Rate of Forced Expiratory Volume in One Second and Forced Expiratory Volume in One Second/Forced Vital Capacity Decline among Indonesian Patients with Chronic Obstructive Pulmonary Disease after a Year of Treatment

Abstract

Background: The rate of decline in lung function in chronic obstructive pulmonary disease (COPD) patients showed more profound decline than normal individuals. However, a 1-year lung function among Indonesian patients with COPD has not been elucidated. **Aim:** This study attempted to determine the rate of lung function decline in terms of obstruction variable among COPD patients after a 1-year of treatment. **Materials and Methods:** This retrospective cohort study measures the rate of decline in forced expiratory volume in 1 s (FEV1) and ratio of FEV1 to forced vital capacity (FEV1/FVC) in COPD patients at COPD Outpatient Clinic Persahabatan Hospital after 1-year of treatment. **Results:** There were 31 COPD patients with the prevalence of 1-year declined FEV1 and FEV1/FVC which were 83.9% and 51.6%, respectively. Among 1-year declined lung function group, there were significant ($P < 0.05$) decline in FEV1 (121.53 ± 120 ml/year) and in FEV1/FVC (2.75 ± 0.47%). The rate of decline in FEV1 was more prevalent in Group D, while the rate of decline in FEV1/FVC was more prevalent in Group B. No significant associations were found between sex, age, respiratory complaints, smoking history, Brinkman index, type of cigarette, comorbid, educational level, diagnosed age, body mass index, symptoms-based COPD classification, and risk-based COPD classification, with the rate of decline in FEV1 and FEV1/FVC. **Conclusions:** Most patients had statistically significant rate of decline in FEV1 and FEV1/FVC within 1-year of COPD treatment. This study recognized an unfavorable prognosis in terms of irreversible deteriorating lung function of COPD patients despite therapeutic management.

Keywords: *Chronic obstructive pulmonary disease, declined lung function, forced expiratory volume in one second, forced vital capacity*

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Introduction

Chronic obstructive pulmonary disease (COPD) is a common disease that is preventable and could be treated and characterized by a persistent airflow limitation and respiratory symptoms due to abnormalities of airway and/or alveolar structures.[1] COPD is one of the leading causes of mortality worldwide with the increasing prevalence and results in high economic and social burden.[2] The rate of decline in forced expiratory volume in 1 s (FEV1) and ratio of FEV1 to forced vital capacity (FEV1/FVC) among COPD patients were reported to be more profound compared to normal population. The rate of decline in FEV1 from a study in Japan was 32 ml/year, and in the Lung Health Study, the declining was 45 ml/year.[3] However, declining lung function within 1 year among Indonesian patients with COPD remains to be clarified.

The current study is intended to reveal the rate of decline in FEV1 and FEV1/FVC in COPD patients after 1 year of treatment at the National Referral Hospital for Respiratory Diseases in Indonesia. We also explored the COPD patient characteristics in each group according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) and the rate of FEV1 and FEV1/FVC decline in each group after 1 year of treatment. Potentially associated factors such as history of exacerbation, host factor, smoking history, and comorbidities were also described.

Materials and Methods

This cohort retrospective study was conducted in the COPD Outpatient Clinic

of Persahabatan Hospital from August 2017 to October 2017. Patients were recruited by consecutive sampling. The study was granted ethical approval from the Institutional Review Board of the Faculty of Medicine Universitas Indonesia (Ethical Clearance No. 697/UN2.FI/ETIK/2017 with Protocol No. 17-07-0720). Inclusion criteria were stable COPD patients and willing to participate in the study by signing the written informed consent. The exclusion criteria were incomplete lung function test results 1 year ago, acute exacerbation of COPD, and those with radiological findings suggestive of typical pulmonary tuberculosis (TB). Patients were subject to medical history interview, physical examination, and spirometry using SPIROBANK II (Medical International Research, Rome, Italy) with the American Thoracic Society criteria test.

Obtained data were then statistically analyzed and $P < 0.05$ was considered statistically significant. All statistical analyses were performed using Statistical Package for the Social Science software version 19.0 for Windows (Chicago, IL, USA).

Results

There were 103 patients admitted to the COPD Outpatient Clinic, and 72 among them were excluded because 54 patients have no spirometry test result 1 year ago,

while 18 other patients' chest X-ray showed pulmonary TB appearance.

Most of the studied partcipants were males, and based on GOLD classification, Group D was the most common group, followed by B, A, and C groups. Individual aged below 64 years was prevalent, predominantly in Group B and D (symptomatic group) with mean age of 64.84 ± 9.63 years. The most common respiratory symptoms were productive cough followed by dyspnea. Majority of individuals were former smoker, and severe Brinkman Index (BI) was the most common among former smoker. All patients used long-acting bronchodilator, and most of patients were diagnosed as COPD at the age ≥60 years. Demographic characteristics are described in Table 1.

