



Original Research Article

Spirometric surveillance of obstructive lung diseases

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ABSTRACT

Background: Obstructive Lung Disease (OLD) becomes global health issues that influencing the physical health and economic conditions of people. Chronic Respiratory Disease (CRD) is the disease of airways characterized by obstruction and influencing the structure of the lungs. It includes chronic bronchitis, COPD, emphysema and asthma. The most common disease is Chronic Obstructive Pulmonary Disease (COPD). The major causes of COPD involve exposure to an irritant that damage the lungs and airways that can cause such disease.

Aim: 1) Assess the prevalence of OLD among the patients admitted to general medical wards using spirometry; 2) Use a symptom questionnaire for screening patients with OLD and compare it with Spirometry; 3) Association of various medical co-morbidities with the diagnosis of OLD.

Materials and Methods: The screening for OLDs and factors that are influencing it along with co morbidities were analyzed. This is a descriptive study conducted on patients admitted to general medical wards in hospital of South India for a period of 2 years. The study has involved the patients who are admitted in general wards and aged > 40 years.

Results: The physician diagnosis of OLD at admission was in 21 out of 144 patients. It was by symptom alone in 11% (16 of 144 patients) and based on spirometry in 3.48% (5 of 144) only. During the hospitalization the diagnosis of OLD increased by 2.08% (3 of 144) on the basis of symptom alone and 1.4% (2 of 144) by spirometry, cumulatively by 3.48% (5 of 144). Therefore, at admission about 14.48% were diagnosed to have OLD. An ROC curve was plotted and the area under the curve was 0.77 95% CI (0.688 — 0.865). By ROC coordinates a cut off of 15.5 for detecting OLDs showed a sensitivity and specificity of 71% and 78% respectively with a positive predictive value of 56% and negative predictive value of 87%.

Conclusion: With the additional yield of Spirometry and association of medical comorbidities can help identify the conditions of patients earlier and pave way for offering appropriate holistic treatment.

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1. Introduction

Various diseases have a direct or indirect impact on the health of people. Medical science is developing approaches and treatment options to provide better services and facilities to people. In the current scenarios, Obstructive Lung Disease (OLD) becomes global health issues that

influencing the physical health and economic conditions of people.¹ Chronic Respiratory Disease (CRD) is the disease of airways characterized by obstruction and influencing the structure of the lungs. It includes chronic bronchitis, COPD, emphysema and asthma. The most common disease is Chronic Obstructive Pulmonary Disease (COPD). The major causes of COPD involve exposure to an irritant that damage the lungs and airways that can cause such disease. Moreover, the consideration of chronic bronchitis and

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emphysema is useful for identifying the health condition of people.

The major cause of COPD is smoking, but non-smokers who are chronically exposed to chemical dusts, biomass fuels are also found to develop COPD.² The issues related to COPD include heart problems and worsening respiratory infections. The symptoms of COPD involve difficulty in breathing, chronic cough with sputum, tightness in the chest and people with COPD have acute exacerbations which are flare-ups of severe symptoms due to various triggers. According to the analysis of health conditions of patients, the early symptoms of COPD include insidious onset of breathlessness, worsening especially after exercise. In addition to this, the worst symptoms of the disease are involving wheezing, chronic cough, frequent respiratory infection and lack of energy.³

Tests to diagnose the issues related to COPD include spirometry to analyze the lungs functions, imaging tests like a chest X-ray and CT scan. These images can be useful for identifying the actual functional conditions of lungs, blood vessels and heart. In addition to this, the arterial blood gas tests provide information related to the blood oxygen level, CO₂ levels representing gas exchanges taking place in the lungs. However, it is difficult for care professionals to have complete and correct diagnosis of airway diseases like COPD without Spirometry.⁴ To provide effective treatment to patients of COPD, the care professionals and health care organizations are offering different types of support that include oxygen therapy, surgery, rehabilitation and changes in the lifestyle. COPD patients are advised to quit smoking, get the nutrition required for the body and follow a healthy eating plan that improves the capacity of the lungs and provide energy. Various resources are used for offering support and maintaining the health conditions of patients. However, some of the patients required high medical assistance as conditions of their lungs become weaker.⁵

