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Effectiveness of upper limb exercises and breathing exercises in COPD stable patients during COVID-19 pandemic era

Abstract

Introduction: The objectives of study are to study and to evaluate the benefits and effectiveness of home-based pulmonary rehabilitation in compliance with Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2020 nonpharmacological initiative for Chronic Obstructive Pulmonary Disease (COPD).

Material and methods: This study was a quasi-experiment conducted from August to November 2020 involving 10 COPD stable patients. In the first meeting at the hospital, patients were taught breathing techniques and upper-limb exercise movements which subsequently had to be done and recorded at home. Patients then sent the videos to the research team via whatsapp to be evaluated. Prior to starting the 4-week with twice-a-week frequency home-based rehabilitation, and again at the end of it, patients' conditions were evaluated based on the following factors: lung functional capacity was measured by 6MWD (6 Minutes Walking Distance), Perceived Exertion Scale by mMRC (modified Medical Research Council) and Borg, the quality of life by SGRQ (St. George's Respiratory Questionnaire) index, the severity of symptoms by CAT (COPD Assessment Test) and changes in muscle mass. Statistical analysis was conducted using the Wilcoxon and paired t-test.

Results: After 4 weeks of home training with twice-a-week frequency, the results showed significant improvement, with p-value < 0.05, in the increased 6MWD value (16.4 ± 4.45 to 19.8 ± 3.64), mMRC (1.90 ± 1.10 to 0.90 ± 0.87), Borg (3.05 ± 1.53 to 1.40 ± 1.42), CAT (15.7 ± 6.63 to 11.8 ± 5.24) and muscle mass (28.36 ± 2.89 to 31.86 ± 3.97).

Conclusion: The method produced positive outcomes in patients' lung function capacity, severity of symptoms, exertion scale, muscle mass, and general quality of life. Accordingly, the home-based rehabilitation programme was as effective as the programme conducted at health-care centers.

Key words: COPD, home-based pulmonary rehabilitation, breathing exercise, upper limb exercise

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Introduction

Chronic obstructive pulmonary disorder (COPD) is a type of respiratory disease which is preventable and treatable, characterized by a chronic obstructed airflow that can lead to a progressive and lifelong condition. The obstruction in the air breathing passage triggers persistent breathing difficulty, chronic productive cough, fatigue, vulnerability to respiratory infection, which results in a systemic effect that requires constant drugs consumption and healthcare treatment e.g. training the respiratory muscles and general physical exercise as part of the Pulmonary Rehabilitation (PR) programme [1, 2].

Pulmonary rehabilitation (PR) is a nonpharmacological intervention which basically aims to manage COPD by reducing clinical symptoms, improving patient's exercise tolerance level and as a tool of self-management [3]. There is evidence that PR programme can increase a patient's physical/sports capability, improve

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the quality of life and reduce the frequency of hospital visits [3, 4].

A comprehensive PR programme involves physical exercises, health education as well as psychological support; and it is proven to be beneficial for patients regardless of their age, gender, the severity of the airflow blockage, and the training location (hospitals, health clinics, or at home). In fact, recent studies have confirmed that home-based lung rehabilitation is safe and effective [5].

A systematic review of a number of controlled random tests also shows that PR produces at least a minimal or moderate improvement in COPD patients' health and overall quality of life, in addition to lowering health-care costs by reducing the number of COPD exacerbations treated at the hospitals [6].

COPD patients are advised to do PR exercise in their home environment, and even without expert supervision it is proven effective to increase patients' tolerance to physical activities [7, 8]. Recently, the use of telehealth has been tried and tested as an alternative, as well as innovative, way of delivering PR programme [9] directly to a patient's home in order to increase absorption and to cater to those living in remote places and having transportation problem [3].

Covid-19 pandemic has quickly made pulmonary rehabilitation programme turn to long-distance method. Several studies indicate that it is highly possible to do online/long-distance physical training and counselling session, training development and self-management, and achieve the same results with center-based PR program [10].

Many studies now focus solely on lower-body exercise to reduce the impact of COPD, while few discuss the importance of training the upper--extremity eventhough it can improve lung function and functional capacity which reduce symptoms and better quality of life of COPD patients. Upper-limb exercise is considered to be able to decrease the dyspnea scale, repair respiratory muscles and adaptability necessary for training. Some patients complain of dyspnea or chest discomfort during exercise, especially at the beginning of the session. Therefore, a combination of breathing techniques to regulate airflow such as pursed-lips breathing is necessary to minimize the impact of the exercise on patients' condition during the session [11].