Next, we determined the decline in FEV1 and FEV1/FCV among COPD individuals [Table 2]. In this study, 26 individuals (83.9%) had declined FEV1 with the rate of 1-year decline of FEV1 as 121.53 ± 120 ml/year (95% CI 72.993–170.08, $P < 0.05$). Sixteen individuals (51.6%) had decline in FEV1/FVC with the rate of 1-year decline of FEV1/FVC as 2.75 ± 0.47% (95% CI 46.07–57.798, $P < 0.05$). The rate of decline in FEV1 and FEV1/FVC in COPD patient in Group A, B, C, and D are described in Table 3.

Variables	COPD classification				Total (%)
	A	**B**	**C**	**D**	
Gender					
Male	5	10	1	14	30 (96.8)
Female	0	0	0	1	1 (3.2)
Age					
<64	1	4	0	12	17 (54.8)
≥65	4	6	1	3	14 (45.2)
Respiratory symptoms					
None	4	0	0	0	4 (12.9)
Cough	1	10	0	0	11 (35.5)
Dyspnea	0	0	1	7	8 (25.8)
Cough and dyspnea	0	0	0	8	8 (25.8)
Smoking history					
Nonsmoker	3	0	0	0	3 (9.7)
Former smoker	2	10	1	15	28 (90.3)
BI					
Never smoke	3	0	0	0	3 (9.7)
Mild	2	0	0	0	2 (6.5)
Moderate	0	10	0	0	10 (32.3)
Severe	0	0	1	15	16 (51.6)
Type of cigarette					
Never smoker	3	0	0	0	3 (9.7)
Filter	2	2	0	0	4 (12.9)
Kretek	0	8	1	12	21 (67.7)
Mix	0	0	0	3	3 (9.7)

Table 1: Chronic obstructive pulmonary disease individuals' characteristics of after 1 year of treatment

Contd...

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Variables	COPD classification				Total (%)
	A	**B**	**C**	**D**	
Comorbid					
None	5	3	0	0	8 (25.8)
Type 2 DM	0	5	0	0	5 (16.1)
Cardiovascular disease	0	2	1	15	18 (58.1)
Education level					
Elementary school	2	0	0	0	2 (6.5)
Junior high school	3	3	0	0	6 (19.4)
Senior high school	0	7	1	7	15 (48.4)
University level	0	0	0	8	8 (25.8)
Working status					
Working	5	10	1	0	16 (51.6)
Not working	0	0	0	15	15 (48.4)
BMI					
Underweight	5	2	0	0	7 (22.6)
Normal	0	8	1	7	16 (51.6)
Obese	0	0	0	8	8 (25.8)
History of exacerbation					
<1x without hospital care	5	10	0	0	15 (48.8)
1x hospital care or 2x ≥ without hospital care	0	0	1	15	16 (51.6)
CAT score					
<10	5	0	1	0	6 (19.4)
≥10	0	10	0	15	25 (80.6)
Obstruction level					
GOLD 1	5	3	0	0	8 (25.8)
GOLD 2	0	7	1	12	20 (64.5)
GOLD 3	0	0	0	3	3 (9.7)
GOLD 4	0	0	0	0	0
The use of LABACS					
No	5	6	0	0	11 (35.5)
Yes	0	4	1	15	20 (64.5)
Age when diagnosed					
<60	2	2	1	6	11 (35.5)
≥60	5	7	1	7	20 (64.5)

BMI: Body mass index; CAT: COPD assessment test; COPD: Chronic obstructive pulmonary disease; GOLD: Global Initiative for Chronic Obstructive Lung Disease; LABA: Long-acting beta agonist; LABACS: LABA with inhaled corticosteroid; BI: Brinkman index

Table 2: Rate of decline in forced expiratory volume in 1 s and forced expiratory volume in 1 s/forced vital capacity

FEV1 and FEV1/FVC	Mean	Rate of decline	95% CI	*P*
FEV1 1 year before	1238±468	121.53±120	72.993-170.08	<0.05
FEV1 after 1 year	1116.9±478			
FEV1/FVC 1 year before	54.67±11.05	2.75±0.47	46.07-57.798	<0.05
FEV1/FVC after 1 year	51.923±11.026			

FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity; CI: Confidence interval

Table 3: Rate of decline in forced expiratory volume in 1 s and forced expiratory volume in 1 s/forced vital capacity in chronic obstructive pulmonary disease patient Group A, B, C, and D

