Research Article

Pamukkale Medical Journal
doi:https://dx.doi.org/10.31362/patd.1292335

Evaluation of cough strength in bronchiectasis

Bronşektazide öksürme kuvvetinin değerlendirilmesi

Ayşenur Yılmaz, Mukaddes Kılınç, Orçin Telli Atalay, Melis Metin, Erhan Uğurlu, Hande Şenol, Göksel Altınışık Ergur

Received:04.05.2023 Accepted:16.06.2023

Abstract

Purpose: This study aimed to evaluate the cough strength in bronchiectasis patients. We also planned to examine the relationship between cough strength, exercise capacity and quality of life.

Materials and methods: The study included 24 bronchiectasis patients (bronchiectasis group) and 25 healthy individuals (healthy group). Exercise capacity was evaluated with the six minute walk test (6MWT). Cough strength (Peak cough flow (PCF)) was assessed using Mini-WrightTM peak flow meter (PFM) with a mouthpiece. The quality of life was evaluated with Leicester Cough Questionnaire (LCQ).

Results: A significant difference was found between the groups in terms of PCF, 6MWT, LCQ total score and subdimension scores showed significant differences in favor of the healthy group (p<0.05). A positive high correlation was observed between PCF and the following variables: 6MWT and LCQ total score (r=0.780, p<0.000 and r=0.885, p<0.000, respectively).

Conclusion: This study found that cough strength was worse in bronchiectasis patients compared with healthy individuals. In addition, cough strength could negatively affect exercise capacity and quality of life. Therefore, cough strength should be added to the evaluation parameters.

Keywords: Bronchiectasis, cough strength, peak cough flow, exercise capacity, quality of life.

Yilmaz A, Kilinc M, Telli Atalay O, Metin M, Ugurlu E, Senol H, Altınisik Ergur G. Evaluation of cough strength in bronchiectasis. Pam Med J 2023;16:528-535.

Öz

Amaç: Bu çalışmada bronşektazi hastalarında öksürme kuvvetinin değerlendirilmesi amaçlandı. Ayrıca öksürme kuvveti ile egzersiz kapasitesi ve yaşam kalitesi arasındaki ilişkiyi incelemeyi planladık.

Gereç ve yöntem: Çalışmaya 24 bronşektazi hastası (bronşektazi grubu) ve 25 sağlıklı birey (sağlıklı grup) dahil edildi. Egzersiz kapasitesi 6 dakika yürüme testi (6DYT) ile değerlendirildi. Öksürme kuvveti (Tepe öksürük akımı (TÖA)), Mini-WrightTM Pef cough metre (PCM) kullanılarak değerlendirildi. Yaşam kalitesi, Leicester Öksürük anketi (LÖA) ile değerlendirildi.

Bulgular: Gruplar karşılaştırıldığında TÖA, 6DYT, LÖA total puan ve alt boyutları arasında sağlıklı grup lehine anlamlı fark görüldü (p<0,05). TÖA ile 6DYT ve LÖA total puan arasında pozitif yönde yüksek düzeyde anlamlı ilişki saptandı (sırasıyla r=0,780, p<0,000 ve r=0,885, p<0,000).

Sonuç: Bronşektazi hastalarının öksürme kuvvetinin sağlıklı bireylere göre daha kötü olduğu görüldü. Ayrıca, öksürme kuvveti egzersiz kapasitesini ve yaşam kalitesini olumsuz etkilediği için değerlendirme parametrelerine öksürük kuvveti eklenmelidir.

Anahtar kelimeler: Bronşektazi, öksürme kuvveti, tepe öksürük akımı, egzersiz kapasitesi, yaşam kalitesi.

Yılmaz A, Kılınç M, Telli Atalay O, Metin M, Uğurlu E, Şenol H, Altınışık Ergur G. Bronşektazide öksürme kuvvetinin değerlendirilmesi. Pam Tıp Derg 2023;16:528-535.

