Classification of Obstructive Pulmonary Diseases Through Clinical Characteristics in a Prospective Cohort Study

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ABSTRACT

Introduction: The use of clinical characteristics to differentiate obstructive lung diseases remains unclear, with limited supporting studies. This study aims to assess the effectiveness of signs and symptoms from clinical questionnaires in diagnosing obstructive lung diseases.

Methods: This prospective cohort study included patients diagnosed with chronic obstructive pulmonary disease (COPD), asthma, or asthma-COPD overlap (ACOS) based on spirometry. Clinical symptoms were gathered using questionnaires and incorporated into a multinomial logistic prediction model to evaluate their role in diagnosing obstructive lung diseases.

Results: A total of 1443 patients were analyzed: 177 (12.3%) with COPD, 135 (9.4%) with asthma, 163 (11.3%) with ACOS, and 968 (67.1%) without obstruction. The average age was 64 years (SD 13.23), with COPD patients being older than those with asthma or ACOS. Forced expiratory volume in the first second of expiration/forced vital capacity ratios after bronchodilator use were 61.1 (SD 8.48) for COPD, 78.9 (SD 6.99) for asthma, 57.3 (SD 9.48) for ACOS, and 81.7 (SD 7.15) for non-obstructed patients. The area under the curve for diagnosing COPD was 0.75, for asthma 0.68, and for ACOS 0.78 (all $P < 0.001$).

Conclusions: Clinical variables can identify patients with obstructive lung diseases effectively, offering strong diagnostic performance and precision.

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INTRODUCTION

Obstructive lung diseases are marked by airflow limitation caused by airway narrowing, which increases resistance to air movement and makes breathing more difficult.[1-3] Chronic obstructive pulmonary disease (COPD) affects between 12.1% and 55.2% of the population, and asthma affects between 13.3% and 61%, while asthma-COPD overlap syndrome (ACOS) is less common, affecting 1.6% to 4.5% of individuals.[4]

Obstructive lung diseases share common symptoms, including dyspnea, cough, expectoration, and wheezing, which can be identified through structured clinical questions.[4,5] Using clinical questionnaires along with pulmonary function tests improves diagnostic accuracy, with a sensitivity of 72% and specificity of 97% for COPD.[6-8] However, the ability to use clinical information alone to distinguish between different obstructive lung diseases remains debated.[9]

Using structured clinical questions can improve the quality of information for the differential diagnosis of obstructive lung diseases.[7-9] This study aims to evaluate how well symptoms gathered from these questions help in diagnosing COPD, asthma, and ACOS.

METHODS

We conducted a prospective cohort study at a hospital in Chía, Colombia, from 2017 to 2020. It aimed to assess the role of clinical symptoms in diagnosing obstructive lung diseases. Patients were enrolled sequentially during the study period and diagnosed with COPD, asthma, or ACOS based on pulmonary function test results.

Selection Criteria

The study included individuals over 18, with or without respiratory symptoms, regardless of severity. All participants underwent spirometry and answered standardized questions from validated questionnaires to assess for obstructive lung diseases.[6-9] Those who did not complete the questions, had poor-quality spirometry, or for whom there was no atopy information were excluded.

Variables

Study variables included age, sex, presence of respiratory symptoms, age at symptom onset, wheezing, cough, expectoration, dyspnea, smoking history (packs per year), and exposure to wood smoke. Data on symptoms were collected using clinical questionnaires, and accuracy was ensured by verification from at least 2 reviewers. Spirometry was performed according to American Thoracic Society/European Respiratory Society guidelines, and results were interpreted by specialists. Key measures included forced expiratory volume in the first second of expiration (FEV1), forced vital capacity (FVC), and the FEV1/FVC ratio pre- and post-bronchodilator. COPD was diagnosed with an FEV1/FVC ratio <0.7, while asthma and ACOS were diagnosed with an FEV1 increase of 200 ml and 12% post-bronchodilator. To reduce bias, the spirometer was calibrated before each session.

