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Development of a simple screening tool for opportunistic COPD case finding in primary care in Latin America: The PUMA study

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ABSTRACT

Background and objective: **Opportunistic chronic obstructive pulmonary disease (COPD) case finding approaches for high-risk individuals with or without symptoms is a feasible option for disease identification. PUMA is an opportunistic case finding study conducted in primary care setting of Argentina, Colombia, Venezuela and Uruguay. The objectives were to measure COPD prevalence in an at-risk population visiting primary care for any reason, to assess the yield of this opportunistic approach and the accuracy of a score developed to detect COPD.**

Methods: **Subjects attending routine primary care visits, ≥40 years of age, current or former smokers or exposed to biomass smoke, completed a questionnaire and performed spirometry. COPD was defined as post-bronchodilator (post-BD) forced expiratory volume in 1 s (FEV_1)/forced vital capacity (FVC) < 0.70 and the lower limit of normal of FEV_1/FVC.**

Results: **A total of 1743 subjects completed the interview; 1540 performed acceptable spirometry. COPD prevalence was 20.1% ($n = 309$; ranging from 11.0% in Venezuela to 29.6% in Argentina) when defined using post-BD $FEV_1/FVC < 0.70$, and 14.7% ($n = 226$; ranging from 8.3% in Venezuela to 21.8% in Colombia) using the lower limit of normal. Logistic regression analysis for both definitions showed that the risk of COPD was significantly higher for persons >50 years, heavy smokers (>30 pack-years), with dyspnoea, and having prior spirometry. A simple score and a weighted score constructed using the following predictive factors: gender, age, pack-years smoking, dyspnoea, sputum, cough and spirometry, had a mean accuracy for detecting COPD (post-BD $FEV_1/FVC < 0.70$) of 76% and 79% for the simple and weighted scores, respectively.**

Conclusion: **This simple seven-item score is an accurate screening tool to select subjects for spirometry in primary care.**

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SUMMARY AT A GLANCE

In an at-risk population visiting primary care for any reason, COPD prevalence was as high as 20.1%; the risk being significantly higher for those >50 years, heavy smokers (>30 pack-years), with dyspnoea, and having prior spirometry. A simple seven-item score was an accurate screening tool to select patients for spirometry.

Clinical Trial registration: NCT01493544 at ClinicalTrials.gov

Key words: case finding, COPD, primary care, PUMA, screening score.

Abbreviations: AUC, area under curve; BD, bronchodilator; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; GOLD, Chronic Obstructive Lung Disease; LLN, lower limit of normal; NNT, number needed to treat; NNS, number needed to screen; OR, odds ratio; PNV, predictive negative value; PPV, predictive positive value; PUMA, Prevalence Study and Regular Practice, Diagnosis and Treatment, Among General Practitioners in Populations at Risk of COPD in Latin America; ROC, received operator curves.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common cause of morbidity and mortality worldwide.[1–4] Population-based studies report an overall COPD prevalence of 10%.[5–7] In Latin America, the PLATINO (the Latin American Project for Investigation of Obstructive Lung Disease) study showed a prevalence of 14.3%,[5] and an under-diagnosis of 89%.[8] One-third of patients detected using population-based studies or case finding approaches in primary care settings are asymptomatic and more than half have mild symptoms.[9–11]

As addressed in COPD recommendations,[12,13] different approaches have been used to identify COPD patients; these vary in setting, target groups, screening tools and diagnostic criteria.[14–18] People with known risk factors for COPD are important targets for screening and are most likely to encounter the healthcare system

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in the primary care setting. Consequently, accurate knowledge of COPD prevalence in this setting is critical for disease detection. Opportunistic case finding approaches in primary care are a feasible option for early COPD identification.

Information on COPD prevalence in this setting is scarce, and available data suggest a prevalence rate of around 20% in this population.[19,20] A study in Mexico reported a prevalence of 20.6%.[21]

Haroon *et al.*[15] found no difference in case finding yield between an opportunistic and a targeted postal approach for COPD over a 3–6-month period. However, extrapolation of the results to 1 year suggests that opportunistic approaches may be more efficient. Several studies have looked at developing screening tools to select persons at risk for further spirometric investigation.[22–26] The simpler and more accurate the screening tool, the more useful for identifying patients for spirometry diagnosis.