Ayşenur Yılmaz, PhD. Pamukkale University, Faculty of Physical Therapy and Rehabilitation, Denizli, Türkiye, e-mail: fzt.aysenurgungor@gmail.com (https://orcid.org/0000-0002-2357-0351) (Corresponding Author)

Mukaddes Kılınç, M.D. Atatürk Chest Diseases and Thoracic Surgery Education Research Hospital, Ankara, Türkiye, e-mail: mukaddessener48@gmail.com (https://orcid.org/0000-0001-7817-2337)

Orçin Telli Atalay, Assoc. Prof. Pamukkale University, Faculty of Physical Therapy and Rehabilitation, Denizli, Türkiye, e-mail: orcint@pau.edu.tr (https://orcid.org/0000-0002-1613-9192)

Melis Metin, M.D. Pamukkale University, Faculty of Medicine, Department of Chest Diseases, Denizli, Türkiye, e-mail: melisyorulmaz2@gmail.com (https://orcid.org/0000-0002-9315-3561)

Erhan Uğurlu, Assoc. Prof. Pamukkale University, Faculty of Medicine, Department of Chest Diseases, Denizli, Türkiye, e-mail: drerhan724@gmail.com (https://orcid.org/0000-0001-5402-6925)

Hande Şenol, Asst. Prof. Pamukkale University, Faculty of Medicine, Department of Biostatistics, Denizli, Türkiye, e-mail: hsenol@pau.edu.tr (https://orcid.org/0000-0001-6395-7924)

Göksel Altınışık Ergur, Prof. Pamukkale University, Faculty of Medicine, Department of Chest Diseases, Denizli, Türkiye, e-mail: gaergur@gmail.com (https://orcid.org/0000-0001-6869-1301)

Introduction

Bronchiectasis is characterized by enlargement of the airways and thickening of the bronchial wall; it occurs together with chronic cough and sputum complaint [1]. The cough-operated mucociliary clearance mechanism constitutes the normal defense mechanism of the lungs. Mucociliary clearance depends on the harmonious action of the cilia and its effective interaction with mucins, one of the proteins synthesized by epithelial cells that form the upper viscous mucus layer in the airways. The stickiness of mucins traps particles, and the lower aqueous layer allows the movement of the cilia [2]. A disrupted mucociliary clearance mechanism in patients makes the lungs vulnerable. A vicious cycle of bacterial infection and inflammation begins with secretion accumulation. Problems also occur in effective coughing due to intense inflammation, damage, and bronchial wall weakness. This leads to problems in clearing secretions and causes a decrease in flow [3]. As a result of increased perception of dyspnea and decreased expiratory airflow, exercise capacity may also be reduced in patients with bronchiectasis [4]. The decrease in exercise capacity is an important finding to evaluate the relationship between cough strength and exercise capacity.

Increased perception of dyspnea, symptoms associated with the disease, especially cough, and decreased exercise capacity negatively affect the quality of life. It is important to determine the relationship between cough and quality of life, including harmony and integrity of mental and physical health, because the quality of life was found to be more important than the deterioration in the lung function of the patient. In fact, the main purpose of rehabilitation programs is to improve the quality of life [5].

Cough is a very important symptom in patients with bronchiectasis and must be evaluated during the medical follow-up. Previous studies were conducted using questionnaires or by assessing the number or severity of coughing [6-8]. Studies evaluating the cough strength with PCF were generally conducted to determine the severity of neuromuscular diseases or to make extubation/decannulation decisions in intensive care [9, 10].

This study aimed to evaluate the cough strength in bronchiectasis patients. We also planned to examine the relationship between cough strength, exercise capacity and quality of life.

Materials and methods

A total of 24 patients with bronchiectasis aged more than 18 years, who were followed up by the Pamukkale University, Chest Diseases Polyclinic with the diagnosis of non-cystic fibrosis (CF) bronchiectasis, who did not have any other respiratory disease, who did not have acute and/or chronic respiratory failure, and who were cooperative and volunteered, besides 25 healthy volunteers of the same age and sex, who had no known comorbidities, were included in the study. The participants were divided into two groups: the bronchiectasis group and the healthy group.