1.1. OLD and its effects

Obstructive Lung Disease (OLD) is a type of lung disease that occurs due to blockage in the airways. These blockages damage the lungs and cause their airways to narrow which influence the functional efficiency of the lungs and affect normal breathing. Healthy lungs are necessary for every individual for managing the daily routine work and physical exercise. When a person breathes, air travel down the windpipe through the series of tubes that known as bronchi. At the ends of these tubes, there are branches of air sacs called alveoli. In healthy lungs, the alveoli fill up with air and pass the oxygen through the blood vessels and at the same time the blood passes CO₂ back to the alveoli.⁶ The obstructive lungs disease influences the air passing and affects the working efficiency of alveoli and lead to less gas exchange. There are two types of disease related to the

lungs, obstructive and restrictive.

The common factors involve in obstructive airflow include the swelling and inflammation in the airways, thick mucus in the airways and damage to the walls of the air sacs. According to the analysis, the risk factors for OLD involve lung irritation that includes chemicals, dust, fumes and excessive exposure to secondhand smoke. There are also some genetic components to obstructive lungs disease. Some people can experience the OLD without smoking but due to exposure to environmental irritants. In addition to this, asthma is also an obstructive lung disease affecting the respiratory system and increasing the problems for the patients.⁷ The definition of COPD in an individual is chronic airflow obstruction occurring due to tobacco smoking and inhaling the noxious chemicals. It becomes difficult to clinically diagnose the airflow obstruction but spirometry is most widely available for testing the functions of the lungs. Spirometry is considered a physiological measure of identifying the issues related to lungs functions.⁸ A spirometry test can be performed for all type of patients but it requires a trained expert for analyzing the value of reading and could offer advice to patients. The treatment of COPD is not affordable for all types of income group people. Many national governments across the world are trying to offer good treatment for patients which would decrease global COPD mortality.⁹

1.2. Risk factors

There are different types of risks factors that are having a significant impact on the health of patients with COPD. The proper consideration of these factors can be useful for prevention and offering the treatment accordingly. The major risks factors are genetics and smoking. People smoke different types of tobacco that are causing OLD and co-morbidities related to it. 40% of OLD cases are related to smoking and occur in low-income groups. In addition to this, 73% of COPD morality is related to smoking which has a significant impact on the healthcare system. Apart from this, non-smoking people are also getting affected by OLD due to genetic problem.¹⁰ The deficiency of the serine protease increases the chance of OLD. The gene of affected people transfers to the next generation which could become familial. Apart from this, increasing levels of pollution worldwide by occupational dust, fumes, environmental gases, chemical gases and various causes leading to asthma also enormously contribute to the burden of obstructive lung diseases.¹¹ According to the analysis, 36% of mortality from lower respiratory disease is also related to indoor smoke exposure.

OLD and Comorbidities

OLDS are often known to have many co morbidities like heart diseases, diabetes, hypertension, anemia, osteoporosis and depression which increase the rate of hospital admissions, cost burden and mortality rates. Appropriate

and effective diagnosis and management of these co-morbidities have significant implications on survival of these patients.

Many community surveys using symptom questionnaires and spirometry have been done worldwide to find the prevalence of OLDs, however no screening is usually done in hospitalized patients to look for their existence and hence miss out an opportunity to diagnose these early and manage better.

2. Objectives

2.1. Primary objectives

Assess the prevalence of OLD among the patients admitted to general medical wards using spirometry.

2.2. Secondary objectives

1. Use a symptom questionnaire for screening patients with OLD and compare it with Spirometry.
2. Association of various medical co-morbidities with the diagnosis of OLD.

3. Materials and Methods

The screening for OLDs and factors that are influencing it along with co morbidities were analyzed. This is a descriptive study conducted on patients admitted to general medical wards in hospital of South India for a period of 2 years.

3.1. Inclusion criteria

The study has involved the patients who are admitted in general wards and aged > 40 years

3.2. Exclusion criteria

1. Patients who could not fill be the questionnaire.
2. Patients who did not offer consent.
3. The patient who is critically ill.
4. Patient with low consciousness.