The aims of the present study were to measure the prevalence of COPD in an at-risk population of adults (≥40 years) attending primary care clinics and to assess the yield of this opportunistic case finding approach. We also assessed the accuracy of a simple and a weighted score for detecting COPD according to different diagnostic criteria.

METHODS

PUMA, the acronym after study original name (Prevalence Study and Regular Practice, Diagnosis and Treatment, Among General Practitioners in Populations at Risk of COPD in Latin America) (Clinical Trial Registration: NCT01493544) was conducted in the primary care setting of four countries: Argentina, Colombia, Venezuela and Uruguay. Complete methodology has been published.[27] Briefly, PUMA is a multicentre, multinational, cross-sectional, non-interventional study including primary care centres without direct connection with respiratory medicine specialists, selected to reflect national primary care practice in terms of geographical distribution (urban or rural) and healthcare sector (public or private). A higher percentage of the urban population were included (only 6% of the sites were from rural area). Subjects were recruited during routine spontaneous or scheduled appointment unrelated to the study. The study was approved by the ethics committees for each site. All patients gave written informed consent.

At-risk subjects were included if they were ≥40 years, current or ex-smokers (≥10 pack-years, ≥50 pipes/year or ≥50 cigars/year), and/or exposure to biomass smoke (wood or coal, for cooking or heating; exposure ≥ 100 h/year).

Participants completed a modified version of the PLATINO study questionnaire for information on factors potentially associated with COPD: demographics, smoking habits, education, employment, respiratory symptoms, use of respiratory medication and prior spirometric testing. Data on prior medical diagnosis of tuberculosis, asthma, chronic bronchitis, emphysema, COPD, self-reported exacerbations and hospitalizations were obtained. Spirometry was performed using the portable, ultrasound Easy One spirometer (ndd Medical Technologies, Zurich, Switzerland). Spirometry tests were performed at baseline and 15 min after bronchodilator (400 μg salbutamol), according to the American Thoracic Society criteria.

Definition and severity stratification of COPD proposed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) was used: post-bronchodilator (post-BD) forced expiratory volume in 1 s/forced vital capacity ($FEV_1/FVC < 0.70$).[12] The post-BD lower limit of normal (LLN) for FEV_1/FVC criteria was also used.

Statistical analysis

Descriptive analyses were done using absolute and relative frequencies for each variable, for the whole sample, and country stratified. Description of COPD individuals according to different criteria was performed. Logistic regression models with COPD as outcome adjusted for the main co-variables were performed; two scores for screening COPD cases (using post-BD $FEV_1/FVC < 0.70$ and post-BD LLN definitions) based on the results of the logistic regression (the adjusted odds ratio (OR)) and relevant clinical criteria were proposed: a simple score, one point was given to each category, starting from zero; and a weighted score, taking into account the coefficient of logistic regression (OR in natural logarithmic scale) multiplied by 10. Received operator curves (ROC) were drawn to calculate the area under the curve (AUC), sensibility and specificity, predictive and negative positive values and number needed to screen (NNS). Analyses were performed using STATA 13.1 software (StatCorp, College Station, Texas, USA).

RESULTS

Participation rates have been published previously.[27] A total of 1743 individuals completed interviews, and 1540 performed acceptable spirometry. Among them, 309 subjects had COPD defined by post-BD $FEV_1/FVC < 0.70$ and 226 by LLN. Up to 77% of the subjects did not have previous COPD diagnosis by post-BD $FEV_1/FVC < 0.70$ criteria.

Description of subjects' characteristics (overall and by country) is shown in Table 1. The proportion of men and women was similar, nearly half of subjects were ≥60 years, and around 65% were heavy smokers (>20 pack-years). Dyspnoea was the most common symptom (~50%); about one-third reported cough and phlegm. Previous spirometry had only been performed in 22% of subjects (ranging from 12% in Venezuela to 35% in Argentina).

