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The Characteristics related to Pulmonary Rehabilitation in Patients with Chronic Obstructive Pulmonary Disease: A Cross-sectional Study, Data from the Korea National Health and Nutrition Examination Survey 2015-2019.

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Objective: Patients with chronic obstructive pulmonary disease (COPD) may experience reduced physical activity and quality of life (QoL) due to decreased pulmonary function. The purpose of this study was to investigate the level of pulmonary function, physical activity, and QoL of COPD patients.

Design: Cross-sectional observational study.

Methods: This study examined the published data of the Korea National Health and Nutrition Examination Survey in 2015-2019. Among 39,759 subjects who participated for 5 years, data from 151 patients diagnosed with COPD were analyzed separately. For the pulmonary function, the results of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV6, forced expiratory flow 25-75%, and peak expiratory flow were observed. Physical activity was identified as frequency and duration. For the QoL, EQ-5D-3L evaluation results were examined, and the frequency and index of the Korean version were investigated.

Results: In pulmonary function, all variables were found to be lower than age and weighted matched normal values. COPD patients showed to perform very low levels of high/medium physical activity and sitting time was confirmed to be more than 8 hours a day. In QoL, it was found that the highest reporting rate of some problems was the “pain and discomfort” and “mobility”.

Conclusions: It was found that COPD patients showed that the prevalence of circulatory disease was relatively high, lowered pulmonary function, and QoL. These can be improved through regular physical activity, and it is thought that this can be achieved through optimization of pulmonary rehabilitation.

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Key Words: Pulmonary function, Physical activity, Quality of life, Chronic obstructive pulmonary disease.

Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by chronic airflow limitation and airway inflammation that is not fully reversible and is progressive [1]. COPD is occurring worldwide, and it is a disease that has a large national burden on the healthcare system [2].

COPD patients demonstrate inflammatory injury of airways and lung parenchyma. Poorly reversible expiratory airflow limitation on spirometry is an important feature of COPD [3]. The assessment of pulmonary function is the most important index of respiratory impairment in COPD [4], the severity of COPD can be measured by the results of spirometry airflow or pulmonary function test (PFT).

Physical activity refers to the voluntary movement of the musculoskeletal system necessary for daily life

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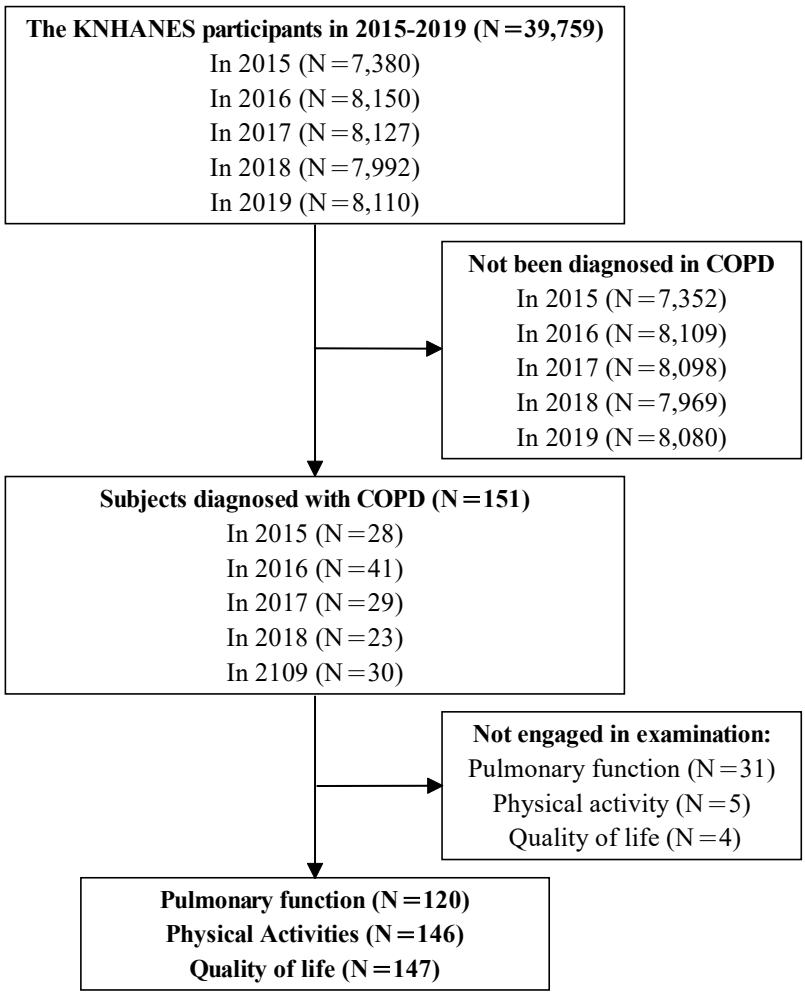