The study consisted of a symptom-based questionnaire having, different questions considering demographic features such as age, sex, occupation, tobacco smoking, biomass fuel use, co-morbid conditions, prior diagnosis of respiratory disease, admission and discharge diagnosis with medications advised by treating physicians. The participants were classified as high, intermediate and low risk for OLD based on a validated symptom questionnaire devised by Dr David Price et al¹² where mild risk score was 0-16.5, moderate risk 16.6-19.5 and high risk >19.6. The questionnaire was utilized in the present study after obtaining permission for its use from the copyright holder Dr David Price. The Spirometry was performed by a trained

technician according to ATS (American Thoracic Society) criteria. The participants who had undergone Spirometry in the previous 12 months were not included in the study. The patients on bronchodilators from earlier diagnosis of probable OLD by their physicians were also included in the study, as most of them had no Spirometric diagnosis.

3.3. Statistical method

The descriptive statistical methods were used in analysis of the study which included the qualitative variables, frequency and percentage value. The qualitative variables of questionnaire and spirometry results were associated with other related characteristics using X²Test or Fisher test. The performance value of the symptom questionnaire was expressed as positive and negative predictive value and were calculated based on the prevalence value of OLDs. The Kappa statistics was used to find the agreement with the spirometric severity and symptom-based risk score severity. Continuous variables were analyzed by two tailed t tests. Man-Whitney test was used to compare quantitative variables OLD and non-OLD and similarly between COPD n non-COPD groups. The statistical significance was inferred at p<0.5.

4. Results

For the survey analysis, a total of 555 medical patients were considered according to inclusion criteria. The sample included 300 males and 255 females and the mean age was 60.2 years. 340 participants were excluded due to serious medical problems, 20 patients have refused to participate and two patients expired before spirometry test and 49 patients were unable to perform technically satisfactory spirometry.

Table 1: Demographic information

Patient characteristics	Numbers of patients (n=144)
Age (years)	56.59
Gender	
Male	98 (68.1%)
Female	46 (31.9%)
BMI	22.86
Underweight	35 (24.3%)
Acceptable	70 (48.6%)
Overweight	28 (19.4%)
Obese	11 (7.6%)
Smoking	15.31
Current	11 (7.6%)
Former	45 (31.2%)
Never	85 (59%)
Passive	3(2.1%)

The symptom-based risk score for predicting OLD for 144 participants showed that 67.4% had mild risk, 10.4% had moderate risk and 22.2% had high-risk score.

Table 2: Historical information

Patient characteristics	Numbers of patients
Previous respiratory disease	33 (22.9%)
COPD	10(6.9%)
Asthma	9 (6.2%)
Old pulmonary tuberculosis (PTB)	9 (6.2%)
COPD + OLD PTB	1 (0.7%)
Asthma + OLD PTB	1 (0.7%)
Asthma + ILD	2 (1.4%)
Earlier spirometry done	10 (6.9%)
Co morbid illness	
Diabetes mellitus	63 (43.8%)
Hypertension	56 (38.9%)
Cardiac disease GERD	26 (18.1%)
Osteoporosis	13 (9%)
Vitamin D deficiency	17 (11.8%)
Depression	15 (10.4%)

Table 3: Spirometric findings and symptom risk score

Symptoms risk score	1*	2*	3*	4*	5*	Total patients
Mild	33 (89.2%)	14 (63.6%)	2 (10.5%)	43 (74.1%)	5 (62.5%)	97 (67.4%)
Moderate	3 (8.1%)	3 (13.6%)	1 (5.3%)	8 (13.8%)	0 (0%)	15 (10.4%)
Severe	1 (2.7%)	5 (22.7%)	16 (84.2%)	7 (12.1%)	3 (37.5%)	32 (22.2%)
Total	37	22	19	58	8	144 (100%)

1* normal, 2* obstruction with reversibility, 3* obstruction with no reversibility, 4* restrictive pattern, 5* reduced MMEF (small airway disease).