Chronic obstructive pulmonary disease prevalence by post-BD $FEV_1/FVC < 0.70$ definition was 20.1% (ranging from 11% in Venezuela to 29.6% in Argentina), and 14.7% using the LLN definition (ranging from 8.3% in Venezuela to 21.8% in Colombia) (Figure S1).

Description of COPD subjects by two definitions is shown in Table 2 and in Table S1. COPD patients were more likely to be ≥60 years, heavy smokers (>30 pack-years), with moderate to very severe airway

Table 1 Population baseline characteristics (total and by country)

Variable	Total *n* (%)	Argentina *n* (%)	Colombia *n* (%)	Venezuela *n* (%)	Uruguay *n* (%)
Total no. of patients	1743	454	465	721	103
Gender					
Female	876 (50.3)	220 (48.5)	202 (43.4)	402 (55.8)	52 (50.5)
Male	867 (49.7)	234 (51.5)	263 (56.6)	319 (44.2)	51 (49.5)
Age (complete years)					
40–49	328 (18.8)	82 (18.1)	46 (9.9)	184 (25.5)	16 (15.5)
50–59	589 (33.8)	124 (27.3)	141 (30.3)	276 (38.3)	48 (46.6)
60 +	826 (47.4)	248 (54.6)	278 (59.8)	261 (36.2)	39 (37.9)
Pack years smoked during life					
<20	585 (34.6)	103 (22.8)	171 (36.9)	278 (40.5)	33 (36.7)
20–30	366 (21.6)	88 (19.5)	91 (19.6)	165 (24.1)	22 (24.4)
>30	740 (43.8)	260 (57.7)	202 (43.5)	243 (35.4)	35 (38.9)
Exposure to biomass (cooking or heating)					
≤10 years	1160 (66.6)	369 (81.3)	184 (39.6)	544 (75.6)	63 (61.2)
>10 years	582 (33.4)	85 (18.7)	281 (60.4)	176 (24.4)	40 (38.8)
Dyspnoea					
No	860 (53.2)	193 (48.1)	206 (47.4)	410 (58.7)	51 (63.0)
Yes	756 (46.8)	208 (51.9)	229 (52.6)	289 (41.3)	30 (37.0
Chronic phlegm					
No	1220 (70.0)	281 (61.9)	311 (66.9)	554 (76.8)	74 (71.8)
Yes	523 (30.0)	173 (38.1)	154 (33.1)	167 (23.2)	29 (28.2)
Chronic cough					
No	1172 (67.2)	294 (64.8)	304 (65.4)	499 (69.2)	75 (72.8)
Yes	571 (32.8)	160 (35.2)	161 (34.6)	222 (30.8)	28 (27.2)
Previous spirometry performed during life					
No	1357 (77.9)	296 (65.2)	408 (87.7)	581 (80.7)	72 (69.9)
Yes	385 (22.1)	158 (34.8)	57 (12.3)	139 (19.3)	31 (30.1)

obstruction (GOLD ≥ 2). Dyspnoea was the most common symptom (63%), whereas less than half reported cough and phlegm. Previous spirometry was reported in only 37%.

Logistic regression analysis for COPD as an outcome according to both definitions showed that crude and adjusted OR for COPD were higher among older persons (>50 years), greater exposure to smoke (>30 pack-years), presence of dyspnoea and prior spirometry performed during life (Table 3 and Table S2). We built a proposed score for COPD based on the OR adjusted for the following predictive factors: gender, age, pack-years smoking, dyspnoea and spirometry, as well as other relevant COPD clinical criteria such as sputum, cough (Table 3 and Table S2). When building the simple score, 1 point for each variable category was used (Table 4). For the weighted score, the β coefficient of the adjusted logistic regression model (Table 3), multiplied by 10 and without any decimal, was used (Table 4).

