Original Article

Correlation Between 6-Minute Walk Distance, Severity of Airflow Limitation and Dyspnea Score in COPD Patients: A Retrospective Study

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ABSTRACT

Objectives: To determine the correlation between 6-minute walk distance (6MWD) and severity of airflow limitation as well as modified Medical Research Council (mMRC) dyspnea score in Chronic obstructive pulmonary disease (COPD) patients

Study design: Retrospective study

Setting: Outpatient Rehabilitation Clinic, Trang Hospital.

Subjects: Patients diagnosed with COPD who completed the 6-minute walk test (6MWT) between January 1, 2022 and December 31, 2023.

Methods: The patients' baseline characteristics were obtained from medical records. The Forced Expiratory Volume in one second (FEV_1), 6MWD, and mMRC dyspnea scores were collected and analyzed.

Results: One hundred and ninety-seven patients with COPD were recruited, of whom 91.9% were male. The average 6MWD was 403.4 meters (SD=78.4). Half the patients had moderate COPD. The majority of the patients had an mMRC dyspnea score of 1. There was a weak positive correlation between 6MWD and FEV_1 ($r = 0.299$, $p < 0.001$) and a weak negative correlation between 6MWD and mMRC dyspnea score ($r = -0.266$, $p < 0.001$). However, there was a strong negative correlation between 6MWD and the mMRC dyspnea score ($r = -0.727$, $p < 0.05$) in patients with very severe degree COPD.

Conclusions: The study showed a significant weak correlation between 6MWD and FEV_1 as well as 6MWD and mMRC dyspnea score. However, in patients with very severe COPD, the correlation between 6MWD and mMRC dyspnea score was stronger than in others. This suggests that 6MWT and mMRC dyspnea score should be routinely evaluated in patients with COPD to monitor clinical change.

Keywords: chronic obstructive pulmonary disease, 6-minute walk distance, dyspnea score, forced expiratory volume in one second

ASEAN J Rehabil Med. 2025; 35(1): 42-45.

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the three leading causes of death worldwide, and 90% of these deaths occur in low- and middle-income countries. More than 3 million people died of COPD in 2012, accounting for 6% of all deaths globally.[1] According to Thailand's medical and public health data center, there were 473,214 COPD patients in 2023, with 13,522 new COPD cases, an increase from the 8,014 new cases in 2022. In 2023, a total of 20,888 patients died of COPD, a rate which continued to increase from 2021 and 2022.[2] For this reason, COPD, a significant public health challenge that is both preventable and treatable, has led to one of the service plans for health system development projects in the field of non-communicable diseases in 2017 which is aimed at reducing the incidence of acute exacerbations and establishing comprehensive and standardized COPD clinics.[3]

COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, coughing, sputum production including exacerbation of those symptoms) due to abnormalities of the airways (bronchitis, bronchiolitis) or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction. COPD is usually caused by significant exposure to noxious particles or gases.[1] From airway inflammation and abnormal inflammatory response in the lung, these pathological changes result in increased resistance to airflow in the small conducting airways, air trapping, and progressive airflow obstruction, which affects gas exchange, causing hypercapnia and hypoxemia, resulting in dyspnea.[4,5] COPD should be considered if the patient has difficulty breathing, chronic cough with or without sputum, and frequent lower respiratory tract infections with a history of exposure to risk factors. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline, spirometry is the gold standard for diagnosing COPD. If the ratio of forced expiratory volume in one second (FEV_1) to forced vital capacity (FVC) is less than 70% after bronchodilator administration, the patient is diagnosed with COPD.[1]

COPD severity can be classified based on airflow limitation using the FEV_1. GOLD grade I (mild degree) is defined as a FEV_1 equal to or greater than 80% of the predicted value; GOLD grade II (moderate degree) as an FEV_1 between 50%

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Received: April 16, 2024 Revised: August 19, 2024 Accepted: September 3, 2024

and 79% of the predicted value; GOLD grade III (severe degree) as an FEV_1 between 30% and 49% of the predicted value; and GOLD grade IV (very severe degree) as an FEV_1 equal to or less than 30% of the predicted value.[1] Lower FEV_1 indicates greater severity of the disease. However, many studies have shown that FEV_1 correlates with disease severity less than other clinical parameters such as dyspnea, quality of life, and functional capacity.[6] That suggests FEV_1 should not be used alone to assess disease severity.