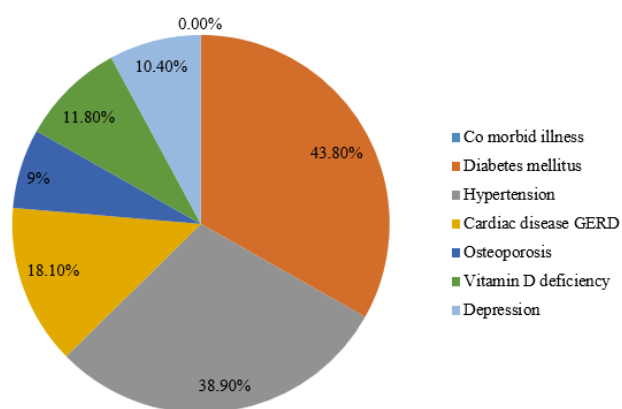


Fig. 1: Co Morbid illness

By symptom-based questionnaire and spirometry it was found that 41(28.47%) had OLD, 19 (13.19%) COPD and 22(15.28%) Asthma. Of the diagnosed COPD patients, majority had moderate and severe obstruction.

The predictability of OLD by using the symptom-based risk score was assessed and it has been found that 65.6% with high-risk score, 36.7% with moderate and 16.5% with a mild risk score had OLD. On assessing the predictability of COPD by questionnaire, it was seen that 50% with severe risk score, 6.66% moderate risk score and 2.1% mild risk

score had spirometric obstruction with no reversibility.

The agreement of symptom risk score with spirometric severity of COPD (by GOLD criteria) using kappa statistics for 19 patients of COPD found that the symptom questionnaire predicted all 11 patients with severe and very severe COPD with corresponding symptom risk score.

In addition to this, 103 of 144 patients were slightly older and having more risk of OLD. Especially male patients who were using the tobacco for smoking are having more chances of getting OLD.

The use of spirometry and symptoms to diagnose OLD during the admission/discharge by physicians were noted.

The physician diagnosis of OLD at admission was in 21 out of 144 patients. It was by symptom alone in 11% (16 of 144 patients) and based on spirometry in 3.48% (5 of 144) only. During the hospitalization the diagnosis of OLD increased by 2.08% (3 of 144) on the basis of symptom alone and 1.4% (2 of 144) by spirometry, cumulatively by 3.48% (5 of 144). Therefore, at admission about 14.48% were diagnosed to have OLD. This figure increased by 3.48% during admission /at discharge and a total of 32 went with a diagnosis of OLD, of which 7 patients (4.9%) had spirometric diagnosis of OLD.

Among all OLDs, the treating physicians diagnosed OLD before and during admission in only 16 (39%) patients. The spirometric surveillance conducted by our study could diagnose an additional 25 (61%) patients. Among the 16

Table 4: Risk score

Risk Score	Degree of obstruction on spirometry (GOLD classification).				Total.
	Mild	Moderate	Severe	Very Severe	
Mild	0 (0%)	2 (28.6%)	0 (0%)	0 (0%)	2(10.5%)
Moderate	0 (0%)	1 (14.3%)	0(0%)	0 (0%)	1(5.3%)
Severe	1 (100%)	4 (57. 1%)	8(100%)	3 (100%)	16 (84.2%)
	1 (100%)	7 (100%)	8(100%)	3(100%)	19(100%)

Table 5: Comparison of patients with OLD and with No OLD

Patient's characteristics	With OLD n =41	With No OLD n= 103	P value
Age	60.68 ± 11.06	54.96 ± 9.91	0.003*
Gender			0.016*
Male	34(82.9%)	64 (62.1%)	
Female	7 (17.1%)	39 (37.9%)	
BMI	21.42± 5.1	23.43± 4.67	0.025*
Underweight	18 (43.9%)	17 (16.5%)	
Acceptable	13 (31.7%)	57 (55.3%)	
Overweight	7 (17.1%)	21 (20.4%)	
Obese	3 (7.3%)	8 (7.8%)	
Smoking			
Pack years	22.55 ± 17.58	9.89 ± 11.37	0.001*
Current	6 (14.6%)	5 (4.9%)	
Former	18 (43.9%)	27 (26.2%)	
Never	17 (41.5%)	68 (66%)	
Passive	0 (0%)	3(2.9%)	
Occupational exposure	0 (0%)	2 (1.9%)	0.463
Biomass fuel exposure	6 (14.6%)	34 (33%)	0.026*
Quantity of biomass exposure (hour- years)	62.5 ± 44	63.62 ± 44.16	0.894
Symptom risk score	19.59 ± 6.689	13.36 ± 4.858	<0.001*
Earlier spiromerty done	8 (19.5%)	2 (1.9%)	<0.001*
Patient's characteristics	With OLD n =41	With No OLD n= 103	P value
Previous respiratory disease	16 (39%)	17 (16.5%)	0.004*
COPD	8 (19.5%)	2 (1.9%)	
Asthma	4 (9.8%)	5 (4.9%)	
Old PTB	1 (2.4%)	8 (7.8%)	
COPD + old PTB	1(2.4%)	0 (0%)	
Asthma + old PTB	1 (2.4%)	1 (1%)	
Asthma + ILD	1 (2.4%)	1(1%)	
Co morbid illness			
Diabetes mellitus	14 (34.1%)	49 (47.6%)	0.143
Hypertension	14 (34.1%)	42(40.8%)	0.461
Cardiac disease	6 (14.6%)	20 (19.4%)	0.501
GERD	10 (22.4%)	16 (15.5%)	0.212
Osteoporosis	5 (12.2%)	8 (7.8%)	0.519
Vitamin D deficiency	5 (12.2%)	12 (11.7%)	1.00
Depression	5 (12.2%)	10 (9.7%)	0.763