The objective of this study was to evaluate the effectiveness of home-based supervised lung telerehabilitation programme, consisted of breathing and upper-limb exercises, as opposed to center-based programme and whether it could generate the same results.

Materials and methods

Study Design

This research was a clinical study using one group pretest-posttest quasi experimental design on 10 test subjects of COPD stable patients from the hospital of Universitas Sumatra Utara, Medan, Indonesia. Subjects' degree of smoking intensity was measured by Brinkman index which was classified into 3 categories: mild, moderate and severe. Test subjects underwent telerehabilitation involving breathing and upper-body exercises for 4 weeks and were monitored via videos sent by the subjects through whatsapp. Prior to the start of the home-based program, the subjects had been taught breathing techniques, had their vital signs checked and their height, weight, muscle mass, 6-minute walk, in addition to the quality of life, the severity of symptoms (CAT), including dyspnea (Borg scale, mMRC) was assessed. All of the data were used to observe any changes in subjects' condition before and after the programme.

Participants

10 subjects were recruited in this study through consecutive sampling method after removing patients that did not meet the inclusion criteria i.e those who had exclusion criteria. Written informed consent was obtained the patients before inclusion in the study. Ethics Committee approval for the study was obtained from the Local Ethics Committee of Universitas Sumatera Utara (No.255/TGL/KEPK FK USU-RSUP HAM/2020. The inclusion criteria in this study were as follows: COPD stable patients (FEV_1/FVC < 70%) based on their last spirometry test, age 40–70 years, mild-severe symptoms based on mMRC 1–3, received therapy from outpatient clinic based on their assigned group A–D, willing to follow the entire research procedures from beginning to end and sign the informed consent form. Other COPD patients with existing comorbidity in the form of cancer/tumor, acute cardiovascular disease, severe muscular and musculoskeletal disorder and those who did not comply with the rules and procedures until the end of the programme were removed from the study.

Protocol

Once all of the participants understood the procedures and the framework of the research,

Figure 1. Procedures for breathing exercise. Breathing exercise

Figure 2. The Bird move

they signed the letter of informed consent. The participants were first trained at the hospital on how to do the home-based telerehabilitation programme before they could do it independently in their own house. Next the participants were scheduled to go through breathing exercises and were observed by the researchers via videos. The following were the procedures of the breathing techniques performed by the participants:

1. Pre-exercise: subjects took fast-acting bronchodillators such as 2.5 mg salbutamol.
2. Subjects did 5–10 minutes of light warm-up and stretching to prevent muscle strains.
3. Procedures for breathing exercise [11]:
   a. Breathing exercise
      A technique that involves breathing (inhaling and exhaling) and *gentle chair exercise* move (exhaling while tilting the head to the shoulders) illustrates in Figure 1.
   b. The Bird move
      Using *pursed-lips breathing technique*, Bird Move involves inhaling while straightening theback and exhaling while bending the body forward illustrates in Figure 2.
   c. The *No-Way* move
      This move incorporates *pursed-lips breathing* and looking to the left and right for neck exercise (looking to the left and right while inhaling and exhaling) illustrates in Figure 3.
   d. The Whatever Move
      The whatever move involves *pursed-lips breathing* while shrugging the shoulders

Figure 3. The No-Way move

Figure 4. The Whatever Move

Figure 5. The Fan

Figure 6. The Clucking Chicken

(inhaling while shrugging the shoulders up and exhaling as the shoulders go down) illustrates in Figure 4.

e. The Fan
The fan move entails *pursed-lips breathing* and twisting the body left and right while the hands touching the shoulders (hands on the shoulders, twist the body left and right while inhaling and exhaling) illustrates in Figure 5.

f. The Clucking Chicken
The clucking chicken involves *pursed-lips breathing*, elevation and rotation movement (put the hands on the shoulders and rotate the shoulders while inhaling and exhaling) illustrates in Figure 6.

g. The Vampire move
The vampire involves straightening both arms in front of the body and twisting the body left and right while breathing through pursed lips (inhaling while straightening the arms forward, and ex-

Figure 7. The Vampire move

Figure 8. The Beckoning

Figure 9. The Butterfly

Figure 10. The cool-down exercise

haling while twisting the body left and right) illustrates in Figure 7.

h. The Beckoning
The beckoning involves elevating the arm up dan down diagonally to the opposite side (putting one arm up and down to the floor to the opposite side while inhaling and exhaling, and then switch the arm) illustrates in Figure 8.

i. The Butterfly
Straighten both arms forward in front of the body and then open them wide to the sides while inhaling and exhaling slowly through pursed lips illustrates in Figure 9.

j. The cool-down exercise
Elevate both arms over the head and lower them down while doing *pursed-lips* inhaling and exhaling illustrates in Figure 10.