Dyspnea is the most common symptom of COPD. The modified Medical Research Council (mMRC) dyspnea score is used to assess dyspnea and is based on five stages of dyspnea ranging from 0 (No dyspnea) to exertion 4 (dyspnea at rest). The mMRC dyspnea score is closely related to other multidimensional health status measures and can be used to predict future mortality risk.[1]

The 6-minute walk distance (6MWD) is a field test used to assess the functional status of patients with COPD. It was introduced in 1976 as a 12-minute walk test to measure exercise capacity for patients with chronic lung disease and was later reduced to six minutes. The 6-minute walk test (6MWT) can be used as a clinical, functional capacity indicator. The purpose of the 6MWT is to evaluate exercise tolerance, monitor therapy, and predict prognosis in patients with chronic respiratory diseases like COPD, interstitial lung disease (ILD), pulmonary hypertension (PH), chronic heart failure, lung transplant and heart-lung surgery as well as to evaluate the functional capacity of the elderly.[7] The test measures walking distance in six minutes at maximal intensity, reflecting the patient's functional exercise capacity for daily physical activity. 6MWT is a reproducible, simple, and inexpensive test. Studies have also found that the 6MWD can be used to monitor clinical changes in COPD better than the FEV_1, which is a less sensitive parameter for detecting clinical changes, especially in the late stage of the disease.[8] A study by Pinto-Plata et al. [9] showed that the level of exercise capacity was a better predictor of mortality than FEV_1. However, other studies have found that many factors can affect exercise capacity in COPD patients. For example, there are pulmonary and non-pulmonary factors associated with a reduced 6MWT performance. Some non-pulmonary factors, such as mMRC dyspnea score and depression score, are more important to and more consistently associated with walking distance compared to the pulmonary parameters.[6,9]

Spirometry is a noninvasive test for diagnosing and assessing airflow limitation in COPD; however, it is not available in every hospital due to a lack of personnel and equipment. Moreover, it takes time to evaluate, making it less convenient for outpatient visits. In contrast, the 6MWT and assessment of dyspnea by mMRC dyspnea scores is easier to conduct and can be performed in all hospitals including those in rural areas. Studies of the correlation between the 6MWD and the severity of airflow limitation as indicated by FEV_1, as well as the mMRC dyspnea score, are still limited in Thailand. The present study aimed to explore these correlations in COPD patients classified by severity level and to use that information for planning future management.

Method

Study design

This research was a retrospective study. The protocol of the study was approved by the Trang Hospital Research Ethics Committee (Certificate No. ID 006/02-2567).

Participants

The study was carried out in Trang Hospital's Rehabilitation Medicine Department. Patients diagnosed with COPD (GOLD criteria) between January 1, 2022 and December 31, 2023, and who were referred for 6MWT by pulmonologists were included in the study. Pulmonologists performed spirometry on all patients within three months of referring them for the 6-minute walk test (6MWT). The 6MWT was completed following the ATS guidelines.[10] At the start of the test, the patient's vital signs were taken, including blood pressure, heart rate, and respiratory rate. The Borg rating of perceived exertion scale (Borg scale), mMRC dyspnea score, and oxygen saturation were also recorded. Patients were encouraged to walk along a flat hospital corridor as rapidly as possible for six minutes. At the end of the test, vital signs, the Borg scale, and oxygen saturation were re-recorded. The distance walked was measured in meters. The patients were observed for 15 minutes following the test to assess any problems. All data were recorded in the hospital's database system.

In this study, the researcher reviewed hospital electronic medical records. COPD patients aged 40 years or older who had completed 6MWT were eligible for the study. Patients were excluded if they were unable to finish the exam.

