Gender differences in pulmonary function, physical activity, and quality of life of patients with COPD based on data from the Korea National Health and Nutrition Examination Survey 2015 to 2019 from the Perspective of Pulmonary Rehabilitation

Kyeongbong Lee, PT, PhD[a], HyoSun Lee, PT, BSc[b], KyungJune Lee, PPOL, PhD[c], SungKyun Hong, PT, PhD[d], HyeonHui Shin, OT, MSc[e], GyuChang Lee, PT, PhD[f],* (ID)

Abstract

The prevalence of chronic obstructive pulmonary disease (COPD) is increasing worldwide, with the fourth highest mortality rate. This study aims to analyze pulmonary function, physical activity, and quality of life (QoL) between genders from the perspective of pulmonary rehabilitation in Korean patients with COPD. This study investigated raw data from the Korea National Health and Nutrition Examination Survey from 2015 to 2019 and included 151 COPD patients (men: 66.55 ± 10.07 years, women: 65.21 ± 11.73) out of 39,759 participants. Pulmonary function, such as forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1), and frequency of physical activities (e.g., physical activity for work and leisure, strengthening exercise, and sitting time a day) and QoL by using EQ-5D-3L, were compared between genders in patients with COPD. Smoking status differed in health-related characteristics between genders ($P < .001$). In pulmonary function, the FVC (men: 3.48 ± 0.98ℓ, women: 2.53 ± 0.56ℓ, $P < .05$), FEV1 (men: 2.13 ± 0.93 ℓ, women: 1.88 ± 0.53 ℓ, $P < .001$), FEV6 (men: 3.16 ± 1.00ℓ, women: 2.46 ± 1.56ℓ, $P < .001$) and peak expiratory flow (men: 5.61 ± 2.44ℓ/s, women: 4.68 ± 1.53ℓ/s, $P < .05$) was higher in men, however, predicted FEV1 (men: 66.03% ± 23.13%, women: 79.95% ± 18.45%, $P < .05$) and predicted FEV1/FVC ratio (men: 59.67% ± 15.02%, women: 74.10% ± 10.49%, $P < .001$) in women. The frequency of strengthening exercise was higher in men ($P < .05$). QoL of patients with COPD was not significantly different between genders. To provide correct interventions and pulmonary rehabilitation to patients with COPD, gender differences, including physiological and psychological differences, must be considered.

Abbreviations: COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in one second, FEV6 = forced expiratory volume in six seconds, FVC = forced vital capacity, KNHANES = Korea National Health and Nutrition Examination Survey, PEF = peak expiratory flow, PFT = pulmonary function test, QoL = quality of life.

Keywords: chronic obstructive pulmonary disease, physical activity, pulmonary function, quality of life

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive lung disorder with long-term respiratory symptoms and restricted airflow. In 2018, 156,045 people died from COPD in the United States. It appeared as the fourth leading cause of death after heart disease, cancer, and unintentional injuries, and the third disease-related cause of death.[1] Since the 20th century, the importance and interest in COPD have become crucial due to the increase in smoking, and various environmental causes.[2]

Deaths caused by COPD are increasing and the prevalence is similar among men and women.[3] Since COPD is considered

a disease that predominantly affects men, it is rarely diagnosed in women. In 2018, the Centers for Disease Control and Prevention reported that the number of deaths due to COPD was higher among women than among men (82,158 vs 73,877). However, the death rate was higher among men (42.9 vs 35.8 per 100,000) because the population of women with COPD is larger than that of men with COPD.[1]

Despite the need to focus more attention on this health issue in women due to the increasing prevalence of COPD among women, men still have a higher diagnostic appropriateness than women. This gender difference disappears when doctors know the significance of using spirometry to assess pulmonary function.[4] Although there are no significant clinical differences between men and women, the diagnosis of COPD is more common than in men.[5] However, there are many differences between these patients regarding gender, and it is necessary to increase an understanding of COPD based on gender in research and pulmonary rehabilitation.

