginning, and it was 0.909 in the final evaluation.

Protocol of Intervention and Control Groups

After providing written and verbal information about the study, the informed consents of the participants were obtained and the study was initiated. Personal information form, numerical rating scale and D-12 were applied to both groups at the first interview. Furthermore, diaphragmatic and pursed lip breathing exercises were taught to the intervention group, and a document and video containing the application steps of these exercises were delivered to them so that they could receive support throughout the study. The individuals in the intervention group performed breathing exercises twice a day for 10 minutes during the four-week study period.[31] No intervention was applied to the control group. At the end of the study, numerical rating and D-12 scales were re-applied to determine the effectiveness of breathing exercises. During the study, the participants were phoned every other day by researchers other than the researcher who collected the data, and the practices were reminded and continued. The steps of the practices made by the intervention group are as follows:[31,32]

Steps of diaphragmatic and pursed lip breathing exercises

1. You can do this practice lying on your back or in a comfortable position.
2. If you are lying on your back, support your head and under your knees with small pillows. Place your passive hand on your chest wall, and your active hand on your upper belly.
3. If you are sitting, support your head and under your knees with small pillows. Place your passive hand on your chest wall, and your active hand on your upper belly.
4. Close your lips and breathe in slowly through your nose (like smelling flowers), you should feel your belly pushing your active hand.
5. Keep your breathing time longer than 4 seconds and try to hold your breath during this time.
6. Make sure that your hand on your chest wall does not move.
7. Purse your lips like whistling and exhale like blowing out a candle, but not so strongly that you blow it out completely. During the exhalation, be careful not to exhale through your nose, not to inflate your cheeks and not to contract your abdominal muscles. The exhalation time should be twice as long as your inhalation time (for example, if you inhale in 4 seconds, you should exhale in 8 seconds). During this process, you should feel that your passive hand does not move, but your active hand slowly descends.
8. After breathing three times in a row, breathe freely and rest.
9. Do this application for 10 minutes in the morning and evening for four weeks.

Statistical Analysis

Data of the study were analyzed in IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, New York, USA) statistical software. Continuous data are presented as Mean±Standard Deviation, and the categorical data are presented as frequency. The normality of distribution was analyzed with Shapiro-Wilk and Kolmogorov-Smirnov Tests and it was determined that the data were normally distributed. Differences in socio-demographic characteristics between groups were analyzed by Chi-square test and the differences of measurable variables (NRS and D-12) were analyzed with t-test. IBM SPSS Statistic program version 23.0 was used for data analysis. Furthermore, statistical significance was determined at $p<0.05$.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. Written and verbal informed consents were obtained from the participants in the intervention and the control groups. Before starting study, the Ministry of Health Scientific Research Commission approved the study protocol first. Besides, Local Ethics Committee approved the study protocol (09/17/2020, decree no: 153).

Results

Descriptive characteristics of the patients in two study groups are presented in Table 1. There was no statistical difference between the groups in terms of the sociodemographic characteristics of the participants ($p>0.05$).

When the means of D-12 scores were compared between two groups (Table 2), it was observed that there was no significant difference between the intervention (22.77±6.05) and control (20.88±4.31) groups in terms of the beginning scores ($p>0.05$), however, it was determined that there was a highly significant difference between the intervention (16.75±4.61) and control (20.65±3.91) groups after the breathing exercises ($p<0.005$).

Numerical Rating Scale scores are presented in Table 3. While there was no significant difference between the intervention (4.87±1.42) and control (4.65±1.19) groups for the initial initial scores ($p>0.05$), there was a highly significant difference between the intervention (3.16±1.43) and control (4.46±1.02) groups after breathing exercises ($p<0.005$).

Table 1. Characteristics of the participants in the intervention and control groups (n=50)