Figure 1. Flow chart for selection of subjects diagnosed with COPD in KNHANES data
Abbreviation: KNHANES, Korea National Health and Nutrition Examination Survey.

[5], it can be assessed by the quantification of these voluntary movements during the way of life. COPD patients have decreased physical activity as well as spirometry-based PFTs results [6]. Physical activity includes elementary, ordinary tasks required for personal self-care and independent daily living [7], they have meaningful lower levels of physical activity compared with healthy individuals [8]. In COPD, quality of life (QoL) is an important factor in disease management, function status, and well-being, which is a subjective awareness related to the physical and mental aspects of daily life [9]. Thus, as the severity of COPD increases, the patient's physical activities and quality of life can decrease in sequence.

Therefore, the purpose of this study is to investigate the pulmonary function, physical activity, and QoL of COPD patients to identify the features of COPD patients. This study intended to provide a reference for the functional improvement of COPD patients focusing on the effects of pulmonary rehabilitation.

Methods

Data collection

This study was based on data from the Korea National Health and Nutrition Examination Survey (KNHANES) in 2015-2019. The KNHANES is a cross-sectional and national survey accompanied by the Division of Chronic Disease Surveillance of the Korea Center for Disease Control and Prevention in the Ministry of Health and Welfare. We collected all examination results of all subjects who participated in the KNHANES for 5 years (n＝39,759) and analyzed

the data of subjects diagnosed with COPD by a doctor among all subjects (Figure 1). To identify the characteristics of COPD patients, the evaluation results for pulmonary function, physical activity, and QoL were extracted and the results were derived. This study used the data of KNHANES, which was conducted after the approval of the institutional review board in Korea Centers for Disease Control and Prevention (2018-01-03-P-A). Also, it is represented as statistical data in South Korea, which is extracted every year by stratified, clustered, and systematic sampling.

Anthropometry and health-related characteristics

Information for the anthropometry and health-related characteristics was attained through the health interview in the KNHANES. The anthropometry had age, height, weight, waist circumference, and body mass index. The health-related characteristics were blood pressure, diagnosis of depression, hypertension, lipidemia, stroke, myocardial infarction, asthma, and diabetes mellitus.

Pulmonary function

PFT is a non-invasive diagnostic test, it provides lung volume, capacities, and flow rate for information on the quality of lung function. PFT can evaluate obstructive pulmonary disease in which air flows out due to increased resistance of the airway, and is used to evaluate restrictive disease caused by lung expansion or dysfunction of the chest muscles. To evaluate the pulmonary function of COPD patients, PFTs of this study were completed as the recommendation of the American Thoracic Society [10]. Dry rolling seal Spirometer (Model 2130; SensoMedics, CA, USA) was used for the PFTs of participants in 2015. From 2016 to 2019, Vyntus Spirometer (JAEGER Vyntus, CareFusion, Höchberg, Germany) was used (the interrater reliability, ICC:0.984-0.996, $p < 0.001$) [11]. The evaluated values of this study are forced vital capacity (FVC), predicted FVC ratio, forced expiratory volume in 1 second (FEV1), predicted FEV1 ratio, percentage of FEV1/FVC, forced expiratory volume in 6 seconds (FEV6), forced expiratory flow (FEF) 25-75% and peak expiratory flow (PEF). Spirometry values were presented as a percentage of the measured to the predicted ratio.

Physical Activity

For physical activity, items related to work, place movement, and leisure were investigated. Types of physical activity include walking days, continuous walking time at once, strengthening exercise, and sedentary time per day [8]. In the present study, high/medium intensity of physical activity, walking exercise frequency, continuous walking time at once, strengthening exercise, sitting time and daily activity restriction of COPD patients were inquired.