Biological factors should be considered for gender-based differences between men and women with COPD, such as the anatomy and physiology of the airways, life expectancy (menopause and aging), and the potential interaction with sex hormones.[6] Moreover, there are differences in sociocultural and behavioral aspects; for example, women are less likely to answer "yes" to questions about sputum and phlegm production.[7] A previous study that matched participants based on age and level of airflow obstruction reported that women with COPD had a higher body weight and presented with obstruction and dyspnea.[8] Another study revealed that women reported less mucus and rated their health poor/very poor.[9] Furthermore, women with COPD report symptoms earlier than men, and because women being ill is socially more acceptable, they seek health care in hospitals and clinics and are thus better prepared to make medical decisions.[10]

There are various implications for prevalence, recognition, biological/clinical differences, and gender in COPD patients. This study aims to investigate the health-related characteristics, lung function, physical activity, and quality of life (QoL) of COPD patients in South Korea. In particular, this study aims to provide a reference that can be approached for pulmonary rehabilitation inclusively based on gender.

2. Methods

2.1. Participants

This study was conducted to compare the pulmonary function, physical activity, and QoL of Korean patients with COPD by gender using raw data from the Korea National Health and Nutrition Examination Survey (KNHANES). The KNHANES was researched based on the World Health Organization's recommendations, and the institutional review board of the Korea Centers for Disease Control and Prevention has approved these data (2018-01-03-P-A and 2018-01-03-C-A). The KNHANES is the open statistical data of South Korea, which is carried out annually after sampling using the laminar collection system extraction method. In this study, the KNHANES data from 2015 to 2019 were vertically integrated, and 39,759 pieces of information were collected. The data from 151 patients with COPD, diagnosed by a doctor, were extracted for analysis from these participants (Fig. 1).

2.2. Demographic and health-related characteristics

Information for the baseline demographics and health-related characteristics, including depression, hypertension, lipidemia, stroke, myocardial infarction, asthma, diabetes mellitus, and activity restriction, was achieved through the KNHANES. The differences in the demographic and health-related characteristics of patients with COPD by gender are shown in Table 1.

2.3. Pulmonary function

For calculating the pulmonary function of patients with COPD, the pulmonary function test (PFT) values of the KNHANES were analyzed. The PFT used in KNHANES was a noninvasive test and evaluated lung volume, capacity, and flow rate. The PFT was performed by the recommendations of the American Thoracic Society.[11] In KNHANSE of 2015, a dry rolling seal Spirometer (Ohio No. 822; Ohio Medical Products; Madison, Wis) was used for PFT and Vyntus Spirometer (Master Screen PFT, Hochberg, Germany) from 2016 to 2019. Forced vital capacity (FVC), forced expiratory volume in one second (FEV1), forced expiratory volume in six seconds (FEV6), and peak expiratory flow (PEF), predicted FVC, predicted FEV1, and percentage of FEV1/FVC were selected and compared by gender as the pulmonary function variables.

2.4. Physical activity

The level of physical activity can be assessed through the International Physical Activity Questionnaire for those aged 16 to 65 years. The International Physical Activity Questionnaire is divided into long- and short forms. Based on KNHANES data, a short form was used to assess physical activity in Koreans and provided reliability and validity.[12] This study surveyed all types of physical activity from KNHANES. Furthermore, we compared the high/medium intensity of physical activity for work and leisure, continuous walking time at once, strengthening exercise, and sitting time.