Variables for statistical analysis

The following data were retrieved from the patients' medical records: baseline characteristics including gender, age, weight and height (for calculating body mass index or BMI), underlying diseases, history of smoking (pack-years), FEV_1/FVC, FEV_1% predicted, modified Medical Research Council Scale for dyspnea (mMRC) and 6-minute walk distance (6MWD) results.

Statistical analysis

All data was analyzed using the R statistical program version 4.3.2. Descriptive statistics, including percentage, frequency, mean and standard deviation (SD), median, and quartile, were used to describe baseline characteristics. The Pearson correlation coefficient (r) was used to evaluate the correlation between 6MWD and FEV_1 and between 6MWD and mMRC dyspnea scores. A *p*-value of less than 0.05 was considered to be clinically significant.

Results

Among the 197 patients with COPD at Trang Hospital who met the inclusion criteria of the study, 181 were male (91.9%) and 16 were female (8.1%). The average age was 69.6 years, and the average FEV_1 was 61.7%. Of these patients, 50.3% had a moderate degree COPD, 26.4% had a severe degree COPD, and 19.3% had a mild degree COPD. The average 6MWD for all patients was 403.4 meters, classified by airflow limitation as mild degree COPD (448.1 meters), moderate degree COPD (396.3 meters), severe degree COPD (401.9 meters), and very severe degree COPD (288.8 meters). Most patients had an mMRC dyspnea score of 1 (Table 1).

Overall, there was a statistically significant positive correlation between 6MWD and FEV_1 ($p < 0.001$). When analyzed by the degree of airflow limitation, patients with moderate to very severe degree COPD showed a positive correlation between 6MWD and FEV_1. However, the correlation was statistically significant only for those with moderate degree COPD ($p < 0.005$) (Table 2).

Both patients with mild or very severe degrees COPD showed a significant correlation between 6MWD and the mMRC dyspnea score. The correlation was particularly strong in very severe degree patients ($r = -0.727$, $p < 0.05$) (Table 2).[11]

Table 1. Baseline characteristics

Variable	N = 197
Age (years)[1]	69.6 (8.7)
Gender[2]	
Male	181 (91.9)
Female	16 (8.1)
BMI, (kg/m^2) [1]	22.2 (3.7)
Smoking (pack-years)[3]	23 (12,40)
mMRC dyspnea score[2]	
0	28 (14.2)
1	143 (72.6)
2	22 (11.2)
3	4 (2.0)
GOLD classification[2]	
GOLD I (mild)	38 (19.3)
GOLD II (moderate)	99 (50.3)
GOLD III (severe)	52 (26.4)
GOLD IV (very severe)	8 (4.1)
FEV_1/FVC[3]	0.6 (0.5, 0.6)
FEV_1%predicted[1]	61.7 (20.1)
GOLD I (mild)	90.9(10.0)
GOLD II (moderate)	64.2 (8.6)
GOLD III (severe)	40.9 (6.3)
GOLD IV (very severe)	24.9 (4.1)
Underlying diseases[2]	
Diabetes mellitus	7 (3.6)
Hypertension	29 (14.7)
Dyslipidemia	17 (8.6)
Cardiovascular disease	8 (4.1)
Musculoskeletal	7 (3.6)
Others	9 (4.6)
6MWD (meters)[1]	403.4 (78.4)
GOLD I (mild)	448.1 (70.3)
GOLD II (moderate)	396.3 (72.2)
GOLD III (severe)	401.9 (65.8)
GOLD IV (very severe)	288.8 (121.8)

[1]Mean (SD), [2]Number (%), [3]Median (IQR)

BMI, body mass index; mMRC, modified Medical Research Council; GOLD, global initiative for chronic obstructive lung disease; FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; 6MWD, 6-minute walk distance

Table 2. Correlation coefficient between 6MWD and both FEV_1 and mMRC dyspnea scores