Table 6:

Physician diagnosis of OLD	Patients with OLD n = 41	Patients with no OLD n= 103
At admission		
Based on symptom only	9 (22%)	7 (6.8%)
Based on spirometry	4 (9.8%)	1 (1%)
During admission.		
Based on symptom only	1 (2.4%)	2 (8%)
Based on spirometry	2 (4.9%)	0 (0%)

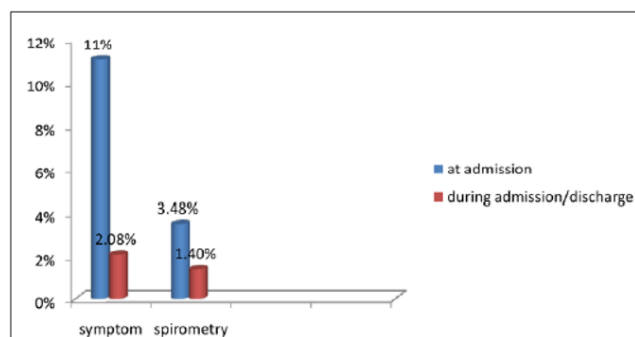


Fig. 2: Frequency of OLD diagnosis by physician on the basis of symptoms and spirometry at admission and during /discharge (n=144).

patients diagnosed of OLD by treating physicians, 9 (22%) had been diagnosed of having airway disease exacerbations and were being treated. Furthermore, the 10 patients who did not have airways disease based on spirometry were diagnosed wrongly as such. Among these 6 patients were diagnosed of having an exacerbation during the admission and were treated for the same.

4.1. Performance of symptom questionnaire in general medical patients

To assess the performance of symptom questionnaire for OLD, an ROC curve was plotted and the area under the curve was 0.77 95% CI (0.688 — 0.865). By ROC coordinates a cut off of 15.5 for detecting OLDs showed a sensitivity and specificity of 71% and 78% respectively with a positive predictive value of 56% and negative predictive value of 87%.

Performance characteristics of symptom score in detecting OLDs.

Table 7: Area under curve

Area	Std. Error _s	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.777	.045	.000	.688	.865

PPV - 55.67%, NPV — 86.75%

Similarly, the ROC curve was plotted to assess the performance of symptom questionnaire in detecting COPD. The area under the curve was 0,902 CI (0.827 — 0.977). By ROC coordinates a cut off of 19.5 showed a sensitivity and specificity of 84% and 87% respectively, with a positive predictive value of 50% and 97.3%.

5. Discussion

There are two main types of disease related to the lungs which are obstructive and restrictive. The common factors