The exclusion criteria for patients with bronchiectasis were as follows: cor pulmonale and/or heart failure, hemoptysis, acute myocardial infarction, vertebral injury, any health problems that prevented coughing, and any problem in the musculoskeletal system that prevented participation in the study and/or presence of mobility problems. The exclusion criteria for volunteers were as follows: Smoking, any health problems that prevented coughing, any problem in the musculoskeletal system that prevented participation in the study and/or presence of mobility problems, and any lung, heart, systemic, orthopedic, and/or neurological disease. Participants were informed about the purpose and scope of the study, and written consent was obtained from each participant. This study was approved by the Pamukkale University Ethics Committee, and the ethical principles stated in the Helsinki Declaration were followed during the study.

Study design

The participants' demographic data were recorded. Dyspnea perception was measured with the Modified Medical Research Council (MMRC) scale. Exercise capacity was evaluated with the six minute walk test (6MWT). Cough strength was assessed using a Mini-Wright™ peak flow meter (PFM) with a mouthpiece. The quality of life was measured with the Leicester Cough Questionnaire (LCQ) specific to cough. The participants who met the inclusion criteria

were questioned about their sociodemographic characteristics through face-to-face interviews.

Respiratory function parameters were measured and evaluated with the Jaeger brand MasterScope device that could also be used for body plethysmography to perform respiratory function test. The patients were seated in a comfortable position, after which they were put on a nose clip to perform a forced vital capacity (FVC) maneuver, for measuring respiratory function parameters. During this maneuver, the person first breathed calmly, and then he/she was asked to take a deep and strong breath and fill the lungs with air. Further, he/she was asked to exhale quickly and powerfully until all the air was out of the lungs. In evaluating the pulmonary function test, the FVC maneuver was repeated at least three times and the best values were accepted. PFT measurements were recorded in the evaluation form for both groups [11].

Cough strength (PCF), was evaluated with a portable PFM device (Mini-Wright™ peak flow meter) while the patients were in a sitting position. After deep inspiration (after waiting for at least 2 s), the peak expiratory flow (PEF) they were able to reach with a strong coughing maneuver was recorded. The PEF maneuver lasted approximately 1 s as opposed to FVC. Three measurements for cough strength were repeated, while the highest value was recorded; a 30-s pause occurred between each measurement. The measurements were both carried out with a mouthpiece [12, 13].

The patient's exercise capacity was measured with the 6MWT. The standard test protocol was applied in a continuous 30-m corridor or in an open flat-floor area. A marker was placed at every 3 m. The patients, who wore comfortable clothes and shoes, were given standard directions during the tests orally. The heart rate and blood pressure were measured before and after the test. In addition, the dyspnea level was measured with a Borg ruler and oxyhemoglobin saturation with pulse oximetry (Pulsemed Finger Type Pulse Oximeter Device). The walking distance was recorded with a measuring stick [14].

The LCQ was used to measure quality of life. The LCQ is a short, easy-to-administer, and cough-specific health-related quality-of-life questionnaire. The LCQ was self-directed and included a 7-point Likert response scale; it had 3 health areas (physical, psychological, and social) and consisted of 19 items. It was practical and short for clinical use. A high LCQ score indicated a good health status. Its validity and reliability were tested [15, 16].

The patient's shortness of breath was evaluated with the MMRC scale. The scale options were read to the patients, who were then asked to select the most appropriate grade that described his/her respiratory distress. The MMRC scored from 0 to 4. A high MMRC score indicated a more severe perception of shortness of breath [17].

The Bronchiectasis Severity Index (BSI) was used to determine the disease severity. The BSI evaluated age, body mass index (BMI), FEV% (expected%), hospitalization, frequency of exacerbation, number of lung lobes affected, mMRC, and colonization. Patients' results were categorized as mild (KSE≤4), medium (BSI 5-8), and severe (KSE≥9) according to the scoring system [18].