The question of high/medium intensity of physical activity is “Do you usually do high/medium-intensity sports, exercise, and recreational activities that keep you short of breath or your heart beats very fast for at least 10 minutes?” Further, a 7-point scale (i.e., 1 = Never, 2 = 1 day, 3 = 2 days, 4 = 3 days, 5 = 4 days, 6 = 5 days, 7 = 6 days, 8 = everyday) was added to for walking question. These raw data were categorized as “1 = Never and 2 = Participation in walking” for this study. Only the subjects who answered “Yes” for the time of high/medium intensity of physical activity were averaged. The daily walking time and strengthening exercises were investigated in the same way. Continuous walking time at once and sitting time were averaged for the subjects who responded to the question. Also, activity restriction due to respiration problems and smoking status was examined. It was reported the reliability and validity of the physical activity questionnaire used in this study [12].

Quality of life

Investigation of QoL was performed using the Korean version of the self-administered EQ-5D-3L questionnaire. EQ-5D-3L is a generic questionnaire used to assess health-related QoL. It is comprised of a descriptive system (utility score) which asks the respondent to consider and rate his/her health ‘today’. The descriptive system enables the respondent to classify his/her health consistent with five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression with 3 levels as follows: 1, no problems; 2, some or moderate problems; and 3,

extreme problems [13]. The patient's individual health status is expressed through one answer in each of the five dimensions of EQ-5D-3L, and a total of 243 health conditions can be expressed. Also, these health statuses are converted into an EQ-5D-3L index that is calculated using the assessed weighted value for Koreans. The index scores range from −0.171 mean severe problems were reported for all five EQ-5D health domains, to 1 that no problems were reported for all five domains. The negative scores mean worse than death, 0 represents death, and 1 indicates perfect health. The validity and reliability of the Korean version of the EQ-5D-3L have been recognized across varied diseases [14, 15].

Statistical analysis

The data of the present study were analyzed with consideration for stratification, sampling weights, and clustering according to the KNHANES data analysis guidelines. Before statistical analysis, the Kolmogorov–Smirnov test was performed to assess the normality of continuous data. Descriptive information was obtained to examine the general characteristics of COPD patients and presented as frequencies and weighted percentages for categorical variables, and continuous variables were presented as estimated mean ± standard errors. In the EQ-5D-3L, the categorical variables were presented as unweighted numbers and estimated percentages. The Index of EQ-5D-3L was calculated as the Korean version. Statistical analysis was performed using SPSS (ver 23.0, IBM Co., USA).

Results

Table 1. demonstrates the anthropometry and subjective health status of COPD patients. Of the 151 subjects, 6 were very good, 12 were good, 57 were normal, 43 were bad, 30 were very bad, and 3 were non-response.

Health-related characteristics and smoking status are revealed in Table 2. Diagnosis rates of hypertension

Table 1. Anthropometry of chronic obstructive pulmonary disease patients. (N=151)

Anthropometry	
Sex (male/female)	93 (61.6 %)/58 (38.4 %)
Age (years)	65.26±10.82
Height (cm)	161.17±15.81
Weight (kg)	61.18±10.76
Waist circumference (cm)	83.97±10.32
BMI (kg/m^2)	22.96±3.70
SBP	124.05±16.39
DBP	73.33±9.90
Pulse Pressure	50.72±14.63
Subjective health status	
Very good	6 (4.0%)
Good	12 (7.9%)
Normal	57 (37.7%)
Bad	43 (28.5%)
Very bad	30 (19.9%)
Non-response	3 (2.0%)

Note: Data presented as the number (weighted %) for categorical variables or as the mean ± standard deviation for continuous variables.
Abbreviation: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 2. Health-related characteristics of chronic obstructive pulmonary disease patients. (N = 151)

Health-related diseases	Yes	No	No response
Depression diagnosis	9(6.0%)	138 (91.4%)	4 (2.6%)
Hypertension diagnosis	60 (39.7%)	91(60.3%)	0 (0.0%)
Hyperlipidemia diagnosis	47 (31.1%)	104 (68.9%)	0 (0.0%)
Stroke diagnosis	5 (3.3%)	142 (94.0%)	4 (2.6%)
MI or angina pectoris diagnosis	13 (8.6%)	138 (91.4%)	0 (0.0%)
Asthma diagnosis	47 (31.1%)	100 (66.2%)	4 (2.6%)
DM diagnosis	22 (14.6%)	129 (85.4%)	0 (0.0%)
Smoking status			
Daily smoking	21 (13.9%)		
occasional smoking	1 (0.7%)		
Smoking cessation	69 (45.7%)		

Note: Data presented as the number (weighted %) for categorical variables. Missing values for each test item were excluded.
Abbreviation: MI, myocardial infarction; DM, diabetes mellitus.