The population was divided into 4 groups based on spirometry results: (1) COPD (obstructive, non-reversible), (2) asthma non-obstructive (reversible), (3) ACOS (obstructive, reversible), and (4) normal (non-obstructive, non-reversible). Respiratory symptoms were assessed using the Lung Function Questionnaire (LFQ), COPD Diagnostic Questionnaire (CDQ), COPD Population Screener (COPD-PS), and the PUMA COPD questionnaire.[6-9]

The LFQ consists of 5 questions about coughing, expectoration, wheezing, dyspnea, and years of smoking, with scores ranging from 5 to 25 points. The CDQ has 8 questions covering age, years of smoking, body mass index (BMI), weather-related cough, and symptoms such as wheezing and allergies, with a score range of 0 to 38. The COPD-PS questionnaire asks 5 questions about shortness of breath, coughing, reduced daily activities, smoking history, and age, with scores from 0 to 10. The PUMA questionnaire includes 7 questions on sex, age, smoking history, dyspnea, expectoration, chronic cough, and previous spirometry, with scores from 0 to 9.[6-9]

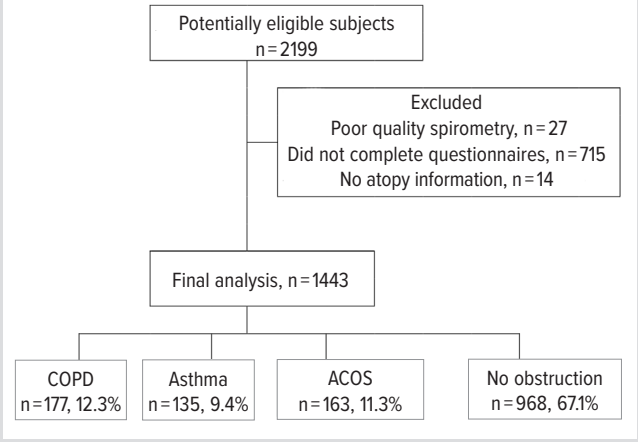
Sample Size

To determine the sample size, data were used from Pascoe et al's study, which reported a 70% sensitivity and specificity for diagnosing COPD, asthma, and ACOS.[3] Using a formula for diagnostic test confidence intervals—with a disease prevalence of 30%, 5% accuracy, and a 95% confidence level—the required minimum sample size was 1076 patients.

Data Analysis

Data were collected in Excel and analyzed using SPSS version 20 (IBM Corp). Descriptive analysis summarized quantitative variables as mean and standard deviation for normal distributions, or median and interquartile range for non-normal data. Qualitative variables were presented as absolute and relative frequencies. Bivariate analysis compared qualitative variables using chi-square, and quantitative variables using *t* test or Mann-Whitney U test, based on distribution. Variables related to obstructive lung diseases that were biologically plausible and statistically significant were included in a multinomial logistic regression model. Significant variables were used to calculate the area under the curve (AUC) for each disease, with $P<0.05$ considered significant.

Figure. Flowchart of Study Population



Abbreviations: COPD, chronic obstructive pulmonary disease; ACOS, asthma-COPD overlap syndrome.

Ethical Considerations

This study followed the ethical guidelines of the Declaration of Helsinki and national regulations (Resolution 8430 of 1993). It was considered risk-free, complying with Law 1266 of 2008 (Habeas Data) and Decree 1377 of 2013, ensuring confidentiality of all data.

RESULTS

A total of 1443 patients were included in the final analysis: 177 (12.3%) had COPD, 135 (9.4%) had asthma, 163 (11.3%) had ACOS, and 968 (67.1%) had no obstruction (Figure). The average age of the population was 64 years, with the COPD group being older than those with asthma or ACOS. Men made up 45% of the population, with 46% having a smoking history and 55% exposed to wood smoke. Baseline characteristics and group differences are shown in Table 1.

Pulmonary Function

The post-bronchodilator FEV1/FVC ratio was 61.1 (SD 8.48) in COPD, 78.9 (SD 6.99) in asthma, 57.3 (SD 9.48) in ACOS, and 81.7 (SD 7.15) in non-obstructed subjects. Significant FEV1 increases (200 ml and 12%) were observed in asthma (2.1, SD