Statistical analysis

The effect size obtained in the reference study was strong (d=1.306). As a result of power analysis made considering that a lower effect size could be obtained, it was found that when at least 46 people (at least 23 for each group) were included in the study for the effect size value at a strong level (d=1), 95% power at a 95% confidence level could be obtained [19].

Statistical analyses were performed using SPSS 25.0. Categorical variables were defined by number and percentage. Continuous variables were defined by the minimum - maximum, median and mean±standard deviation. Shapiro Wilk test was used for determination of normal distribution. For independent group comparisons, we used Independent samples t test when parametric test conditions were satisfied and Mann-Whitney U test when parametric test conditions were not satisfied. Pearson and Spearman correlation analysis was used for analyzing the relationships between continuous variables. The difference between categorical variables were analyzed with Chi-square analysis. Statistical significance was determined as p<0.05.

Results

The study included 24 (11 women and 13 men) patients with bronchiectasis and 25 (15 women and 10 men) healthy controls. The comparison of the groups revealed no significant difference in terms of age, height, and BMI (p>0.05). A significant difference was found between the groups in terms of respiratory parameter results (p<0.05). The results are shown in Table 1. The mean disease duration of patients with bronchiectasis was found to be 25.39±17.12 years. The mean MMRC score was 2.45±1.06.

Underlying etiologies of non-CF bronchiectasis were idiopathic in 8 (33.3%), infection in 4 (16.7%), tuberculosis in 1 (4.2%), and childhood infections in 4 (16.7%) pneumonia in 4 (16.7%) tuberculosis 2 (8.2%) in and whooping cough in 1 (4.2%). There were 12 (50%) mild, 10 (41.7%) moderate, and 2(8.3%) severe patients according to the Bronchiectasis severity Index.

The examination of the groups' PCF, 6MWT, LCQ total score and subdimension scores showed significant differences in favor of the healthy group (p<0.05). The results are shown in Table 2.

The relationships between PCF, 6MWT, LCQ total score and subdimension scores, dyspnea scores and disease duration of bronchiectasis patients are shown in Table 3.

Table 1. Mean values (mean ± SD) and ranges of characteristics of spirometric and anthropometric values in the bronchiectasis and healthy groups

Variables	Bronchiectasis group (n=24)		Healthy group (n=25)		*p*
	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)	
Age (year)	51.75±4.28	55 (22-70)	50.84±10.18	48 (30-67)	0.610‡
Height (cm)	165.75±8.4	166.5 (150-180)	165.32±9.11	169(150-180)	0.888§
Weight (kg)	71±12.69	70 (43-94)	69.28±11.03	68 (46-94)	0.624§
BMI (kg/m²)	25.94±4.83	25.73(15.99-34.11)	25.35±3.42	25.29(15.92-32.53)	0.603§
FEV1	1.71±0.88	1.35 (0.72-3.86)	2.78±0.67	2.75 (1.31-3.72)	**0.000**‡
FEV1%	58.03±23.71	55 (23-106)	87.76±9.29	89 (64-100)	**0.000**§
FVC	2.35±1.01	2.26 (0.80-4.81)	3.36±0.84	3.24 (1.64-4.92)	**0.001**§
FVC%	66.57±21.22	65 (23-107)	90.68±11.13	92 (69-111)	**0.000**§
FEV1/FVC	71.05±15.14	75 (37-91.42)	82.70±5.56	81 (74-97)	**0.002**§
PEF	4.07±2.03	3.30 (1.10-8.03)	5.97±1.40	5.56 (4.03-8.90)	**0.002**§
PEF%	54.77±23.62	56.5 (16-106)	79.04±9.82	79 (62-103)	**0.000**§
Sex	**n**	**%**	**n**	**%**	***p***
Female	11	45.8	15	60	
Male	13	54.2	10	40	0.321‖