Characteristics of the participants	Intervention groups (n=24)	Control groups (n=26)	Test value p value
Gender n, %			0.034[a], 0.853
Female	8 (33.3)	7 (26.9)	
Male	16 (66.7)	19 (73.1)	
Age (years), (mean±SD)	48.70±11.96	55.53±16.64	-1.653[d], 0.105
Education, n, %			3.679[b], 0.596
Illiterate	1 (4.2)	4 (15.4)	
literate	1 (4.2)	3 (11.5)	
Primary school	4 (16.7)	2 (7.7)	
Middle School	4 (16.7)	3 (11.5)	
High school	6 (25.0)	7 (26.9)	
University	8 (33.3)	7 (26.9)	
Marital status, n, %			0.001[a], 1.000
Married	18 (75.0)	20 (76.9)	
Single	6 (25.0)	6 (23.1)	
Profession, n, %			8.723[b], 0.121
Housewife	6 (25.0)	4 (15.4)	
Worker	7 (29.2)	5 (19.2)	
Officer	5 (20.8)	3 (11.5)	
Retired	1 (4.2)	8 (30.8)	
Self-employed	5 (20.8)	4 (15.4)	
Student	0 (0.0)	2 (7.7)	
Smoking, n, %			[c], 0.469
No	22 (91.7)	25 (96.2)	
Yes	2 (8.3)	1 (3.8)	
Chronic disease, n, %			2.527[a], 0.112
No	19 (79.2)	14 (53.8)	
Yes	5 (20.8)	12 (46.2)	
Diabetes mellitus, n, %			[c], 0.084
No	21 (87.5)	18 (69.2)	
Yes	3 (12.5)	8 (30.8)	
Hypertension, n, %			[c], 0.203
No	20 (83.3)	18 (69.2)	
Yes	4 (16.7)	8 (30.8)	
Renal failure, n, %			[c], 0.539
No	22 (91.7)	23 (88.5)	
Yes	2 (8.3)	3 (11.5)	
Cancer, n, %			[c], 0.547
No	23 (95.8)	24 (92.3)	
Yes	1 (4.2)	2 (7.7)	

SD: Standard deviation; a: Yates' Chi-square test; b: Pearson Chi-square test; c: Fisher's Exact Chi-square test; d: Independent Samples t-Test.

Comparison of NRS scores by groups (Table 4) revealed a statistically highly significant difference between the means of the initial scores of the intervention group (4.87±1.42) and the mean scores obtained after the breathing exercises (3.16±1.43) in ($p<0.005$). However, in control group, there was no statistically significant difference between the mean initial scores (4.65±1.19) and the mean final scores obtained after the breathing exercises (4.46±1.02) ($p>0.05$). There was a very strong positive correlation between the scores of the intervention group ($r=0.820$), and a strong positive correlation between the scores of the control group ($r=0.686$).

The comparison of the D-12 scores in relation to the study groups is presented in Table 5. There was a statistically and

Table 2. Comparison of the Dyspnea-12 Scale measurements between groups

Measurements	Group	n (%)	Mean±SD	* Test value p-value
The Dyspnea-12 Scale Initial Scores	Intervention group	24 (48.0)	22.77±6.05	t(48)=1.26
	Control group	26 (52.0)	20.88±4.31	0.213
The Dyspnea-12 Scale Post-Scores	Intervention group	24 (48.0)	16.75±4.61	t(48)=-3.23
	Control group	26 (52.0)	20.65±3.91	**0.002**

SD: Standard deviation; *: Independent Sample t-Test.

Table 3. Comparison of Numeric Rating Scale measurements between groups

Measurements	Group	n (%)	Mean±SD	*Test value p-value
Numeric Rating Scale Initial Scores	Intervention group	24 (48.0)	4.87±1.42	t(48)=0.596
	Control group	26 (52.0)	4.65±1.19	0.554
Numeric Rating Scale Post-Scores	Intervention group	24 (48.0)	3.16±1.43	t(48)=-3.689
	Control group	26 (52.0)	4.46±1.02	**0.001**

SD: Standard deviation; *: Independent Sample t-Test.

Table 4. Comparison of Numeric Rating Scale measurements according to the groups

Groups	Measurements	Mean±SD	*Test value p-value
Intervention group	Numeric Rating Scale initial scores	4.87±1.42	t(23)=9.74, r=0.820
	Numeric Rating Scale post-scores	3.16±1.43	**0.001**
Control group	Numeric Rating Scale initial scores	4.65±1.19	t(25)=1.09, r=0.686
	Numeric Rating Scale post-scores	4.46±1.02	0.284

SD: Standard deviation; *: Paired Samples t-Test.

Table 5. Comparison of The Dyspnea-12 Scale measurements according to the groups

Groups	Measurements	Mean±SD	*Test value p-value
Intervention group	The Dyspnea-12 Scale initial scores	22.75±6.05	t(23)=13.69, r=0.955
	The Dyspnea-12 Scale post-scores	16.75±4.61	**0.004**
Control Group	The Dyspnea-12 Scale initial scores	20.88±4.31	t(25)=0.515, r=0.850
	The Dyspnea-12 Scale post-scores	20.65±3.91	0.611

SD: Standard deviation; *: Paired Samples t-Test.

highly significant difference between the means at the beginning (22.75±6.05) and the final scores (16.75±4.61) obtained after the breathing exercise in the intervention group ($p<0.005$), however there was no statistically significant difference between the means at the beginning (20.88±4.31) and the last measurement (20.65±3.91) obtained after the breathing exercise in the control group ($p>0.05$). Furthermore, there was a very strong positive correlation between the scores of the intervention group ($r=0.955$) and control group ($r=0.850$).