Table 1. Baseline Characteristics of the Study Population

	Total n=1443	COPD n=177	Asthma n=135	ACOS n=163	No Obstruction n=968	*P* value
Age, mean (SD)	64.2 (13.23)	71.69 (11.36)	64.59 (12.76)	67.41 (11.20)	62.17 (13.34)	<0.01
Male sex, n (%)	643 (44.6)	97 (54.8)	48 (35.6)	97 (59.5)	401 (41.4)	<0.01
Full years of study, mean (SD)	9.03 (5.60)	6.61 (5.34)	8.93 (5.48)	8.31 (5.50)	9.60 (5.60)	<0.01
Clinical symptoms n (%)	1240 (85.9)	156 (88.1)	126 (93.3)	151 (92.6)	807 (83.4)	<0.01
Age onset of symptoms, mean (SD)	56.4 (17.94)	60.98 (18.46)	56.26 (18.72)	54.81 (20.55)	55.75 (17.07)	
Wheezing, n (%)	440 (30.5)	60 (33.9)	52 (38.5)	78 (47.9)	250 (25.8)	<0.01
Personal History						
Smoking n (%)	664 (46)	93 (52.5)	50 (37)	82 (50.3)	439 (45.4)	<0.01
Age of initiation of smoking, mean (SD)	18.7 (6.17)	17.61 (5.89)	19.52 (6.15)	17.35 (4.26)	250 (0.26)	
End of smoking age, mean (SD)	41.7 (16.36)	44.94 (15.54)	40.98 (16.41)	45.48 (17.50)	40.42 (16.15)	
Package/year index, mean (SD)	15.6 (24.49)	17.87 (26.51)	11.95 (13.89)	25 (24.38)	13.9 (24.64)	
Passive smoker, n (%)	267 (18.5)	30 (16.9)	23 (17)	33 (18.7)	181 (21.6)	0.64
Years of exposure, mean (SD)	24.2 (16.26)	26.28 (13.31)	18.86 (16.46)	24.06 (15.81)	24.62 (16.66)	
Wood smoke exposure, n (%)	793 (55)	124 (70.1)	76 (56.3)	105 (64.4)	488 (50.4)	<0.01
Years of exposure, mean (SD)	22.3 (4.70)	25.22 (4.36)	19.87 (5.59)	23.92 (4.80)	21.56 (4.59)	
History of atopy, n (%)	363 (25.2)	34 (19.2)	43 (31.9)	49 (30.1)	237 (24.5)	<0.01
Previous diagnosis of COPD, n (%)	401 (27.8)	79 (44.6)	35 (25.9)	85 (52.1)	202 (20.9)	<0.01
Previous asthma diagnosis, n (%)	213 (14.8)	19 (10.7)	30 (22.2)	44 (27)	120 (12.4)	<0.01

Abbreviations: COPD, chronic obstructive pulmonary disease; ACOS, asthma-COPD overlap syndrome.
Statistical significance $P<0.05$.

0.72) and ACOS (1.7, SD 0.61). Table 2 summarizes lung function data.

Table 2. Pulmonary Function

	Total n=443	COPD n=177	Asthma n=35	ACOS n=163	No Obstruction n=968
Weight kg, mean (SD)	70.8 (13.79)	69.0 (14.04)	70.7 (13.51)	67.2 (12.26)	71.8 (13.91)
Height cm, mean (SD)	160.0 (9.14)	159.6 (8.94)	158.1 (8.49)	160.8 (9.38)	160.2 (9.20)
Pulmonary function, mean (SD)					
FVC (L) pre-B2	3.0 (1.00)	2.9 (0.95)	2.5 (0.91)	2.6 (0.88)	3.1 (1.01)
FVC (L) post-B2	3.0 (0.98)	2.9 (0.98)	2.7 (0.94)	3.0 (0.93)	3.1 (0.99)
FEV1 (L) pre-B2	2.2 (0.82)	1.7 (0.63)	1.8 (0.63)	1.4 (0.58)	2.5 (0.77)
FEV1 (L) post-B2	2.3 (0.83)	1.8 (0.67)	2.1 (0.72)	1.7 (0.61)	2.5 (0.80)
FEV1 (%) change	8.0 (10.40)	5.2 (4.47)	19.9 (9.12)	26.1 (14.60)	4.0 (4.52)
FEV1/FVC pre-B2	73.4 (13.15)	60.2 (9.07)	73.9 (10.15)	53.5 (10.83)	79.1 (8.86)
FEV1/FVC post-B2	76.2 (12.15)	61.1 (8.48)	78.9 (6.99)	57.3 (9.84)	81.7 (7.15)

Abbreviations: FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; COPD, chronic obstructive pulmonary disease; ACOS, Asthma-COPD overlap syndrome.

Discriminative Power of Questionnaires

The CDQ had 4 out of 8 significant questions for differentiating diseases, COPD-PS had 4 of 5, PUMA had 6 of 7, and all LFQ questions showed discriminatory power. Significant questions are in Table 3, and selected variables formed a unified questionnaire (Table 4).