Rate decline in FEV1 and FEV1/FVC	A	B	C	D
FEV1 (ml/year)	72.5	85	60	110
FEV1/FVC (percentage/year)	2.9	3.29	1	2

COPD: Chronic obstructive pulmonary diseas; FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity

In this study, however, there were no statistically significant association between gender, age, BMI, symptom-based COPD group, risk-based COPD group, comorbidity, respiratory symptoms, BI, level of education, the use of long-acting beta agonist with inhaled corticosteroid (LABACS), age when COPD diagnosis, history of smoking, history of exacerbation, COPD assessment test (CAT) score, and obstruction severity as appear on FEV1 and FEV1/FVC [Table 4].

Table 4: Factors associated with rate of decline in forced expiratory volume in 1 s

Variables	FEV1 decline		Total	*P*
	Yes	No		
Gender				
Male	25	5	30	0.389
Female	1	0	1	
Age				
<64	13	4	17	0.23
≥65	13	1	14	
BMI				
Underweight	6	1	7	0.68
Normal obese	20	4	24	
Risk-based group				
A-B (low risk)	14	1	15	0.18
C-D (high risk)	12	4	16	
Symptom-based group				
A-C (less symptoms)	5	1	6	0.687
B-D (more symptoms)	21	4	25	
Comorbid				
Yes	19	4	23	0.615
No	7	1	8	
Respiratory symptoms				
Yes	23	4	27	0.525
No	3	1	4	
BI				
Mild-moderate	12	0	12	0.089
Severe	12	4	16	
Level of education				
Low-middle	7	1	8	0.615
High	19	4	23	
The use of LABACS				
Yes	10	1	11	0.405
No	16	4	20	
Age when diagnosis				
<60	10	1	11	0.405
≥60	16	4	20	
History of smoking				
Nonsmoker	2	1	3	0.42
Former smoker	24	4	28	
History of exacerbation				
<1x without hospital care	14	1	15	0.186
1x with hospital care, or 2x > without hospital care	12	4	16	
CAT score				
<10	5	1	6	0.687
≥10	21	4	25	
GOLD				
1-2	23	5	28	0.578
3-4	3	0	3	

CAT: COPD assessment test; COPD: Chronic obstructive pulmonary disease; FEV1: Forced expiratory volume in 1 s; GOLD: Global Initiative for Chronic Obstructive Lung Disease; LABACS: LABA with inhaled corticosteroid; LABA: Long acting beta agonist; BI: Brinkman index

Discussion

COPD is characterized by a progressive deteriorating airway obstruction, and preserving lung function was one of the main targets of treatment. The current study observed a reduced lung function, i.e., FEV1 and FEV1/FVC, within 1 year among Indonesian patients with COPD.

This study identified a marked decline in FEV1 which might be associated with the patients characteristic, such as male, mean of age 64.84 ± 9.63 years, former smoker with severe BI, Kretek cigarette, cardiovascular disease as comorbid, history of exacerbation leading to hospital, CAT score >10, and age during COPD diagnosis ≥60 years.

The rate of decline in FEV1 in Group A was 72.5 ml/year, Group B 85 ml/year, Group C 60 ml/year, and Group D 110 ml/year. Higher rate of decline in FEV1 was in Group D and B (symptomatic group) followed by A and C (less symptomatic group). The rate of decline in FEV1/FVC in Group A was 2.9%, Group B 3.29%, Group C 1%, and Group D 2%; this suggests that most common decline in FEV1/FVC was in Group B and A (low-risk group) compared to D and C (high-risk group).

Result in this study was different with the study performed by Kanazawa *et al*. in 55 COPD patients with marked decline in FEV1 in Group B (59.7 ml/year) and C (54.0 ml/year).[4] Kim *et al*. showed decline of FEV1 was common in Group A (34.4 ± 7.9 ml/year) followed by Group B (26.2 ± 9.4 ml/year), Group D (24.0 ± 8.7 ml/year), and Group C (22.7 ± 16.0 ml/year).[5]

Studi by Chen *et al*. found that a decline in FEV1 was 129 ml in low-risk group of COPD and this is 30 ml different higher compared to decline in high-risk group.[6] A prospective cohort study, the Korean Obstructive Lung Disease, by Kim *et al*. showed that a decline in FEV1 was faster in low-risk group of COPD compared to the high-risk group (31.0 ± 6.1 ml/year vs. 23.6 ± 7.7 ml/year), although it was not statistically significant (*P* = 0.44).[5] They also found that less symptomatic COPD patients had a lesser decline in FEV1 compared to more symptomatic patients (32.3 ± 7.2 ml/year vs. 25.0 ± 6.5 ml/year).[5]