The AUCs for the simple score for COPD as outcome are shown in Figure S2 (post-BD $FEV_1/FVC < 0.7$) and Figure S3 (post-BD LLN). Sensitivity, specificity, predictive positive value (PPV), predictive negative value (PNV) and NNS for each cut-off point of the simple score are shown in Table 5 and Table S3. The mean accuracy of the simple score for detecting COPD using post-BD $FEV_1/FVC < 0.70$ and LLN definitions are 76% and 73%, respectively. The best cut-off point according to Youden's index (sensitivity + specificity) in the simple score was ≥5 for both definitions. Using the post-BD $FEV_1/FVC < 0.70$ definition, a subject having a score of <5 using the simple score has a 91% chance of not having COPD (Table 5). A similar score was observed with the LLN (<5 has a 93% chance of not having COPD) (Table S3).

The AUCs for the weighted score for COPD are shown in Figure S2 (post-BD $FEV_1/FVC < 0.70$) and Figure S3 (post-BD LLN). Sensitivity, specificity, PPV, PNV, and NNS for each cut-off point of the weighted score are shown in Table 6 and Table S4. The mean accuracy of the weighted score for detecting COPD using post-BD $FEV_1/FVC < 0.70$ and LLN definitions are 79% and 75%, respectively. The best sensitivity, specificity, PPV and PNV for the weighted score was ≥25 points (for both COPD definitions).

DISCUSSION

The principal outcomes of this opportunistic COPD case finding study in an at-risk population attending primary care were as follows: first, COPD prevalence was 20.1% and 14.7% using post-BD $FEV_1/FVC < 0.70$ and LLN definitions, respectively. Second, COPD was associated with increased age, greater exposure to smoking, presence of dyspnoea and prior spirometry performed during life. Third, the accuracy of simple and weighted scores for detecting COPD according to the post-BD $FEV_1/FVC < 0.70$ definition were 76% and 79%, respectively.

Table 2 Patients' baseline characteristics (total and by country) in individuals with chronic obstructive pulmonary disease (defined as post-bronchodilator forced expiratory volume in 1 s/forced vital capacity < 0.70, *n* = 309)

Variable	Total *n* (%)	Argentina *n* (%)	Colombia *n* (%)	Venezuela *n* (%)	Uruguay *n* (%)
Gender					
Female	136 (44.0)	53 (40.2)	33 (38.4)	41 (56.2)	9 (50.0)
Male	173 (56.0)	79 (59.9)	53 (61.6)	32 (43.8)	9 (50.0)
Age (complete years)					
40–49	7 (2.3)	3 (2.3)	1 (1.2)	3 (4.1)	0 (0.0)
50–59	71 (23.0)	24 (18.2)	16 (18.6)	24 (32.9)	7 (38.9)
60 +	231 (74.7)	105 (79.6)	69 (80.2)	46 (63.0)	11 (61.1)
Pack years smoked during life					
<20	54 (18.0)	17 (13.2)	14 (16.3)	19 (27.1)	4 (26.7)
20–30	48 (16.0)	19 (14.7)	18 (20.9)	9 (12.9)	2 (13.3)
>30	198 (66.0)	93 (72.10)	54 (62.8)	42 (60.0)	9 (60.0)
Exposure to biomass (cooking or heating)					
≤10 years	185 (59.9)	99 (75.0)	27 (31.4)	50 (68.5)	9 (50.0)
>10 years	124 (40.1)	33 (25.0)	59 (68.6)	23 (31.5)	9 (50.0)
Dyspnoea					
No	104 (36.4)	44 (37.0)	24 (29.3)	30 (42.3)	6 (42.9)
Yes	182 (63.6)	75 (63.0)	58 (70.7)	41 (57.7)	8 (57.1)
Chronic phlegm					
No	170 (55.0)	64 (48.5)	47 (54.7)	49 (67.1)	10 (55.6)
Yes	139 (45.0)	68 (51.5)	39 (45.3)	24 (32.9)	8 (44.4)
Chronic cough					
No	174 (56.3)	72 (54.6)	45 (52.3)	48 (65.8)	9 (50.0)
Yes	135 (43.7)	60 (45.4)	41 (47.7)	25 (34.2)	9 (50.0)
Chronic Obstructive Lung Disease stages					
I	53 (17.1)	22 (16.7)	13 (15.1)	13 (17.8)	5 (27.8)
II	169 (54.7)	71 (53.8)	43 (50.0)	42 (57.5)	13 (72.2)
III–IV	87 (28.2)	39 (29.6)	30 (34.9)	18 (24.7)	0 (0.0)
Previous spirometry performed during life					
No	195 (63.1)	60 (54.4)	74 (86.1)	52 (71.2)	9 (50.0)
Yes	114 (36.9)	72 (54.6)	12 (13.9)	21 (28.8)	9 (50.0)