2.5. QoL

Self-reported health-related QoL was evaluated using the Korean version of the EuroQol-5 Dimension (EQ-5D)-3L questionnaire based on the standard proposed by the Korean Centers for Disease Control and Prevention. The EQ-5D-3L is a descriptive classification asking respondents about their
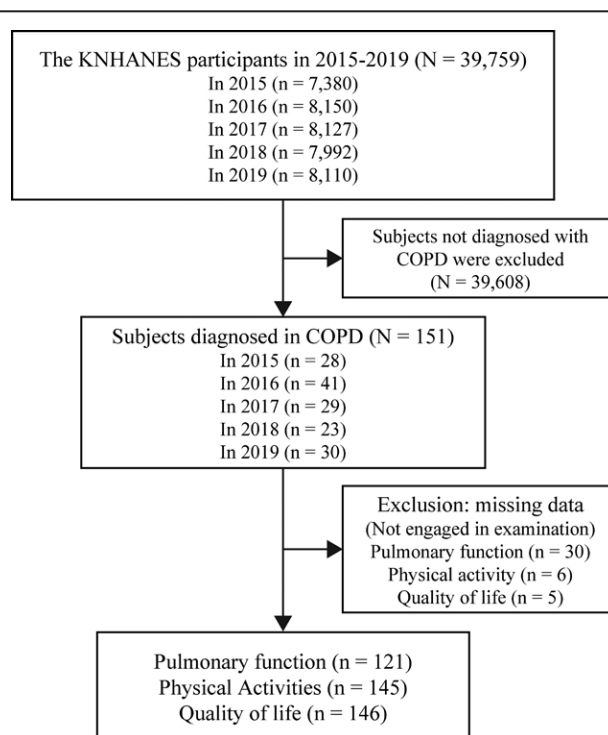

Figure 1. Flow chart of the present study for pulmonary function, physical activities and quality of life of patients with COPD. COPD = chronic obstructive pulmonary disease.

Table 1

Demographic and Health-related characteristics of chronic obstructive pulmonary disease patients by gender in Korea National Health and Nutrition Examination Survey (N = 151).

	Men (N = 93)	Women (N = 58)	*P* value
Anthropometry			
Age (yr)	66.55 ± 10.07	63.21 ± 11.73	>.05
Height (cm)	167.09 ± 5.95	151.67 ± 21.25	<.05
Weight (kg)	63.95 ± 10.18	56.74 ± 10.26	<.05
Waist circumference (cm)	85.43 ± 9.43	81.65 ± 11.31	<.05
BMI (kg/m^2)	22.84 ± 3.03	23.15 ± 4.60	>.05
Health-related characteristics			
SBP	123.85 ± 15.07	124.36 ± 18.44	>.05
DBP	73.45 ± 10.04	73.14 ± 9.76	>.05
Pulse pressure	50.40 ± 13.78	51.22 ± 16.02	>.05
Depression diagnosis (Y/N)	3 (3.3%)/88 (96.7%)	6 (10.7%)/50 (89.3%)	>.05
HTN diagnosis (Y/N)	41 (44.1%)/52 (55.9%)	19 (32.8%)/39 (67.2%)	>.05
Lipidemia diagnosis (Y/N)	27 (29.0%)/66 (71.0%)	20 (34.5%)/38 (65.5%)	>.05
Stroke diagnosis (Y/N)	4 (4.4%)/87 (95.6%)	1(1.8%)/55 (98.2%)	>.05
MI or angina pectoris diagnosis (Y/N)	9 (9.7%)/84 (90.3%)	4 (6.9%)/54 (93.1%)	>.05
Asthma diagnosis (Y/N)	29 (31.9%)/62 (68.1%)	18 (32.1%)/38 (67.9%)	>.05
DM diagnosis (Y/N)	14 (15.1%)/79 (84.9%)	8 (13.8%)/50 (86.2%)	>.05
Activity restriction (Y/N)	27 (29.7%)/64 (70.3%)	16 (28.6%)/40 (71.4%)	>.05
Due to respiratory problem (Y/N)	16 (59.3%)/11 (40.7%)	7 (43.8%)/9 (56.3%)	>.05
Smoking history			<.001
Never	8 (8.8%)	49 (86.0%)	
Current smoking	81 (89.0%)	8 (14.0%)	
Smoking cessation	2 (2.2%)	0 (0.0%)	

Data presented as the number (weighted %) for categorical variables or as the mean ± standard deviation for continuous variables. Missing values for each variable were excluded.
BMI = body mass index, DBP = diastolic blood pressure, DM = diabetes mellitus, MI = myocardial infarction, SBP = systolic blood pressure.