Diagnostic Performance

The AUC for diagnosing COPD was 0.75 (95% CI, 0.71-0.79; $P<0.001$, Supplemental Figure 1), for asthma 0.68 (95% CI, 0.63-0.72; $P<0.001$, Supplemental Figure 2), and for ACOS 0.78 (95% CI, 0.75-0.82; $P<0.001$, Supplemental Figure 3).

DISCUSSION

The study aimed to evaluate how well symptoms reported through questionnaires help identify obstructive lung diseases. Factors such as age, sex, smoking history, and symptoms of bronchial obstruction were useful for non-expert examiners in diagnosing COPD, asthma, or ACOS. While creating new questionnaires was not the goal, the findings suggest that asking the right questions about symptoms can help differentiate patients with these conditions.

Age is a useful factor in distinguishing between asthma and COPD. Holm et al noted a sharp rise in COPD prevalence after age 60, while asthma is more common under age 40 and remains stable throughout life.[10-13] In our study, COPD patients were older than those with asthma or ACOS.[3,14] While COPD is typically associated with men and asthma with women, a Canadian study found no gender differences for asthma or ACOS.[3,15,16] In our cohort, men were more likely to have COPD or ACOS, though a 2018 study showed ACOS was more frequent in women.[17]

COPD patients – especially in advanced stages – tend to have

Table 3. Variables Selected From the Validated Questionnaires

	Total n = 1443	COPD n = 177	Asthma n = 135	ACOS n = 163	No Obstruction n = 968	*P* value
COPD Diagnostic Questionnaire, mean (%)						
1. BMI < 25	452 (31)	63 (36)	38 (28)	65 (40)	286 (30)	< 0.01
BMI 25.4 – 29.7	629 (44)	80 (45)	56 (41)	74 (45)	419 (43)	
BMI > 29.7	362 (25)	34 (19)	41 (30)	24 (15)	263 (27)	
2. Does the weather affect the cough?						
Yes	860 (60)	107 (60)	86 (64)	124 (76)	543 (56)	< 0.01
3. In the cold do you have a cough and expectoration?						
Yes	658 (46)	89 (50)	58 (43)	95 (58)	416 (43)	< 0.01
4. Do you usually have a cough and phlegm in the morning?						
Yes	441 (31)	67 (38)	40 (30)	63 (39)	271 (28)	< 0.01
5. Do you wheeze?						
Very frequent	451 (31)	62 (35)	53 (39)	79 (48)	257 (27)	< 0.01
Never	992 (69)	115 (65)	82 (61)	84 (52)	711 (73)	
Lung Function Questionnaire, mean (%)						
1. How often do you cough up mucus?						
Very often	101 (7)	16 (9)	7 (5)	22 (13)	56 (6)	< 0.01
Frequently	183 (13)	28 (16)	14 (10)	30 (18)	111 (11)	
Sometimes	311 (22)	29 (16)	37 (27)	43 (26)	202 (21)	
Rarely	494 (34)	64 (36)	48 (36)	47 (29)	335 (35)	
Never	354 (25)	40 (23)	29 (21)	21 (13)	264 (27)	
2. How often do you feel noises in your chest (gasping, hissing, vibrating) when you breathe?						
Very often	99 (7)	18 (10)	8 (6)	21 (13)	52 (5)	< 0.01
Frequently	175 (12)	22 (12)	22 (16)	34 (21)	97 (10)	
Sometimes	352 (24)	44 (25)	35 (26)	57 (35)	216 (22)	
Rarely	234 (16)	27 (15)	27 (20)	25 (15)	155 (16)	
Never	583 (40)	66 (37)	43 32)	26 (16)	448 (46)	
3. How often do you feel short of breath during physical activity (walking up stairs or climbing a hill without stopping to rest)?						
Very often	321 (22)	46 (26)	34 (25)	57 (35)	184 (19)	0.026
Frequently	338 (23)	47 (27)	39 (29)	31 (19)	221 (23)	
Sometimes	306 (21)	33 (19)	33 (24)	25 (15)	215 (22)	
Rarely	191 (13)	19 (11)	17 (13)	24 (15)	131 (14)	
Never	287 (20)	32 (18)	12 (9)	26 (16)	217 (22)	
COPD Population Screener, mean (%)						
1. During the past 4 weeks, how many times did you feel short of breath?						
Never / rarely	683 (47)	69 (39)	60 (44)	56 (34)	498 (51)	< 0.01
Sometimes	403 (28)	53 (30)	47 (35)	41 (25)	262 (27)	
Most of the time / all of the time	357 (25)	55 (31)	28 (21)	66 (40)	208 (21)	
2. Do you ever cough up something, mucus or phlegm?						
Yes, every day	160 (11)	25 (14)	13 (10)	34 (21)	88 (9)	< 0.01
Some days of the month/ Almost every day of the week	394 (27)	52 (29)	43 (32)	55 (34)	244 (25)	
No / never / nly with occasional colds or chest infections	889 (62)	100 (56)	79 (59)	74 (45)	636 (66)	
3 During the past year, have you reduced your daily activities due to breathing problems?						
Yes, a lot	165 (11)	26 (15)	19 (14)	31 (19)	89 (9)	< 0.01
Yes	409 (28)	43 (24)	44 (33)	52 (32)	270 (28)	
No, not at all / almost nothing / I'm not sure	869 (60)	108 (61)	72 (53)	80 (49)	609 (63)	
4. Have you smoked at least 100 cigarettes in your life?						
Yes	594 (41)	89 (50)	50 (37)	75 (46)	380 (39)	< 0.01
PUMA COPD Questionnaire, mean (%)						
1. Dyspnea: Yes	895 (62)	121 (68)	95 (70)	116 (71)	563 (58)	< 0.01
2. Chronic expectoration: Yes	393 (27)	57 (32)	40 (30)	66 (40)	230 (24)	< 0.01
3. Chronic cough: Yes	683 (47)	95 (54)	68 (50)	91 (56)	429 (44)	< 0.01
4. Spirometry has been performed previously: Yes	679 (47)	112 (63)	67 (50)	96 (59)	404 (42)	< 0.01