*p<0.001, † p<0.05, ‡: Mann Whitney U test, §: Independent samples t test, ‖: Chi Square test. SD: Standart deviation, BMI: Body mass index %: Percentage, FEV1: Forced expiratory volume in first second, FEV1/FVC: Tiffeneau index,FVC: Forced vital capacity, PEF: Peak expiratory flow

Table 2. Comparison of mean values (±SD) of PCF, 6MWT, and LCQ total score and subcategories between the bronchiectasis and healthy groups

Variables	Bronchiectasis group (n=24)		Healthy group (n=25)		*p*
	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)	
PCF (L/m)	323.12±142.46	300 (150-700)	493.6±103.51	500 (350-750)	**0.000**†
6MWT (m)	386.02±143.06	395.78 (20-608.92)	589.41±83.58	582 (450-770)	**0.000**‡
LCQ total score	11.16±5.12	10.35 (3.89-20.09)	–	–	–
LCQ Psychosocial	3.66±1.63	3.5 (1.14-6.71)	–	–	–
LCQ Social	3.54±1.78	3.25 (1-6.5)	–	–	–
LCQ Physical	35±1.9	3.5 (1.25-6.88)	–	–	–

*p<0.001, †: Mann Whitney U test, ‡: Independent samples t test, SD: Standart deviation, PCF: Peak cough flow, 6MWT: Six minute walk test LCQ: Leicester Cough Questionnaire

Table 3. Relationship between PCF, 6MWT, LCQ total score and subcategories, duration of illness, disease severity, and dyspnea in the bronchiectasis group

Variables	PCF	
	r	*p*
6MWT (m)	0.780	**0.000**§
LCQ total score	0.885	**0.000**‡
LCQ Psychosocial	0.886	**0.000**‡
LCQ Social	0.888	**0.000**§
LCQ Physical	0.832	**0.000**‡
BSI	-0.619	**0.001**§
MMRC	-0.794	**0.000**§
Duration of illness (year)	-0.209	0.326‡

˙$p<0.05$, † $p<0.001$; PCF: Peak cough flow, 6MWT: Six minute walk test; LCQ: Leicester cough.questionnaire
BSI: Bronchiectasis severity index, MMRC:.Modified.medical research council; §: Spearman correlation coefficient
‡: Pearson correlation coefficient

Discussion

Cough is a serious problem in patients with bronchiectasis. Studies showed that the cough strength could be measured with a portable PFM in evaluating respiratory muscle strength that provides the efficiency of coughing and mucus clearance in neuromuscular diseases. However, these studies were generally used to determine the termination of mechanical ventilation in intensive care units or for follow-up in neuromuscular diseases [9, 10, 19]. No previous study evaluated cough strength using a PFM in patients with bronchiectasis. Studies on patients with bronchiectasis and other respiratory diseases were mostly conducted with questionnaires to evaluate cough frequency, severity, and sensitivity of the underlying cough reflex [6-8].

One study reported that the orally applied PFM method was an easy and accurate method of measuring cough flow because the intubation tube passed the glottis space [9]. Although the measurements were made through a mouthpiece connected to the tracheal tube, no clear information was available about the position of the patient. The participants in the present study were cooperative and had no orthopedic problems. Therefore, the measurements were made in a sitting position with the spine kept vertical, where lung ventilation could be provided under the most ideal conditions. In addition, the patients placed the instrument in their mouth after deep inspiration, and the measurement was taken with the “Cough” command, which helped capture the measurement in the expressive phase of the cough. This way we were able to catch the glottis opening immediately after closing, which suggested that the glottis factor did not affect the cough flow rate measurement result.

In addition, a significant relationship was found between exercise capacity, quality of life, mMRC, and BSI in both measurements. The data obtained from this study supported the view that the PFM provided sufficient and consistent information about cough strength in patients with bronchiectasis by measuring the cough flow rate. A study comparing cough flow velocity in healthy individuals with that in patients with neuromuscular diseases measured once using the portable PFM and then by pneumotachograph reported no large difference between the measurement results of the two devices, and that the PFM could be easily used in the clinic [13].