current health status. It consists of a classification into 5 health conditions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression with 3 levels: no problems; some or moderate problems; and extreme problems.[13] Respondents select an answer for a health condition out of 5 items, and 243 types can be expressed. This health status can be evaluated by converting it to the EQ-5D-3L index, which is set differently for each country. The Korean version was calculated for this study data. The index is calculated from –0.171 to 1.000, the former means a severe problem, and the latter means there is no problem. A negative score means worse than death, 0 means death, and 1 means perfect health. The validity and reliability of the Korean version of EQ-5D-3L in participants with various diseases have been reported in previous studies.[14,15]

2.6. Statistical analysis

This study analyzed data according to the KNHANES data analysis guidelines. Raw data from KNHANES from 2015 to 2019 were vertically integrated and analyzed. The Kolmogorov–Smirnov test was performed to assess the normality of continuous data. Descriptive information was obtained to examine the demographic and health-related characteristics of patients with COPD with respect to gender. The chi-square test was used for categorical variables, and continuous variables were compared using Student's *t* test. The categorical variables of the EQ-5D-3L questionnaire that evaluated QoL were expressed as the number and percentage of answers for each item. Statistical analyzes were performed using the Statistical Package for the Social Sciences version 23.0 software (IBM Corp., Armonk, NY); results were considered significant with a *P* value of < .05. A retrospective sample size was calculated based on FEV1 values, which is one of the main variables to assess the severity of pulmonary obstruction. The present study referred to a previous study that investigated the sex-based differences among patients with COPD for pulmonary function; the mean and standard

deviation of the FEV1 values were used to estimate an appropriate sample size.[16] Although patients with COPD have various symptoms, such as difficulty in breathing normally due to decreased expiration of air, FEV1 is an important criterion in determining the grade of the disease. Sample size was calculated based on the FEV1 value used in a previous study that reported sex differences in patients with COPD. To compare the mean difference between the 2 groups, the mean and standard deviation of the FEV1 were used based in Student's *t* test hypothesis. The α value was set at 0.05, and the power was 80% (G*power 3.1.7, Kiel, University, Germany). Considering this reference, data for 48 participants was calculated, and the number of participants in each group was 27 and 21, respectively.

3. Results

There was a significant difference in demographic characteristics, except for body mass index, *P* < .05). Health-related characteristics, such as hypertension, lipidemia, myocardial infarction, asthma, and restriction of activity due to respiratory problems, did not show a difference. However, smoking history was significantly different between genders (*P* < .001).

In pulmonary function, FVC (*P* < .05), FEV1 (*P* < .001), FEV6 (*P* < .001), and PEF (*P* < .05) were significantly higher in men than in women. However, the predicted FEV1 (*P* < .05) and the FEV1/FVC ratio (*P* < .001) were significantly higher in women than in men (Fig. 2).

There were no significant differences in physical activities with a high/medium intensity of physical activity for work and leisure (Table 2), as well as continuous walking time at once and time to sit per day. However, the frequency of strengthening exercises performed per week was significantly higher in men (*P* < .05).