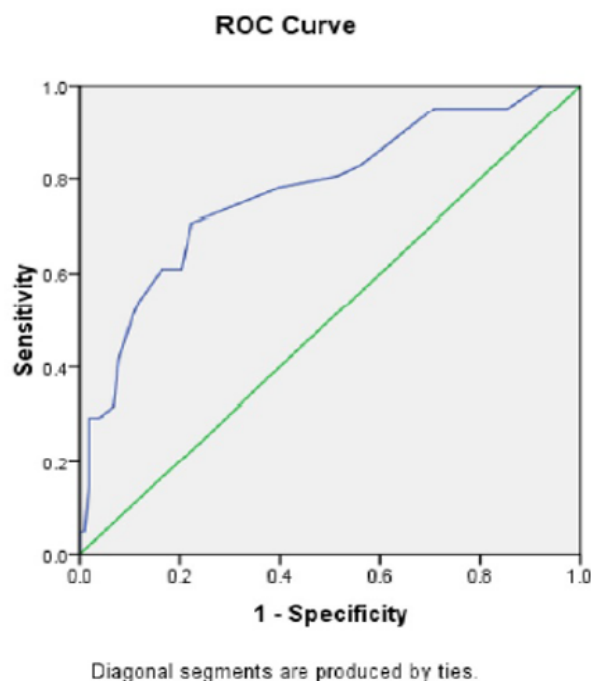


Fig. 3: Performance characteristics of symptom score in detecting OLDs

involving in obstructive airflow include the swelling and inflammation in the airways, thick mucus in the airways and damage to the walls of the air sacs.¹³ These lung diseases get missed unless routinely tested for and add to the ever-increasing burden of lung disease in the world. The treatment of COPD is not affordable for all types of income group people.¹⁴ The national governments are trying to offer good treatment for patients and trying to decrease global COPD mortality. The predictability of OLD by using the symptom-based risk score was assessed and it has been found that 65.6% have the high-risk score, 36.7% with moderate and 16.5% with a mild risk score. The findings of the majority of community-based studies have estimated a prevalence of OLD ranging between 4% to 14%. There are very few such prevalence studies that have been done in hospitalized patient though screening for common disease is relatively easier to diagnose and frequently done.¹⁵ However there are no studies estimating the prevalence of OLDs in hospitalized patients. The present study tried to estimate the number of patients with underlying airway diseases which were not a part of their admission diagnosis. Though the spirometry is a simple test which would easily diagnose an OLD, especially COPD, it is under-utilized.

In the present study, the prevalence of OLD patients in hospitalized was 28.5%, where COPD was 13.2% and asthma 15.3%. The majority of COPD patients belonged to the moderate and severe group. Using a symptom-based questionnaire helps to categorize the at-risk patients for

OLD directing the physicians to perform spirometry in at risk patients. The study could find that the diagnosis of OLD during hospitalization increased by using spirometry along with symptom questionnaire. The symptom questionnaire in our study had predicted all patients with severe and very severe COPD with good agreement. The OLD patients were also found to be having co morbidities like Diabetes (34%), Hypertension (34%), cardiac disease (14%), GERD (22%), Osteoporosis (12%), vitamin D deficiency (12%) and medically diagnosed Depression (12%).

The smoking habits of Indian are high and increased significantly as the community variables are influencing the behavior of youngsters.¹⁶ There is ever increasing scenario of air pollution in many countries adding on to the burden of OLDs. It has become an essential task medial fraternity to diagnose these patients at the earliest utilizing simple tests like spirometry and questionnaires, prevent development of irreversible disease by providing awareness and efficiently treat them with appropriate medications.

6. Conclusion

This study was an observational research done in tertiary care hospital of South India with a major objective to screen for OLD among general medical patients aged >40years using symptom-based questionnaire and a Spirometry. The study could correlate the questionnaire and the Spirometric severity showing a simple way of screening for undiagnosed OLDs especially COPD and asthma which would otherwise go missed and untreated for. With the additional yield of Spirometry and association of medical comorbidities can help identify the conditions of patients earlier and pave way for offering appropriate holistic treatment. As frequency of routine utilization of spirometry in medical patients is minimal, this study reinforces its effective utilization as a part of evaluation for diagnosing OLD as significant number of asthma and COPD patients otherwise would miss their diagnosis and end up with irreversible morbidities contributing to burden of disease and health care costs.

7. Source of Funding

No financial support was received for the work within this manuscript.

8. Conflict of Interest

The authors declare they have no conflict of interest.