6MWD	FEV_1		mMRC	
	r[1]	*p*-value	r[1]	*p*-value
All (N=197)	0.299	<0.001	-0.266	<0.001
GOLD classification				
I (N=38)	-0.301	0.066	-0.332	0.041
II (N=99)	0.232	0.020	-0.121	0.231
III (N=52)	0.139	0.324	-0.126	0.371
IV (N=8)	0.008	0.985	-0.727	0.040

[1]Pearson correlation coefficient, statistically significant at $p < 0.05$

Discussion

The study found that the average 6MWD was highest in mild degree patients and lowest in those with very severe degree COPD. This result is in line with a study by C. Casanova et al.[8] which explored changes in 6MWD in 294 COPD patients over five years. A significant decline in 6MWD was found in severe and very severe degree COPD patients. The reason is that in advanced COPD, there is often muscle atrophy, loss of fat-free mass, deconditioning, and peripheral muscle weakness leading to exercise intolerance. In addition, the 6MWD depends on multiple factors, not only on the severity of lung function, but also on extrapulmonary manifestations such as age, comorbidities, nutritional status, and psychological condition which can also affect the 6MWD.

Overall, there was a statistically significant positive correlation between FEV_1 and 6MWD, indicating that patients with higher FEV_1 likely also have higher 6MWD. However, these correlations showed only weak relationships. These results are consistent with the study by Agrawal MB et al.[12] which reported a weak positive correlation between 6MWD and FEV_1, a result similar to that of Pinto-Plata et al.[9] which noted a weak correlation between 6MWD and FEV_1. Examination of the data on COPD severity in this study found a significant correlation only in patients with moderate COPD. This finding suggests that 6MWD depends on multiple factors, as noted above. Thus, patients with the same FEV_1 may eventually have different 6MWD, which is consistent with the findings of Chauhan NK et al.[13] and Karanth MP et al.[14], which found no statistical correlation between 6MWD and FEV_1, and is similar to a study by C. Casanova et al.[8] which found that the decline in 6MWD increased with disease severity. In contrast, the decline in FEV_1 was smaller in patients with more severe degrees due to the low FEV_1 in advanced COPD.

The mMRC dyspnea score also has a statistically significant negative correlation with 6MWD ($p < 0.001$). This correlation is particularly strong in patients with very severe degree COPD ($p < 0.05$), similar to the findings of Zeng GH et al.[15] which noted a significant correlation between 6MWD and mMRC as well as Chen H et al.[16] which concluded that in cases of very severe degree COPD, 6MWD has a significant negative correlation with the dyspnea scale. The present study suggests that patients with a higher dyspnea score (higher mMRC) probably tend to walk shorter distances independent of changes in FEV_1.

Spirometry remains the standard for diagnosing and assessing the severity of airflow limitation in COPD patients. However, spirometry may not be available in all hospitals due to limitations of personnel and equipment. For that reason, conducting the 6MWT annually in COPD patients is beneficial for monitoring disease progression, especially in patients with severe or very severe degrees COPD. The FEV_1 behaves as a more rigid and less sensitive parameter for detecting clinical changes which can be used with patients when it is not possible to perform spirometry. This finding is consistent with the study by C. Casanova et al.[8] which suggested that the 6MWD is particularly helpful in long-term evaluations, especially in patients with severe and very severe degrees of COPD. This study does have some limitations. First, this was a retrospective study, meaning the researcher could not select the study participants, there was a disparity in the ratio of males and females. Second, 50.3% of the patients had moderate degree COPD, and only 4.1% had very severe degree COPD. A future prospective study should be conducted to include an equal distribution across all levels of severity of COPD and gender.

Conclusions

In conclusion, 6MWD decreases as pulmonary function declines. The study showed a significant weak positive correlation between 6MWD and FEV_1 and a negative correlation between 6MWD and mMRC dyspnea score. In patients with very severe degree COPD, the correlation between 6MWD and mMRC dyspnea score was stronger than in others. The author suggests that 6MWT, and mMRC dyspnea score should be routinely evaluated in patients with COPD, especially in those with severe and very severe degree, to monitor clinical change.

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