In health-related QoL, there were no significant differences between genders for the 5 health conditions and the EQ-5D index, indicating that "some problem" reports were higher in women in the 4 categories of health conditions (Table 3).
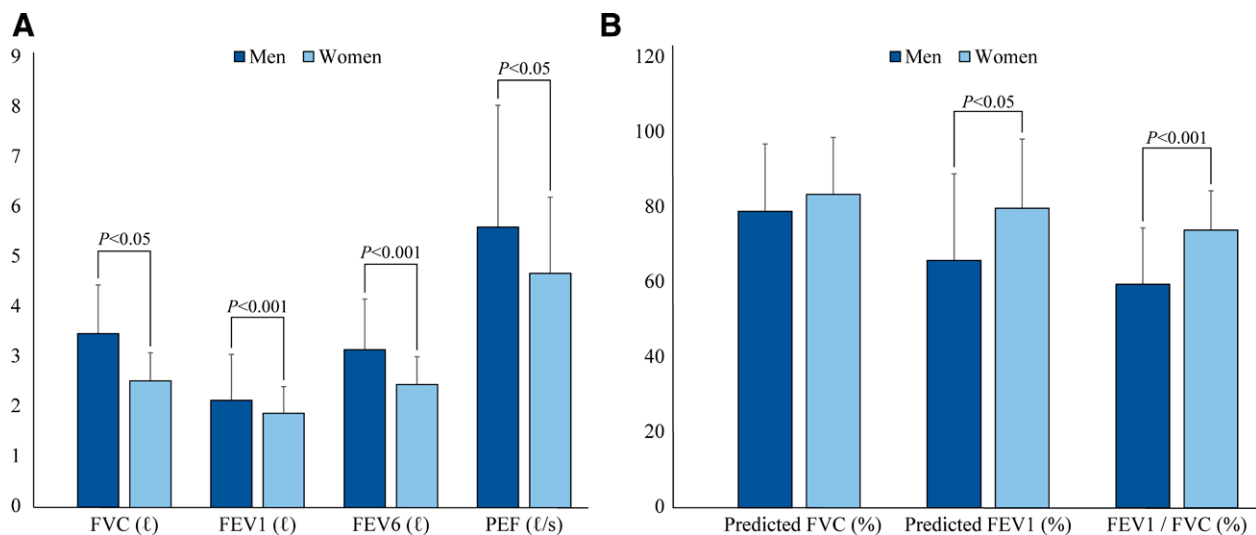
Figure 2. The differences in pulmonary function of patients with COPD by gender in the Korea National Health and Nutrition Examination Survey. COPD = chronic obstructive pulmonary disease.

Table 2

Differences of physical activity of chronic obstructive pulmonary disease patients by gender in Korea National Health and Nutrition Examination Survey (N = 145).

	Men (N = 93)	Women (N = 58)	P value
High intensity of PA for work (Y/N)	3/86	1/55	>.05
D/wk	0.10 ± 0.61	0.07 ± 0.53	>.05
Min/d	5.05 ± 32.92	0.52 ± 3.94	>.05
Medium intensity of PA for work (Y/N)	10/80	8/48	>.05
D/wk	7.45 ± 1.78	7.67 ± 1.19	>.05
Min/d	12.37 ± 67.38	18.28 ± 60.47	>.05
High intensity of PA for leisure (Y/N)	7/83	4/52	>.05
D/wk	7.67 ± 1.36	7.72 ± 1.82	>.05
Minutes/d	3.06 ± 13.38	2.07 ± 9.51	>.05
Medium intensity of PA for leisure (Y/N)	21/69	6/50	>.05
Days/wk	7.13 ± 1.85	7.52 ± 1.59	>.05
Minutes/d	7.90 ± 16.42	4.40 ± 14.45	>.05
Continuous walking time at once			
Minutes/d	36.24 ± 39.84	36.29 ± 40.72	>.05
Strengthening exercise			
Days/wk	4.92 ± 2.27	4.43 ± 2.39	<.05
Time to sit			
Min/d	506.02 ± 262.82	490.17 ± 277.95	>.05

Data presented as the number (weighted %) for categorical variables or as the mean ± standard deviation for continuous variables. Missing values for each variable were excluded.
PA = physical activities.

4. Discussion

This study compared pulmonary function, physical activity, and QoL of patients with COPD in terms of gender through KNHANES data for 5 years (2015–2019). The pulmonary function of patients with COPD in South Korea was different regarding gender, with the absolute value higher in men, and the predicted value higher in women. However, besides the frequency of strengthening exercise, physical activity was not significantly different between genders. The QoL results show that women report a high rate of "some problems," which corresponds to "level 2: some or moderate problems" and "level 3: extreme problems" out of 3 items, suggesting that a treatment and pulmonary rehabilitation approach from the perspective of the sex of patients with COPD is necessary.