Abbreviations: COPD, chronic obstructive pulmonary disease; ACOS, asthma-COPD overlap syndrome; COPD-PS, chronic obstructive pulmonary disease population screener.

Statistical significance $P < 0.05$.

Table 4. Likelihood Ratio Tests

Variable	*P* value
Age	< 0.01
Sex	< 0.01
Weight	< 0.01
Have you smoked at least 100 cigarettes in your entire life?	< 0.01
How many years have you smoked?	< 0.01
Have you ever been exposed to wood smoke in your life?	< 0.01
During the past 4 weeks, how many times did you feel short of breath?	< 0.01
How often do you feel short of breath during physical activity (walking upstairs or climbing a hill without stopping to rest)?	0.026
How often do you feel noises in your chest (gasping, hissing, vibrating) when you breathe?	< 0.01
Spirometry has been performed previously	< 0.01

Statistical significance $P < 0.05$.

lower BMI and muscle mass, unlike asthma patients, whose nutritional status remains stable.[18,19] Smoking history is a key differentiator in questionnaires between COPD and healthy individuals, as it is a clear risk factor for COPD but less so for asthma.[20] Smoking also plays a major role in ACOS diagnosis, according to Spanish guidelines.[4,20] In our study, the smoking history difference between COPD and asthma was over 15.5% and 13% between ACOS and asthma.

Current diagnostic criteria for obstructive lung diseases share common features, making it challenging to differentiate between them. Pascoe et al used a model of 41 patient factors—including demographics and symptoms—compared to pulmonary function tests, achieving 89% specificity and 62% sensitivity.[3] Key variables for distinguishing these diseases were smoking, age, allergies, and sputum expectoration. In our study, asking about severe dyspnea improved discriminatory power for COPD from 13% to 20%.[3,21]

Factors including age, nutrition, and sex can help identify clinical phenotypes, but they may be less clear in early stages or when multiple phenotypes develop.[22] Additionally, the absence of a "gold standard" test complicates efforts to differentiate obstructive lung diseases using only targeted questions.

Limitations

One limitation of our study is that it was conducted at a single center, which may limit the generalizability of the results. However, the large sample size still provides meaningful data. The higher male participation may have influenced the discriminatory power of this variable. Using spirometry as the final evaluation method could have caused some overlap in diagnoses, but it remains a valuable tool for distinguishing respiratory conditions. While a useful questionnaire was developed, further studies are needed to assess long-term outcomes, prognosis differences, and criteria for improving diagnostic accuracy in clinical practice.

CONCLUSIONS

Patients with obstructive lung diseases can be identified accurately using clinical variables, such as age, sex, weight, smoking history, and bronchial obstruction symptoms. These variables can be useful for non-experts in recognizing COPD, asthma, or ACOS.

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Appendices: Supplemental Figures available at www.wmjonline.org.

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