4. Participants had to perform each move/exercise in 10 repetitions with the intensity of 13-minute duration. This upper-extremity exercise was based on the video previously shown by the researchers.
5. The training session would be temporarily stopped if subjects reported muscle pain, breathing difficulty or headache. It would be resumed when the symptoms receeded.
6. After the training session was over, subjects did the cool-down exercise for 5–10 minutes.

After the participants concluded the twice-a-week upper-limb and breathing exercise rehabilitation programme for 4 weeks, they were invited back to the hospital to have their muscle mass, 6-minute walk, exertion scale, severity symptoms and quality of life evaluated again.

Statistical Analysis

The data collected were processed using SPSS software version 23. A univariant analysis

was conducted to determine the values of mean and standard deviation before and after the intervention. Then a bivariant analysis was used to compare the pre- and post-intervention data. Next, Shapiro-Wilks test was performed to test the normality of the data with p value (< 0.05). If the data had a normal distribution, they would be analyzed using paired t-test; if the data were not normally distributed, Wilcoxon test would be utilized.

Results

In this study, the largest age group was 60–69 years (70%), and the majority of the test samples was a cigarette smoker (90%), and based on the Brinkman index 50% of them was a heavy/severe smoker with the highest average number of cigarettes smoked/day > 30 cigarettes/day (40%). The characteristics of the test samples could be found in Table 1.

Table 2 shows significant changes in the functional capacity, exertion scale, severity of symptoms, quality of life, and muscle mass after the test samples went through the breathing and upper-body exercises for 4 weeks. Lung functional capacity measured by 6-Minute Walking Distance indicated a significant improvement (16.4 ± 4.45 to 19.8 ± 3.64) after paired t-test analysis with p-value < 0.05. The indicators of the perceived exertion scale i.e. Borg and mMRC also showed significant improvement: Borg (3.05 ± 1.53 to 1.40 ± 1.42) analyzed by Wilcoxon test with p-value < 0.05, and mMRC (1.90 ± 1.10 to 0.90 ± 0.87) also analyzed by Wilcoxon test with p-value < 0.05. The quality of life was evaluated using SGRQ parameters (which will be shown in the following graph). Based on the total points of the questionnaire, paired-t test analysis showed a decrease severity of symptoms by CAT (15.7 ± 6.63 to 11.8 ± 5.24) with p-value < 0.05. The results of paired t-test analysis on muscle mass showed a significant increase with p-value < 0.05 (28.36 ± 2.89 to 31.86 ± 3.97).

Based on the answers of SGRQ questionnaire given during interview, test subjects reported positive and significant changes in their condition after the breathing and upper-limb exercise programme, the line graph illustrates in Figure 11. At the end of the rehabilitation programme, in terms of the severity of symptoms, activity and impact, there was a significant reduction of 12.68 (symptoms), 15.4 (activity) and 9.66 (impact).

Table 1. Characteristics of test subjects

Characteristics	n	%
Age Group (Years)		
40–49	1	10.0
60–69	7	70.0
> 69	2	20.0
Gender		
Male	10	100.0
Height		
< 160	7	70.0
> 160	3	30.0
Smoking Status		
Smoker	9	90.0
Non-smoker	1	10.0
Degree of Brinkman Index		
Mild	1	10.0
Moderate	3	30.0
Heavy/Severe	5	50.0
Non-smoking	1	10.0
Cigarettes Consumption (cigarette stick/day)		
< 20	3	30.0
20–30	2	20.0
> 30	4	40.0
None	1	10.0
CAT Score (Pre)		
< 10	1	20.0
≥ 10	9	80.0
mMRC Score (Pre)		
0–1	4	70.0
≥ 2	6	30.0
BORG Score (Pre)		
Extremely mild dyspnea	1	10.0
Very Mild dyspnea	1	10.0
Mild dyspnea	1	10.0
Moderate dyspnea	3	30.0
Slightly severe dyspnea	2	20.0
Severe dyspnea	2	20.0

Data was presented in frequencies and percentage (%). CAT — COPD Assessment Test; mMRC — modified Medical Research Council; Borg Socre — Borg rating of perceived exertion scale.