In general, the anthropometry of men is higher than women. Therefore, the demographic characteristics of the Korean COPD participants differed in height, weight, and waist circumference,

and there was no difference in age and body mass index. There were no differences in the health-related characteristics investigated in this study. However, women are more likely to have higher body weight, obstruction, and dyspnea scores due to a lower body mass index.[8] Another study reported that asthma, fractures, osteoporosis, rheumatoid arthritis, and depression/anxiety were more prevalent in women. Type I and II diabetes mellitus, kidney disease, and cardiovascular disease were more prevalent in men.[17] According to previous studies, it is considered necessary to conduct more research on health-related characteristics according to the gender of patients with COPD.

However, there was a clear difference in smoking status: 8% of men and 48% of women had never smoked, 81% of men and 14% of women are currently smoking, and 2.2% of men are nonsmoking. Smoking prevalence among women has increased in several countries. The smoking rate of men has decreased by half, but the smoking rate of women in their 20 and 40 seconds has doubled over the past 20 years in South Korea.[18] Although

Table 3

Differences of quality of life of chronic obstructive pulmonary disease patients by gender in Korea National Health and Nutrition Examination Survey (N = 146).

Level	Mobility		Self-care		Usual activities		Pain and discomfort		Anxiety and depression		Index	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
1	62 (66.7%)	34 (58.6%)	83 (89.2%)	49 (84.5%)	68 (73.1%)	43 (74.1%)	61 (65.6%)	31 (53.4%)	76 (81.7%)	41 (70.7%)		
2	26 (28.0%)	19 (32.8%)	7 (7.5%)	7 (12.1%)	22 (23.7%)	12 (20.7%)	27 (29.0%)	18 (31.0%)	13 (14.0%)	13 (22.4%)		
3	3 (3.2%)	3 (5.2%)	1 (1.1%)	0 (0.0%)	1 (1.1%)	1 (1.7%)	3 (3.2%)	7 (12.1%)	2 (2.2%)	2 (3.4%)		
Missing	2 (2.2%)	2 (3.4%)	2 (2.2%)	2 (3.4%)	2 (2.2%)	2 (3.4%)	2 (2.2%)	2 (3.4%)	2 (2.2%)	2 (3.4%)	2 (2.2%)	2 (3.4%)
Total*	93 (100%)	58 (100%)	93 (100%)	58 (100%)	93 (100%)	58 (100%)	93 (100%)	58 (100%)	93 (100%)	58 (100%)	0.890 ± 0.169	0.841 ± 0.206
χ^2 (p)/t (p)	1.208 (0.751)		1.738 (0.628)		0.458 (0.922)		5.358 (0.147)		3.055 (0.383)		1.572 (0.118)	
Percentage reporting some problems†	31.2%	38.0%	8.6%	12.1%	24.8%	22.4%	32.2%	43.1%	15.1%	25.8%		

Data are expressed as frequencies and percentages, n (%).

*Results are for those who responded to questionnaire. 98.7% of respondents to EQ-5D-3L.

†"Some problems" = Level 2 + 3.

the average age of Korean women with COPD was approximately 63 years, and the smoking rate was higher in men, based on the trend of a significant increase in the smoking rate of young women, it is considered necessary to emphasize the importance of women's cessation of' smoking to prevent worsening and reduce the prevalence among women with COPD. FEV1, one of the important indicators of pulmonary obstruction, was reported to have a higher annual rate of decline in women than in men, even if the amount of smoking was less.[19] Further, women have a 2.5 times higher rate of improvement in FEV1 than men in the first year of quitting smoking.[20] In addition to socioeconomic and occupational factors, women are gradually becoming more susceptible to smoking and air pollutants.[21] Although women are younger and smoke less, they have the same level of airflow limitation as men.[22] Women who smoke have more severe lung damage than men among patients with COPD.[23] In the case of men with COPD, quitting smoking is even more important, because they still have a higher rate of smoking than women, causing increased cough and sputum production.[24] Pulmonary rehabilitation requires physical therapy to improve pulmonary function, and a multidisciplinary approach; therefore, it is necessary to understand the effects of smoking cessation and gender.