Table 3. Differences in pulmonary functions of chronic obstructive pulmonary disease patients (N = 151)

Pulmonary function	
FVC (ℓ)	3.119±0.958
Percentage of normal estimates FVC (%)	80.84±17.05
FEV1 (ℓ)	2.040±0.81
Percentage of normal estimates FEV (%)	71.29±22.44
FEV1/FVC (%)	65.16±15.16
FEV6 (ℓ)	2.897±0.924
FEF 25-75% (ℓ/s)	1.49±1.07
PEF (ℓ/s)	5.260±2.179

Note: Values are expressed as mean ± standard deviation. Missing values for each test item were excluded.
Abbreviations: FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; FEV6, forced expiratory volume in 6 seconds; FEF, forced expiratory flow; PEF, peak expiratory flow.

(39.7%), lipidemia (31.1%), and asthma (31.1%) were higher than those of other diseases. Also, the current smoking rate was 13.9 % and the smoking cessation rate was 45.7%.

Table 3. reveals the pulmonary function of the participants. FVC was 3.119±0.958ℓ, predicted FVC was 80.84±17.05%, FEV1 was 2.040±0.820ℓ, and predicted FVC was 71.29±22.44%. The FEV1/FVC ratio was 65.15±15.16%, FEV6 was 2.897±0.924ℓ, FEF 25-75% was 1.490±1.070ℓ, and PEF was 5.260±2.179ℓ.

The features of physical activity in COPD patients were described in Table 4. The subjects who performed high intensity of physical activity for work and leisure were 2.6% and 7.3%, respectively. In addition, subjects who performed medium intensity of physical activity for work and leisure were 11.9% and 17.9%, respectively. The number of walking exercise frequency per week was 2.2 days, and the continuous walking time at once was 38.4 minutes. Strengthening exercise was performed 1.9 days per week, and the sitting time per day was 499 minutes. 28.5% of subjects had daily activity restriction, among which restriction due to respiratory problems was revealed in

Table 4. Physical activities of chronic obstructive pulmonary disease patients. (N=151)

Types of physical activities	
High intensity of physical activity	
For work (Y/N/No response)	4(2.6%)/141(93.4%)/6(4.0%)
Days/week	3.3±1.7
Minutes/day	125.0±116.1
For leisure (Y/N/No response)	11(7.3%)/135(89.4%)/5(3.3%)
Days/week	3.3±1.2
Minutes/day	41.4±22.8
Medium intensity of physical activity	
For work (Y/N/No response)	18(11.9%)/128(84.8%)/5(3.3%)
Days/week	3.8±2.2
Minutes/day	122.8±151.2
For leisure (Y/N/No response)	27(17.9)/119(78.5)/5(3.3%)
Days/week	3.8±1.5
Minutes/day	36.7±16.8
Walking exercise frequency	
Days/week	2.2±2.2
Continuous walking time at once	
Minutes/day	38.4±41.3
Strengthening exercise	
Days/week	1.9±1.8
Sitting time	
Minutes/day	499.9±267.9
Daily activity restriction (Y/N/No response)	43(28.5%)/104(68.9%)/4(2.6)
Due to respiratory problem (Y/N/No response)	23(15.2%)/20(13.2%)/108(71.5%)

Note: Data presented as the number (weighted %) for categorical variables or as the mean ± standard deviation for continuous variables. Missing values for each test item were excluded.