References

1. Amaral AF, Patel J, Kato BS, Obaseki DO, Lawin H, Tan WC, et al. Airflow obstruction and use of solid fuels for cooking or heating. BOLD (Burden of Obstructive Lung Disease) results. *Am J Respir Crit Care Med*. 2018;197(5):595–610.
2. Antuni JD, Barnes PJ. Evaluation of Individuals at Risk for COPD: Beyond the Scope of the Global Initiative for Chronic

- Obstructive Lung Disease. *Chronic Obstr Pulm Dis*. 2016;3(3):653–67. doi:10.15326/jcopdf.3.3.2016.0129.
3. Backman H, Lindberg A, Oden A, Ekerljung L, Hedman L, Kainu A, et al. Reference values for spirometry-report from the Obstructive Lung Disease in Northern Sweden studies. *Eur Clin Respir J*. 2015;2(1):26375. doi:10.3402/ecrj.v2.26375.
4. Choi SM, Lee J, Park YS, Lee CH, Lee SM, Yim JJ, et al. Prevalence and global initiative for chronic obstructive lung disease group distribution of chronic obstructive pulmonary disease detected by preoperative pulmonary function test. *PLoS One*. 2015;10(1):115787. doi:10.1371/journal.pone.0115787.
5. Fortis S, Comellas A, Kim V, Casaburi R, Hokanson JE, Crapo JD, et al. Low FVC/TLC in Preserved Ratio Impaired Spirometry (PRISm) is associated with features of and progression to obstructive lung disease. *Sci Rep*. 2020;10(1):5169. doi:10.1038/s41598-020-61932-0.
6. Martinez CH, Mannino DM, Jaimes FA, Curtis JL, Han MK, Hansel NN, et al. Undiagnosed obstructive lung disease in the United States. Associated factors and long-term mortality. *Ann Am Thoracic Soc*. 2015;12(12):1788–95.
7. Sanchez TR, Powers M, Perzanowski M, George CM, Graziano JH, Navas-Acien A. A meta-analysis of arsenic exposure and lung function: is there evidence of restrictive or obstructive lung disease. *Curr Environ Health Rep*. 2018;5(2):244–54.
8. Sharifi H, Ghanei M, Jamaati H, Masjedi MR, Aarabi M, Sharifpour A, et al. Burden of Obstructive Lung Disease study in Iran: First report of the prevalence and risk factors of COPD in five provinces. *Lung India*. 2019;36(1):14–9. doi:10.4103/lungindia.lungindia_129_18.
9. Young KA, Strand M, Ragland M, Kinney GL, Austin EE, Regan EA, et al. Pulmonary Subtypes Exhibit Differential Global Initiative for Chronic Obstructive Lung Disease Spirometry Stage Progression: The COPDGene® Study. *Chronic Obstructive Pulmonary Diseases (Miami, Fla)*. 2019;6(5):414–29. doi:10.15326/jcopdf.6.5.2019.0155.
10. Gedejberg A, Szépligeti SK, Wackerhausen LMH, 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(3):204–12.
11. McCartney CT, Weis MN, Ruppel GL, Nayak RP. Residual volume and total lung capacity to assess reversibility in obstructive lung disease. *Respir Care*. 2016;61(11):1505–12.
12. Price DB, Tinkleman DG, Halbert RJ, Nordyke RJ, Isonaka S, Nonikov D, et al. Symptom-based questionnaire for identifying COPD in smokers. *Respiration*. 2006;73(3):285–95. doi:10.1159/000090142.
13. Denguezli M, Daldoul H, Harrabi I, Gnatiuc L, Coton S, Burney P, et al. COPD in nonsmokers: reports from the Tunisian population-based burden of obstructive lung disease study. *PLoS one*. 2016;11(3):151981. doi:10.1371/journal.pone.0151981.
14. Regan EA, Lynch DA, Curran-Everett D, Curtis JL, Austin JH, Grenier PA. Clinical and radiologic disease in smokers with normal spirometry. *JAMA Internal Med*. 2015;175(9):1539–49.
15. Lee JY, Rhee CK, Jung KS, Yoo KH. Strategies for Management of the Early Chronic Obstructive Lung Disease. *Tuberc Respir Dis (Seoul)*. 2016;79(3):121–6. doi:10.4046/trd.2016.79.3.121.
16. Bajc M, Markstad H, Jarenbäck L, Tufvesson E, Bjermer L, Jögi J, et al. Grading obstructive lung disease using tomographic pulmonary scintigraphy in patients with chronic obstructive pulmonary disease (COPD) and long-term smokers. *Ann Nucl Med*. 2015;29(1):91–9.

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