Discussion

Although it is thought that patients with dyspnea and oxygen desaturation will have sequelae in the lungs in the long term after the acute period of the COVID-19[33] it has been stated that practices such as coughing, pursed-lip breathing and diaphragmatic exercises may be beneficial on lung functions. Although early PR is recommended at the bedside and in the post-acute period in studies, it has been shown that tele-rehabilitation procedures can be applied when face-to-face rehabilitation is not possible.[34]

When the literature is reviewed, studies on early rehabilitation are observed.[35-37] However, when early PR is not possible, PR in the post-acute period is considered to be as valuable as an early PR program. The results of our study show that PR applied in the post-acute period provides improvement for dyspnea. In this study, individuals with persistent dyspnea for at least 3 months were included in respiratory exercise.

In the study, D-12 and NRS tools were used to evaluate the effect of respiratory exercises on dyspnea control. Dyspnea scores were found to be moderately high in both groups before respiratory exercises, and post-intervention dyspnea scores were significantly lower in the intervention group compared to the control group (Table 2, 3). When the difference between the initial and post-intervention mean scores of D-12 and NRS of the groups were observed (Table 4, 5), there was no significant difference in the control group, but the dyspnea scores in the intervention group decreased significantly. Liu et al.[35] investigated the effects of PR on respiratory functions, quality of life, morbidity and psychological functions in 72 elderly individuals diagnosed with COVID-19. During the study, respiratory muscle training, coughing exercises, diaphragm training, stretching and home exercises were applied twice a day for 10 minutes for 6 weeks. At the end of the study, there was a significant difference in pulmonary function tests, exercise capacity, quality of life and anxiety between the groups and between the initial and final follow-ups of the intervention group, however no significant difference was found for daily living activities and depression. Al Chikkanie et al.[37] studied the effects of PR after ICU stay in patients with COVID-19, and determined significant differences between pre-post evaluations for fatigue, anxiety and depression, in respiratory function tests, 6-minute walking test, but not for quality of life and post-traumatic stress. Curci et al.[38] applied early rehabilitation in the post-acute period to 36 patients diagnosed with COVID-19, and stated that PR applied in the early recovery period might be beneficial to prevent poor outcomes. Zha et al.[36] integrated acupressure into rehabilitation exercises to improve respiratory functions and to facilitate sputum production in mild cases of COVID-19 and noted that cough, difficulty in sputum production, and severity of dyspnea gradually decreased during the 4-week follow-up period. Tang et al.[39] applied Liuzijue exercises for 20 minutes once a day for 4 weeks to 33 discharged COVID-19 patients and reported that the patients had improvements in their functional capacity, quality of life, and decreased levels of depression and anxiety. In addition, it was stated that dyspnea was significantly alleviated as shown by the Modified British Medical Research Council Scale scores. Pehlivan et al.[40] studied the effect of tele-rehabilitation exercise programs on physical performance, fatigue and dyspnea, and applied breathing, extremity range of motion and light aerobic exercises. In their study, they determined a significant improvement in performance tests, however, no significant difference in fatigue and dyspnea despite improvement was observed. Studies in the literature show that different PR programs have positive effects on respiratory functions and dyspnea and support the findings of our study.

Limitations of the study, the breathing exercises of the individuals in the intervention group were not performed under supervision, dyspnea was evaluated only using scales according to the individual's statement, and the sample size was small.

Conclusion

Respiratory exercises on dyspnea in the post-acute period of COVID-19 for 10 minutes twice a day for 4 weeks contributed to the reduction of symptoms in patients. Therefore, respiratory exercises can be applied in the post-acute period, even in patients who did not have PR in the early period. Moreover, objective assessment tools such as pulmonary function tests can be used on more participants to investigate the effects of such practices. Besides, long-term observational studies can be recommended to popularize respiratory exercises and to determine whether the positive effect of the practice continues in the long term.

Disclosures

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Ethics Committee Approval: The Kayseri City Clinical Research Ethics Committee granted approval for this study (date: 17.09.2020, number: 153).

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Conflict of Interest: None declared.

Authorship Contributions: Concept - ŞÇ, MÇ, AK, ÖK; Design - ŞÇ, MÇ, AK, ÖK, İÇ; Data Collection and/or Processing - ŞÇ, AK, İÇ; Analysis and/or Interpretation - ŞÇ, AK, ÖK; Literature Research - ŞÇ, MÇ, AK, ÖK, İÇ; Critical Review - ŞÇ, MÇ, AK, ÖK, İÇ.

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