Table 5. Quality of life of chronic obstructive pulmonary disease patients. (N=151)

Level	Mobility	Self-care	Usual activities	Pain and discomfort	Anxiety and depression	Index (Korean)
1	96(65.3%)	132(98.8%)	111(75.5%)	92(62.6%)	117(79.5%)	
2	45(30.6%)	14(9.5%)	34(23.1%)	45(30.6%)	26(18.4%)	
3	1(0.7)	1(0.7%)	2(1.4%)	10(6.8%)	3(2.1%)	
Total[a]	147(100%)	147(100%)	147(100%)	147(100%)	146(100%)	0.864±0.198
Percentage reporting some problems[b]	46(31.3%)	15(10.2%)	36(24.5%)	55(37.4%)	29(20.5%)	

Note: Data presented as the number (weighted %) for categorical variables or as the mean ± standard deviation for continuous variables. Missing values for each test item were excluded. [b]'Some problems' = Level 2 + 3

15.2%. However, 53.5% of the subjects who responded complained of daily activity restriction due to respiratory problems.

Table 5. reveals the QoL by using EQ-5D-3L of COPD patients. EQ-5D-3L consists of five items: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. 31.3% and 37.4% of some problems were reported in the "mobility" and "pain and discomfort". In "self-care" showed some problems of 10.2%, "usual activity" 24.5%, and "anxiety and depression" 20.5% of COPD patients demonstrated some problems.

Discussion

The present study investigated the results of the pulmonary function, physical activity, and QoL of 151 COPD patients all examination results of all subjects who participated in the KNHANES for 5 years. Subjective health status was poor, and pulmonary function was all lower than the estimated normal values. In addition, the level of physical activity was also found to be very low, and the QoL showed some problems in "pain and discomfort" and "mobility".

In subjective health status, those who answered "very good" and "good" were 11.9%, and the subjects who answered "bad" and "very bad" were 48.4%. Excluding those who answered "normal", nearly four times the number of subjects answered "bad" and "very bad". It is a natural result, but COPD patients subjectively think of their health status as bad, this suggests that it can negatively affect the mental health and social participation of COPD patients [16, 17].

In the health-related characteristics examined in this study, more than 30 % of the COPD subjects had hypertension, hyperlipidemia, and asthma. Pulmonary function impairment was found to be associated with a more comorbid disease, Global Initiative for Obstructive Lung Disease stage 3 or 4 COPD had a higher prevalence of hypertension and cardiovascular disease [18]. In the health-related characteristics investigated in this study, COPD patients with a history of myocardial infarction or angina pectoris and diabetes were 8.7% and 14.6%, whereas those with hypertension were found to be relatively high at 37.2%. This study showed similar results that the proportion of COPD patients with hypertension was relatively high compared to other diseases, such as COPD patients in the United States [18]. In addition, the risk of cardiovascular disease was found to be high in COPD patients of middle age [19]. It is considered necessary to manage various circulatory diseases through active interventions for COPD patients, including pulmonary rehabilitation.

The American College of Physicians, American College of Chest Physicians, American Thoracic Society, and European Respiratory Society recommended that spirometry can be used to identify airflow obstruction in patients with respiratory symptoms [20]. The present study also evaluated pulmonary function using a spirometer to assess airway obstruction. The FVC and FEV1, which can be evaluated through exhalation, are representative variables. The FVC of COPD patients is an imperative factor in evaluating the clinical outcome and prognosis [21], the FEV1 can evaluate the severity of the airflow limitation which provides important information to enable optimization of management [22]. The subject's FVC was 80.84% of the normal estimate, and FEV1 was 71.29%. In addition, the FEV1/FVC value was about 75% normal [23], but 65% of the subjects in this study. The FEV6, FEF 25-75%, and PEF for evaluating the subject's exhalation were all lower-than-normal estimates. COPD is a disease in which various clinical symptoms appear through decreased pulmonary function due to chronic airway obstruction due to the reduced smooth exhalation of air.

Naturally, all pulmonary functions of Korean COPD patients were found to be lower than normal from the results of this study. Pulmonary function impairment is associated with multiple manifestations of physical functional limitation among COPD patients because of decreased respiratory function. Although COPD is a chronic irreversible disease, various interventions, including pulmonary rehabilitation, are considered necessary to address the manifestations that may occur due to reduced pulmonary function.

Physical activity can be defined as the amount of energy expenditure by the movement of skeletal muscles. It is dependent on various factors such as physiologic, behavioral, social, environmental, and

cultural aspects. Besides, physical activities are correlated with maximal walking distance, level of airway obstruction, and physical health status, the present study surveyed the physical activity of COPD patients [24]. Physical activity is characterized by type, intensity, duration, pattern, routine, and activity-related symptoms [25]. Because COPD patients have significantly lowered physical activity than healthy subjects [8] the present study surveyed high/medium intensity physical activity related to work and leisure. Also, walking exercise frequency, continuous walking time at once, strengthening exercise per week, and sitting time a day was observed.