Pulmonary function can be affected by the size of the lungs and the body's muscle mass. For example, women with similar anthropometry to men have lower lung capacity, flow volume, and rates than men due to their biologically small lung volume.[25] Pulmonary function, such as FVC, FEV1, FEV6, and PEF, was higher in men than in women among Korean patients with COPD. The results of the present study were similar to those of the previous study, which may be due to differences in biological and anthropometric characteristics between genders.

Predicted FEV1 is a value obtained by dividing the subject's FEV1 by the average FEV1 of people of similar age, sex, and body composition. The normal range of predicted FEV1 and the percentage of FEV1/FVC is from 80% to 120%.[26] In patients with COPD, the value of FVC and FEV1 is decreased due to the difficulty of expelling air from the lungs.[27] Also, the percentage of FEV1/FVC used to diagnose restrictive and obstructive pulmonary disease decreases in patients with COPD. The predicted FEV1 and the percentage of FEV1/FVC were higher in women than in men in the present study. This means that the obstruction level in women is lower than in men. In general, the severity of COPD is classified according to the predicted value among the PFT results.[28] The predicted value calculated by similar age, gender, and body composition was higher in women. It is considered related to the difference in smoking history within the

variables surveyed in this study. Although FVC, FEV1, FEV6, and PEF were higher in men than in women due to the difference in biological and anthropometric characteristics,[25] the predicted value, one of the criteria for classifying the levels of obstruction and restriction of pulmonary diseases, was higher in women. The main cause of the prevalence of COPD is smoking.[29] Given that the smoking rate of men with COPD in South Korea is significantly higher than women, it is necessary to consider the difference between gender and managing pulmonary rehabilitation to improve independence and functional status. Although the value of pulmonary function itself tends to be higher in men, the predicted value and the smoking rate are lower than in women, so healthcare providers will have to communicate this to the patient during pulmonary rehabilitation procedures. In addition, they must share that the damage to pulmonary function caused by smoking is greater for women than men, although the women's smoking rate is better than that in men.

Physical activity refers to any body movement caused by skeletal muscle that requires energy expenditure.[30] Patients with severe COPD have decreased physical activity that causes body movements, such as walking and standing.[31] Daily physical activity and exercise capacity were reported to be very low compared to people of similar age, BMI, and sex.[32] Physical activity had significant associations with decreased lung function,[33] readmissions to the hospital,[34] and mortality[35] in patients with COPD. On the other hand, patients with COPD with active physical activity showed a better functional status and systemic inflammation conditions.[36] As a result, the level of physical activity level is consistently associated with mortality and exacerbations.[37]

In this study, the frequency of strengthening exercise per week was higher in men, and there was no difference by gender in high/medium intensity of physical activity for work and leisure, continuous walking time at once and time to sit a day. It was remarkable that most of the participants did not perform physical activity, and the time and frequency of performing physical activity were not significantly different between male and female COPD patients. COPD is a chronic disease, and physical activity has many benefits for patients with COPD. Therefore, physical activity should be improved, especially in Korea, where patients with COPD have very low levels of physical activity. Furthermore, when providing education and intervention to patients with COPD, such as managing a pulmonary rehabilitation program, the importance of physical activity should be emphasized. Healthcare providers should educate COPD patients on the importance of regular and proper physical

activity in daily life and consistent participation in proper medication and pulmonary rehabilitation.

EQ-5D-3L is one of the tools to evaluate QoL that has been reported to have construct validity and test-retest reliability in a study with COPD patients.[38] In dimensions of "mobility," "self-care," "usual activities," "pain and discomfort," and "anxiety and depression," gender statistical differences were not revealed. However, the percentage of women reporting "some problems" was greater among women in most categories, especially "anxiety and depression," at >10%.