An inverse relationship was observed between cough strength and dyspnea and disease severity in the present study. This indicated that the cough strength decreased as the severity of the disease increased. Likewise, the cough strength decreased as the severity of dyspnea increased. No relationship between the duration of disease and cough strength was found. The reason for the lack of relationship might be factors other than the duration of the disease on the severity of the disease [20].

Studies involving field intraoral pressure measurements were used for measuring

respiratory muscle strength. Cough strength, which reflected the role of respiratory muscles more functionally and whose importance was emphasized clinically in the prevention of pulmonary complications, was not evaluated much; also, its relationship with exercise capacity was not examined. Chronic cough, sputum production, recurrent infections, and airway obstruction are common symptoms in patients with bronchiectasis [1]. Shortness of breath and fatigue are important symptoms that limit the activity of a person in daily life, and exercise capacity is also lower than expected in these patients [21].

Respiratory muscles play an important role in observing functional limitations and symptoms related to chronic respiratory diseases. The disparity between workload and capacity of the muscle, which develops due to the weakness of inspiratory muscle strength, can result in dyspnea and a decrease in exercise capacity. In the case of decreased expiratory muscle strength, effective cough is eliminated and problems related to the release of secretions occur [22, 23]. This may reduce exercise capacity in patients with bronchiectasis with increased perception of dyspnea and expiratory flow limitation [4] Symptoms such as excessive sputum production, ineffective cough with inadequate sputum discharge, dyspnea, and decreased muscle strength in patients with bronchiectasis negatively affect exercise capacity [4, 24]. Exercise tests are a key approach to evaluating the effects of treatments on function in patients. The 6MWT, evaluating exercise capacity, is the most used test. The present study found that patients diagnosed with bronchiectasis had lower exercise capacity compared with healthy individuals, and a high correlation existed with cough strength. Measuring the patient's exercise capacity is also a key approach to evaluating the effects of treatment on function. In this context, we think that using a PFM is an appropriate method in the follow-up and treatment of patients.

Like reduced exercise capacity, shortness of breath has more than one cause; possible causes include varying pulmonary mechanics, insufficient gas exchange, decreased muscle mass, and accompanying psychological morbidity [3]. Decreased exercise capacity is closely related to increased dyspnea perception scores. The vicious cycle in disease pathogenesis also manifests itself in symptoms. Increasing dyspnea limits exercise capacity and negatively affects the quality of life, whereas decreased exercise tolerance leads to a decrease in the perception threshold of dyspnea. Dyspnea is a symptom observed in patients with bronchiectasis; some studies showed that it is one of the factors affecting exercise capacity [4]. The present study showed a strong negative relationship between cough strength and dyspnea.

Quality-of-life measures can be used to facilitate communication with patients and inform them about the problems affecting them. Questionnaires can be comprehensive and disease-specific. General quality-of-life questionnaires regarding the respiratory system, for example, St. George's Respiratory Questionnaire, identify various problems affecting patients but do not evaluate the effect of cough [15]. Cough-specific, health-related quality-of-life questionnaires assess aspects of cough severity that are important to patients. They should be short, easy to implement, and well verified. The LCQ was used to evaluate coughing in previous studies. It is a symptom-specific questionnaire aiming to evaluate the physical, psychological, and social effects of chronic cough, the main symptom of bronchiectasis; its validity and reliability testing was performed in patients with bronchiectasis. It was used to evaluate cough in studies conducted on patients with bronchiectasis [16]. Therefore, the LCQ was used in the present study specifically cough. A high correlation was found between PCF and LCQ scores. Insufficient cough negatively affected exercise capacity over time because of secretion accumulation and restriction of expiratory airflow. Quality of life and exercise capacity were affected in patients with bronchiectasis with increased perception of dyspnea and limitation of expiratory flow.