Only 4.2% of the subjects performed high intensity of physical activity for work, and 11.9% of medium-intensity. In addition, medium intensity of physical activity for work was 7.3%, and leisure was only 17.9%. Walking exercise frequency was 2.2 days per week, and continuous walking time at once was 55.34 minutes. In particular, the strengthening exercise was found to be less than two days per week, and the average sitting time per day was 8 hours and 18 minutes. Although only 43 of the total subjects responded, more than half of them appeared to have restrictions in daily activity due to respiratory problems. It can be considered that it is also a key element to improve the pulmonary function of COPD patients because restriction of daily activity is associated with lowering physical activity [6]

In previous studies, physical activity levels can predict important outcomes in COPD, lower physical activity levels are associated with a higher risk of an exacerbation-related hospitalization [26, 27]. As a result, patients with COPD due to lowered levels of physical activity increase the risk of all-cause mortality after controlling for relevant confounding factors such as admission and exacerbation [28]. From the results of this study, COPD patients need more regular and diverse physical activities and decrease sitting time a day. One of the proper ways to solve this is obviously to further vitalize the pulmonary rehabilitation program to improve the physical function of COPD patients and to obtain positive effects by reducing sedentary time.

Due to the characteristics of COPD, such as airway obstruction, the patients gradually decrease their daily activities. Thus, health-related QoL tends to decrease as COPD severity worsens [29], and impaired health status is a risk factor for exacerbations of the respiratory problem and hospitalization [30]. The present study surveyed the EQ-5D-3L, and the highest percentage of reporting some problems was “pain and discomfort”. The EQ-5D-3L scores are correlated with validated measures of disease severity including COPD admission, comorbidities, and physical activity [31]. The health-related QoL can be changed depending on variations of pulmonary function and physical activity in COPD patients [28, 32], it is an important factor to manage the QoL of COPD patients by improving the level of pulmonary function and physical activity. The present study showed that over 30% complained of some problems with “pain and discomfort” and “mobility”. Considering that the rate of complaints of discomfort to “mobility” was high, it is thought the improvement of the quality of life is necessary by increasing the physical activity of COPD patients such as regular exercise programs and pulmonary rehabilitation. This is because the pulmonary rehabilitation program includes not only improvement of pulmonary function but also endurance, flexibility, and strengthening exercises [33]. In future studies, it is considered necessary to compare the QoL with subjects without COPD to understand the actual level of decline in the QoL of patients with COPD.

Limitations of this study

This study has several limitations. First, the results of the present study may not be generalized to patients with COPD in other countries because many studies presented were related to South Korea. Another limitation, since the data of physical activity and QoL of KNHANES is a cross-sectional and self-reporting questionnaire, the results of this study is having weak evidence for COPD patients. Therefore, longitudinal studies are needed to confirm the exact level of physical activities and QoL. The third limitation was that this study compared the physical activities and health-related QoL with COPD patients, other factors had to be investigated to clarify the specific features of COPD. However, these factors affect COPD patients' medical status, and daily life, future research may be necessary to determine the specific features

that affect COPD patients depending on the patient's condition. In addition, it is considered necessary to identify specific differences in comparison with the same variables surveyed in the general subjects without COPD.

Conclusion

The proportion of Korean COPD patients with the circulatory disease was relatively high, and more than half of the respondents complained of activity restriction due to respiratory problems. Pulmonary function was lower than normal estimates, and the rate of regular physical activity was also very low. In QoL, it was found that the highest reporting rate of some problems was “pain and discomfort” and “mobility”. These impairments occur naturally due to decreased pulmonary function, and it is necessary to pursue functional improvement in COPD patients through pulmonary rehabilitation.

Disclosure

Kyeongbong Lee is a professor of the Department of Physical Therapy, Kangwon National University, Samcheok, Korea, but he made no influence on this work in relation with the company or its products.

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Conflict of interest

The author confirms there is no conflict of interest.

Patient consent

This study obtained the written informed consent of the participants.

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