In asthma, one of the obstructive pulmonary diseases, because the perception of dyspnea by women was higher than that of men, their sensitivity to this symptom increased, resulting in a lower overall QoL.[39] Anxiety and depression are the strongest predictors of reduced QoL.[40] The incidence of comorbidities of anxiety and depression is higher in women with COPD.[36,37] Anxiety can also lead to a stronger perception of respiratory failure, resulting in emotional agitation in breathing and a "dyspnea-anxiety-dyspnea cycle."[41] Among patients with emphysema, one of the obstructive pulmonary diseases predicted, women with a similar predicted FEV1, age, smoking status, or severity reported more severe dyspnea than men due to mental health problems, resulting in decreased QoL.[42] Furthermore, since patients complaining of anxiety and depression are less likely to complete pulmonary rehabilitation, anxiety and depression may be one of the risk factors for future exacerbation.[43] In the case of Korean patients with COPD investigated in this study, the proportion of "some problem" was higher in women than in men. More than 10% of responses were shown in the dimensions of "pain and discomfort" and "anxiety and depression," showing results similar to previous studies. This result informs that healthcare providers must consider gender differences in COPD patients when providing intervention or pulmonary rehabilitation. Appropriate approaches will be possible by recognizing differences in the QoL of patients with COPD and to gender. Additionally, healthcare professionals will need to conduct more precise research and therapeutic approaches to women with COPD after better understanding these differences.

Decision-making can improve the systematic treatment of patients with COPD. A clear understanding of gender differences can help set interventions and approaches appropriately. Sex has a comprehensive meaning for anatomical and physiological characteristics, and gender refers to men and women who interact with sex, biological, physical, and social characteristics.[44] Sex and gender are interrelated, but gender has a meaning that includes various elements related to health. Therefore, it is necessary to approach pulmonary rehabilitation from the perspective of understanding the differences by gender, and further research on factors that have not yet been recognized will be needed.

4.1. Limitations

In the present study, there were several research limitations. First, a potential confounding bias cannot be excluded as this is a retrospective cross-sectional study. Although the data of the participants diagnosed with COPD by the doctor were investigated, the data were not classified according to the severity of the disease of the subject, and regular use of medications and participation in treatment were not confirmed. Second, as this study analyzed the data only for adult Korean patients with COPD, it cannot be generalized to other countries and races. It is difficult to apply to other healthcare systems. More research is expected to be needed to identify the characteristics of COPD patients according to sex through integrated data analysis with other countries. Third, because the result of physical activity is a response to the frequency recently performed, long-term follow-up data on physical activity should be used as basic data for pulmonary rehabilitation in such patients. Despite these limitations, this study

is the first to analyze the difference in pulmonary function in Korean patients with COPD investigated by KNHANES and provided a reference for the execution of pulmonary rehabilitation.

5. Conclusions

Globally, the prevalence and mortality of COPD are continuously increasing. Therefore, it is necessary to understand the various characteristics of patients diagnosed with COPD, and recognize that there are differences in pulmonary function based on gender. The present study showed the difference in smoking status, pulmonary function, and frequency of strengthening exercise among the physical activity in Korean patients with COPD and gender, and similar QoL results as in previous studies. Smoking is the biggest risk factor for COPD, and with the increasing trend of smoking among women, various activities are warranted for women to stop smoking. Although the predicted percentage of pulmonary function is higher in women in many respects, weak points are more common in women with COPD. Both men and women showed a very low level of physical activity, and daily care is required to improve this level. Recognizing that there are differences in Korean patients with COPD based on gender, appropriate prevention, and intervention, especially pulmonary rehabilitation, is warranted to understand the weaker factors in individual sexes.

Author contributions

Conceptualization: Kyeongbong Lee.
Data curation: Kyeongbong Lee, HyoSun Lee, SungKyun Hong, HyeonHui Shin.
Formal analysis: Kyeongbong Lee, KyungJune Lee.
Investigation: HyoSun Lee, SungKyun Hong, HyeonHui Shin.
Project administration: Kyeongbong Lee, HyoSun Lee, SungKyun Hong, HyeonHui Shin.
Resources: Kyeongbong Lee, GyuChang Lee.
Supervision: HyoSun Lee, SungKyun Hong.
Validation: HyoSun Lee.
Visualization: Kyeongbong Lee, GyuChang Lee.
Writing – original draft: Kyeongbong Lee.
Writing – review & editing: KyungJune Lee, GyuChang Lee.

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