Taking the patient's perspective into account when assessing the quality of life is what can enable the patient and the physician to reach a consensus on the health impact of the disease and treatment choices. In addition, an objective and correct assessment of cough may be a guiding factor in the diagnosis and treatment. Predicting pharmacological responses to antitussive therapies can provide

useful guidance for treatment. Also, a study conducted on patients with COPD reported that an increase in cough strength was achieved at the end of a 4-week rehabilitation program [25]. When looking at the issue from this angle, it can be said that cough strength can be used for the follow-up of rehabilitation programs. We think that the use of a PFM together with cough-specific quality-of-life questionnaires may be very effective in the follow-up of the disease.

The strength of our work, our study is the first study that objectively evaluates coughing in patients with bronchiectasis. Studies were mostly evaluated with questionnaires or subjective methods. In our study, we evaluated both subjectively and objectively and looked at the relationship between them. We have shown that with the PFM, clinical evaluation can be made both quickly and objectively. The limitation of our study, although our power analysis was adequate, it would be better to evaluate more patients.

In conclusions, cough strength negatively affects quality of life and exercise capacity. In addition, since the cough strength is lower than in healthy individuals, it is very important to evaluate the cough strength in patients with bronchiectasis. PFM is an easy-to-use, portable, objective, and cheap device. We have shown in our study that this can be done with the PFM. We think that a PFM is a useful tool for both physicians and physiotherapists to follow up on the patient's clinical and rehabilitation programs.

Conflict of interest: The authors declare that they have no conflict of interest.

References

1. Boyton RJ. Bronchiectasis. J Med 2008;36:315-320.
2. Albert RK, Spiro SG, Jett JR. Comprehensive respiratory medicine. Mosby International Ltd; 1999.
3. Onen ZP, Gulbay BE, Sen E, et al. Analysis of the factors related to mortality in patients with bronchiectasis. Respir Med 2007;101:1390-1397. https://doi.org/10.1016/j.rmed.2007.02.002
4. Koulouris NG, Retsou S, Kosmas E, et al. Tidal expiratory flow limitation, dyspnoea and exercise capacity in patients with bilateral bronchiectasis. Eur Respir J 2003;21:743-748. https://doi.org/10.1183/09031936.03.00301103
5. Stewart DG, Drake DF, Robertson C, Marwitz JH, Kreutzer JS, Cifu DX. Benefits of an inpatient pulmonary rehabilitation program : a prospective analysis. Arch Phys Med Rehabil 2001;82:347-352. https://doi.org/10.1053/apmr.2001.20838
6. Cho PSP, Birring SS, Fletcher HV, Turner RD. Methods of cough assessment. JACI 2019;7:1715-1723. https://doi.org/10.1016/j.jaip.2019.01.049
7. Key AL, Holt K, Hamilton A, Smith JA, Earis JE. Objective cough frequency in idiopathic pulmonary fibrosis. Cough 2010;6:1-7. https://doi.org/10.1186/1745-9974-6-4
8. Spinou A, Lee KK, Sinha A, et al. The objective assessment of cough frequency in bronchiectasis. Lung 2017;195:575-585. https://doi.org/10.1007/s00408-017-0038-x
9. Winck JC, LeBlanc C, Soto JL, Plano F. The value of cough peak flow measurements in the assessment of extubation or decannulation readiness. Rev Port Pneumol 2015;21:94-98. https://doi.org/10.1016/j.rppnen.2014.12.002
10. Lalmolda C, Prados H, Mateu G, Noray M, Pomares X, Luján M. Titration of mechanical ınsufflation – exsufflation optimal pressure combinations in neuromuscular diseases by flow / pressure waveform analysis. Arch Bronconeumol 2019;55:246-251. https://doi.org/10.1016/j.arbr.2018.10.012
11. Vanderschueren D, Decramer M, Van Den Daele P, Dequeker J. Pulmonary function and maksimal transrespiratory pressures in ankylosing spondylitis. Ann Rheum Dis 1989;48:632-635. https://doi.org/10.1136/ard.48.8.632
12. Gregg I, Nunn AJ. Peak expiratory flow in normal subjects. Br Med J 1973;3:282-284. https://doi.org/10.1136/bmj.3.5874.282
13. Sancho J, Servera E, Díaz J, Marin J. Comparison of peak cough flows measured by pneumotachograph and a portable peak flow meter. Am J Phys Med Rehabil 2004;83:608-612. https://doi.org/10.1097/01.PHM.0000133431.70907.A2
14. Jay SJ. Reference equations for the six-minute walk in healthy adults. Am J Respir Crit Care Med 2000;161:1396. https://doi.org/10.1164/ajrccm.161.4.16147a
15. Birring SS, Prudon B, Carr AJ, Singh SJ, Morgan MDL, Pavord ID. Development of a symptom specific health status measure for patients with chronic cough: Leicester.Cough.Questionnaire (LCQ). Thorax 2003;58:339-343. https://doi.org/10.1136/thorax.58.4.339
16. Swaminathan S, Kuppurao KV, Somu N, Vijayan VK. Reduced exercise capacity in non-cystic fibrosis bronchiectasis. Indian J Pediatr 2003;70:553-556. https://doi.org/10.1007/BF02723157