We did not find significant association between obstruction variable in lung function with individual characteristics. This result is different with previous study. In one study by Watson *et al*., decline in FEV1 was associated with respiratory symptoms only in male individuals.[7] Study by Han *et al*. found that a decline in FEV1 was important predictor of the disease state.[8]

We did not find a significant association between the use of LABACS and declined lung function among COPD patients. A multicenter study, ISPIRE, performed for a 2-year period showed no significant association between FEV1 in both salmeterol/fluticason propionat group and tiotropium group.[9]

BMI was not associated with the decline in FEV1 in our cohort, and this is consistent with previous cross-sectional study by Kakarla *et al*. who demonstrated no significant association between FEV1 and 6 min walk test (6MWT), both in lower BMI and high BMI group.[10]

Patients with T2DM in the current study were only 5 patients, and we did not observe an association between comorbidity and decline in FEV1 and in FEV1/FCV. This is different with study by Kwon *et al*. who observed a significant association between T2DM and decline in both FEV1 and FVC.[11]

Patients with respiratory symptoms had more profound decline in lung function although this did not reach statistical threshold. This is consistent with previous study by Watson *et al*. who demonstrated that decline FEV1 within 1 year was not significantly associated with respiratory symptoms both in men and women.[7]

The study limitation was a relatively small sample because the study was performed in a short term. Further study involving larger sample size is required to identify potential factors that might contribute in the reduced lung function among Indonesian patients with COPD.

Conclusions

Taken together, a marked proportion of COPD patients suffered a declining FEV1 and FEV1/FVC within 1 year, and this represents unachieved therapeutic target. There were no significant associations between sex, age, respiratory complaints, smoking history, BI, type of cigarette, comorbid, educational level, diagnosed age, body mass index, symptoms-based COPD classification, and risk-based COPD classification, with the rate of decline in FEV1 and FEV1/FVC.

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Conflicts of interest

There are no conflicts of interest.

References

1. Global Strategy for the Diagnosis, Management and Prevention of COPD. Global Initiative for Chronic Obstructive Lung Disease (GOLD); 2017. Available from: http://www.goldcopd.org. [Last accessed on 2017 Oct 28].
2. Gedebjerg A, Szépligeti SK, Wackerhausen LH, Horváth-Puhó E, Dahl R, Hansen JG, *et al*. Prediction of mortality in patients with chronic obstructive pulmonary disease with the new global initiative for chronic obstructive lung disease 2017 classification: A cohort study. Lancet Respir Med 2018;6:204-12.
3. Chen S, Wang C, Li B, Shi G, Li H, Zhang J, et al. Risk factors for FEV1 decline in mild COPD and high-risk populations. Int J Chron Obstruct Pulmon Dis 2017;12:435-42.
4. Kanazawa H, Hirata K, Yoshikawa J. Accelerated decline of lung function in COPD patients with chronic hepatitis C virus infection: A preliminary study based on small numbers of patients. Chest 2003;123:596-9.
5. Kim J, Yoon HI, Oh YM, Lim SY, Lee JH, Kim TH, *et al*. Lung function decline rates according to GOLD group in patients with chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 2015;10:1819-27.
6. Bhatt SP, Soler X, Wang X, Murray S, Anzueto AR, Beaty TH, *et al*. Association between functional small airway disease and FEV1 decline in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2016;194:178-84.
7. Watson L, Vonk JM, Löfdahl CG, Pride NB, Pauwels RA, Laitinen LA, *et al*. Predictors of lung function and its decline in mild to moderate COPD in association with gender: Results from the euroscop study. Respir Med 2006;100:746-53.
8. Han MK, Postma D, Mannino DM, Giardino ND, Buist S, Curtis JL, *et al*. Gender and chronic obstructive pulmonary disease: Why it matters. Am J Respir Crit Care Med 2007;176:1179-84.
9. Wedzicha JA, Calverley PM, Seemungal TA, Hagan G, Ansari Z, Stockley RA, *et al*. The prevention of chronic obstructive pulmonary disease exacerbations by salmeterol/fluticasone propionate or tiotropium bromide. Am J Respir Crit Care Med 2008;177:19-26.
10. Kakarla B, Boddula RP, Gongati P. Relation between body mass index, forced expiratory volume in one second and 6 minute walk test in stable COPD patients. Int J Res Med Sci 2016;4:5144-8.
11. Kwon CH, Rhee EJ, Song JU, Kim JT, Kwag HJ, Sung KC, *et al*. Reduced lung function is independently associated with increased risk of type 2 diabetes in Korean men. Cardiovasc Diabetol 2012;11:38.