Discussion

Pulmonary rehabilitation programme aims to strengthen peripheral muscle, increase muscle oxygen utilization, improve the performance of patient's physical exercise and reduce dyspnea [12]. Croitoru et al. observed a thrice-a-week PR programme that lasted for 7 weeks by focusing on exercise tolerance level, exertion scale, and qual-

Table 2. Standard deviation dan mean of lung functional capacity, quality of life and perceived exertion scale

	Mean ± SD		P
	Pre-Treatment	Post-Treatment	
6 Minutes Walking	16.4 ± 4.45	19.8 ± 3.64	0.001**
BORG	3.05 ± 1.53	1.40 ± 1.42	0.028*
mMRC	1.90 ± 1.10	0.90 ± 0.87	0.015**
CAT	15.7 ± 6.63	11.8 ± 5.24	0.028*
Muscle Mass	28.36 ± 2.89	31.86 ± 3.97	0.028*

Data was presented in mean ± SD. CAT — COPD Assessment Test; mMRC score — modified Medical Research Council; Borg Socre — Borg rating of perceived exertion scale; *p-value from paired T-test, considered significant if $p < 0.05$; **p-value from Wilcoxon Test, considered significant if $p < 0.05$

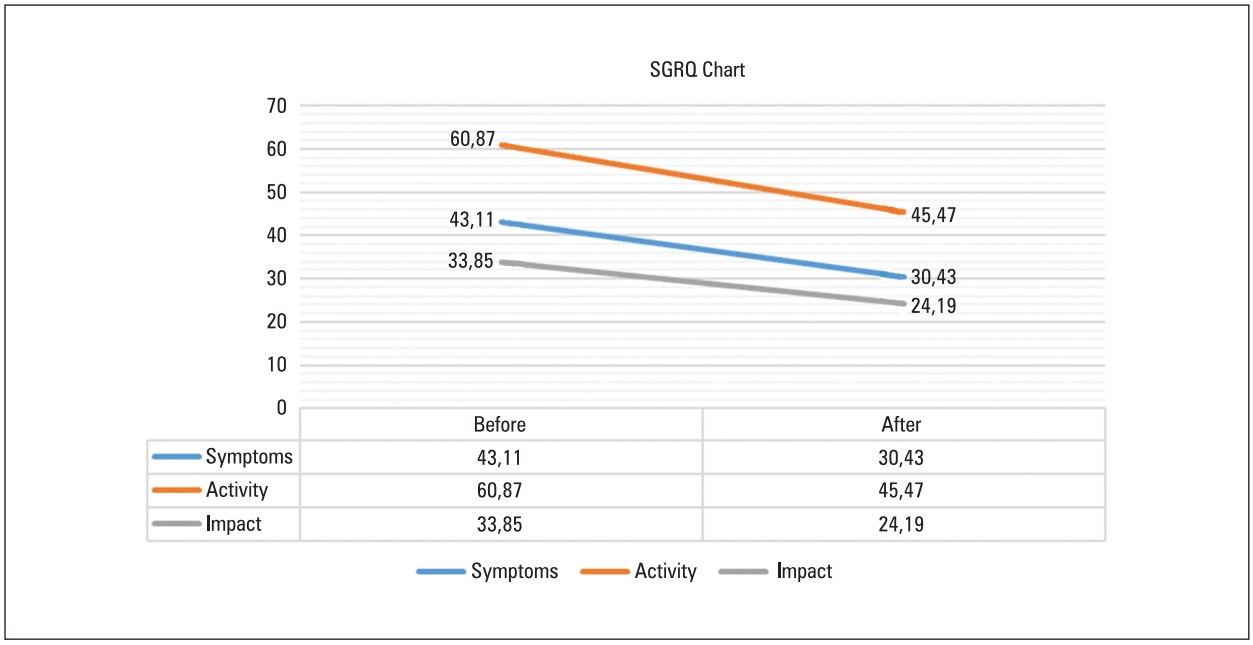

Figure 11. Comparison of the quality of life: before and after the upper-limb and breathing exercises

ity of life. When the observation was concluded, there was a notable improvement in each 6MWD, mMRC and SGRQ [13]. Similarly, our study also produced positive results wherein 6MWD increased from 16.5 ± 4.45 to 19.8 ± 3.64, mMRC improved from 1.90 ± 1.10 to 0.90 ± 0.87, and SGRQ declined significantly which can be seen from Figure 1. Another research further supported this finding and reported a positive development in 6MWD of COPD or ILD (Interstitial Lung Disease) patients who participated in a 22-week lung rehabilitation programme [14].