17. Crisafulli E, Clini EM. Measures of dyspnea in pulmonary rehabilitation. Multidiscip Respir Med 2010;5:202-210. https://doi.org/10.4081/mrm.2010.529

18. Guan WJ, Chen RC, Zhong NS. The bronchiectasis severity index and FACED score for bronchiectasis. Eur Respir J 2016;47:382-384. https://doi.org/1183/13993003.01717-2015

19. Jiang C, Esquinas A, Mina B. Evaluation of cough peak expiratory flow as a predictor of successful mechanical ventilation discontinuation: a narrative review of the literature. J Int Care 2017;5:33(e1-5). https://doi.org/10.1186/s40560-017-0229-9

20. Ellis HC, Cowman S, Fernandes M, Wilson R, Loebinger MR. Predicting mortality in bronchiectasis using bronchiectasis severity index and FACED scores: a 19-year Cohort study. Eur Respir J 2016;47:482-489. https://doi.org/10.1183/139993003.01312-2015

21. Kosmas EN, Milic Emili J, Retsou S, et al. Exercise testing and exercise-limiting factors in patients with bilateral bronchiectasis. Pneumon 2009;22:306-314.

22. Troosters T, Gosselink R, Decramer M. Respiratory muscle assessment. Eur Respir Mon 2005;31:57-71. https://doi.org/10.1183/1025448x.00031004

23. Gibson GJ. Measurement of respiratory muscle strength. Respir Med 1995;89:529-535. https://doi.org/10.1016/0954-6111(95)90153-1

24. Lee AL, Cecins N, Hill CJ, et al. The effects of pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis: protocol for a randomised controlled trial. BMC Pulm Med 2010;10:5. https://doi.org/10.1186/1471-2466-10-5

25. Arifin SWA, Indra R, Widjanantie SC, Nusdwinuringtyas N. Improvement of the functional parameter in patient with chronic obstructive pulmonary disease after pulmonary rehabilitation. IndoJPMR 2017;6:44-50. https://doi.org/10.36803/ijpmr.v6i02.161

Consent of publication: Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Acknowledgments: The authors would like to thank participants in this study.

Ethics committee approval: Permission was obtained from Pamukkale University Non-Interventional Clinical Research Ethics Committee dated 27.10.2020 and numbered 20 for the study.

Author contributions

A.Y. was responsible for drafting the manuscript. A.Y. and M.K. was responsible for Data collection and Interpretation and for drafting the manuscript. G.A. was responsible for conceptualization, funding acquisition, desing of the study, supervision and for drafting the manuscript. E.U. was responsible for data collection and Interpretation. M.M. and O.T.A. was responsible for data collection and Interpretation. H.S. was responsible for data analysis and Interpretation. All authors reviewed the article critically for important intellectual content and approved the final version to be submitted.