This study also utilized CAT to assess patients' severity of symptoms pre- and post-rehabilitation, and the result was a significant decrease from 15.7 ± 6.63 to 11.8 ± 5.24. Vasilopoulou et al. investigated the effectiveness of home-based lung telerehabilitation as opposed to hospital-based rehabilitation in reducing the risk of acute COPD exacerbation, and the result stated that there was a significant decrease in CAT from before the intervention and 14 months after [15].

Other researches also touted the effectiveness of pulmonary rehabilitation program in lessening the symptom of dyspnea in patients waiting for a lung transplant who underwent twice-a-week PR programme to improve lung capacity for 8 weeks [16]. Likewise, our study also found a significant decrease in Borg scale value of the test subjects before rehabilitation (3.05 ± 1.05) and after rehabilitation (1.40 ± 1.42).

Cachexia refers to a condition of extreme weight loss that includes disproportionate loss of muscle (muscle wasting). This syndrome of-

ten occurs in many chronic diseases including COPD [17]. Chronic diseases such as COPD can gradually lead to loss of muscle mass due to the breakdown of muscle protein and the development of skeletal muscle atrophy. This condition will eventually cause a decline in lung function and exercise capacity, poor quality of life and increase patient's mortality [12]. Training and rehabilitation are therapeutic strategy often recommended to treat diseases related to loss of skeletal muscle which potentially reduce muscle wasting and increase muscle mass [17].

Jipa Duna et al. conducted a test study on 10 patients (5 COPD patients, 2 Bronchiectasis, 1 Cystic Fibrosis, 1 Lung Cancer and 1 Idiophatic Pulmonary Fibrosis) who underwent a rehabilitation programme. At the end of the programme, the muscle mass increased from 53.03 kg to 56.84 kg [18]. The data also correlated with our study results where the increase in muscle mass was quite significant, from 28.36 ± 2.89 to 31.86 ± 3.97. This study has some limitations such as researcher cannot directly evaluate participants when doing exercises, only videos sent by participants through whatsapp application and cannot ensure whether the participant underwent a rehabilitation program with excessive or less frequency while doing the recommended exercise.

Conclusion

The home-based method of lung telerehabilitation consisted of breathing techniques and upper-extremity exercises conducted for 4 weeks with a frequency of twice a week had resulted in significant positive effects. According to the results of this study, home-based pulmonary telerehabilitation was just as effective as hospital or health center-based rehabilitation programme.

Main Points

- COPD disease not only has an impact on decreased lung function but also can have systemic effects.
- COPD sufferers are advised to perform pulmonary rehabilitation exercises to reduce the adverse effects of COPD disease.
- Effectiveness of Upper Limb Exercises and Breathing Exercises has many positives impact on exercise tolerance level, exertion scale, increase in muscle mass and the quality of life COPD patients.
- Home lung telerehabilitation methods can be used as an alternative during covid-19 pandemic era to pulmonary rehabilitation which is usually implemented in hospital or health center-based rehabilitation programme.

Conflict of interest

None declared.

References

7. Dias FD, Sampaio LM, da Silva GA, et al. Home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomized clinical trial. Int J Chron Obstruct Pulmon Dis. 2013; 8: 537–544, doi: 10.2147/COPD.S50213, indexed in Pubmed: 24235824.
8. Wuytack F, Devane D, Stovold E, et al. Comparison of outpatient and home-based exercise training programmes for COPD: A systematic review and meta-analysis. Respirology. 2018; 23(3): 272–283, doi: 10.1111/resp.13224, indexed in Pubmed: 29194864.
9. Bourne S, DeVos R, North M, et al. Online versus face-to-face pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: randomised controlled trial. BMJ Open. 2017; 7(7): e014580, doi: 10.1136/bmjopen-2016-014580, indexed in Pubmed: 28716786.
10. Holland AE, Mahal A, Hill CJ, et al. Home-based rehabilitation for COPD using minimal resources: a randomised, controlled equivalence trial. Thorax. 2017; 72(1): 57–65, doi: 10.1136/thoraxjnl-2016-208514, indexed in Pubmed: 27672116.
11. Coquart JB, Le Rouzic O, Racil G, et al. Real-life feasibility and effectiveness of home-based pulmonary rehabilitation in chronic obstructive pulmonary disease requiring medical equipment. Int J Chron Obstruct Pulmon Dis. 2017; 12: 3549–3556, doi: 10.2147/COPD.S150827, indexed in Pubmed: 29263659.
12. Güell MR, de Lucas P, Gáldiz JB, et al. [Home vs hospital-based pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: a Spanish multicenter trial]. Arch Bronconeumol. 2008; 44(10): 512–518, indexed in Pubmed: 19006630.
13. Maltais F, Bourbeau J, Shapiro S, et al. Chronic Obstructive Pulmonary Disease Axis of Respiratory Health Network, Fonds de recherche en santé du Québec. Effects of home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. Ann Intern Med. 2008; 149(12): 869–878, doi: 10.7326/0003-4819-149-12-200812160-00006, indexed in Pubmed: 19075206.
14. Mendes de Oliveira JC, Studart Leitão Filho FS, Malosa Sampaio LM, et al. Outpatient vs. home-based pulmonary rehabilitation in COPD: a randomized controlled trial. Multidiscip Respir Med. 2010; 5(6): 401–408, doi: 10.1186/2049-6958-5-6-401, indexed in Pubmed: 22958267.
15. Gonzalez-Gerez JJ, Bernal-Utrera C, Anarte-Lazo E, et al. Therapeutic pulmonary telerehabilitation protocol for patients affected by COVID-19, confined to their homes: study protocol for a randomized controlled trial. Trials. 2020; 21(1): 588, doi: 10.1186/s13063-020-04494-w, indexed in Pubmed: 32600378.
16. Malaguti C, Dal Corso S, Janjua S, et al. Home-based or remote exercise testing in chronic respiratory disease, during the COVID-19 pandemic and beyond: A rapid review. Chron Respir Dis. 2020; 17: 1479973120952418, doi: 10.1177/1479973120952418, indexed in Pubmed: 32840385.
17. Tarigan AP, Ananda FR, Pandia P, et al. The impact of upper limb training with breathing maneuver in lung function, functional capacity, dyspnea scale, and quality of life in patient with stable chronic obstructive of lung disease. Open Access Maced J Med Sci. 2019; 7(4): 567–572, doi: 10.3889/oamjms.2019.113, indexed in Pubmed: 30894913.
18. Cilekar S, Tülek B, Kanat F, et al. Effect of low-intensity pulmonary rehabilitation program on quality of life and pulmonary functions in patients with stable chronic obstructive pulmonary disease. Eurasian Journal of Pulmonology. 2019; 21(1): 14, doi: 10.4103/ejop.ejop_16_19.
19. Croitoru A, Ioniță D, Stroescu C, et al. Benefits of a 7-week outpatient pulmonary rehabilitation program in COPD patients.

Pneumologia. 2013; 62(2): 94–8, 101, indexed in Pubmed: 23894790.
20. Lalwani L, Mishra G. Effect of Pulmonary Rehabilitation on Six-Minute Walk Distance in Patients with Chronic Obstructive Pulmonary Disease or Interstitial Lung Disease. Indian Journal of Basic and Applied Medical Research. 2019; 8(2): 405–409.
21. Vasilopoulou M, Papaioannou AI, Kaltsakas G, et al. Home-based maintenance tele-rehabilitation reduces the risk for acute exacerbations of COPD, hospitalisations and emergency department visits. Eur Respir J. 2017; 49(5), doi: 10.1183/13993003.02129-2016, indexed in Pubmed: 28546268.
22. Kilic L, Pehlivan E, Balci A, et al. Effect of 8-week pulmonary rehabilitation program on dyspnea and functional capacity of patients on waiting list for lung transplantation. Turkish Thoracic Journal. 2020; 21(2): 110–115, doi: 10.5152/turkthoracj.2019.18202.
23. Vogiatzis I, Simoes DCM, Stratakos G, et al. Effect of pulmonary rehabilitation on muscle remodelling in cachectic patients with COPD. Eur Respir J. 2010; 36(2): 301–310, doi: 10.1183/09031936.00112909, indexed in Pubmed: 20110400.
24. Jipa-Dună D, Croitoru A, Bezdedeanu A, et al. The effects of a respiratory rehabilitation programme on body composition. Pneumologia. 2020; 69(1): 29–36, doi: 10.2478/pneum-2020-0008.