Accurate knowledge of COPD prevalence in primary care has been considered critical to planning strategies for detection and management of the disease. COPD prevalence in this setting has been analysed elsewhere.[18,19,28–30] Using a similar design to the present study (opportunistic case finding), Hill *et al.*[19] measured COPD prevalence in an at-risk population (≥40 years with smoking-history ≥20 pack-years) who visited primary care for any reason. Of the 1003 participants, 208 met the criteria for COPD (GOLD ≥2) with a prevalence of 20.7%. Cough was the most common symptom (53.7%). In rural primary care settings, Dales *et al.*[28] determined COPD prevalence in smokers (≥35 years) presenting for any reason. Airflow obstruction (pre-BD $FEV_1/FVC < 0.70$) prevalence was 17.4%; 59.2% had dyspnoea and 56.7% wheeze. Other studies have reported a prevalence of 13% in patients at risk in primary care.[29] When the presence of respiratory symptoms was considered in the selection of subjects at risk for COPD, prevalence increased to 34.8–47.4%.[18,30] The results of the present study showed a COPD prevalence of 20.1% by post-BD $FEV_1/FVC < 0.70$ definition and 14.7% using LLN. Dyspnoea was the most common symptom (63%).

These results indicate that criteria used to define COPD have a significant influence on the prevalence, so it is essential to know the definition used when analysing the prevalence. Additionally, it is important to be aware of differences in population samples (multinational vs national) and inclusion criteria (smoking exposure and presence of symptoms) as this might influence prevalence findings. Smoking exposure criteria used here was ≥10 pack-years, whereas Hill *et al.*[19] used ≥20 pack-years. The PUMA study includes individuals from an international multicentre sample while others are frequently national primary care samples.[18,19,28–30] In PUMA, as well as in other studies,[19,28,29] COPD prevalence was lower compared with studies with the presence of respiratory symptoms as an inclusion criterion.[18,30] Detection of COPD is, therefore, feasible in general practice by offering spirometry to individuals with relevant exposure, particularly those with respiratory symptoms; that is, the concomitant presence of symptoms in exposed individuals increases the likelihood of identify patients with COPD in primary care setting.

Screening an at-risk population of 11 027 subjects, smokers or ex-smokers, Zielinski *et al.*[31] found association of airflow limitation with age and pack-years. In a sample of 3955 individuals screened for work-related medical evaluation, Ohar *et al.*[32] reported

Table 3 Logistic regression analysis (chronic obstructive pulmonary disease as outcomes, by post-BD $FEV_1/FVC < 0.70$ definition) for score proposal created using baseline characteristics

	Post-BD $FEV_1/FVC < 0.70$			
	Prevalence	Crude	Adjusted†	Coefficient
Variable	%	OR (95% CI)	OR (95% CI)	(β)
Gender				
Female	17.3	1.00	1.00	0.0
Male	22.9	1.42 (1.10; 1.82)	1.23 (0.92; 1.66)	0.2
Age (complete years)				
40–49	2.3	1.00	1.00	0.0
50–59	13.1	6.31 (2.86; 13.91)	5.07 (2.25; 11.44)	1.6
60+	33.1	20.70 (9.62; 44.55)	15.19 (6.94; 33.19)	2.7
Pack years smoked during life				
<20	10.8	1.00	1.00	0.0
20–30	14.8	1.43 (0.94; 2.17)	1.21 (0.76; 1.92)	0.1
>30	29.8	3.51 (2.53; 4.87)	2.23 (1.55; 3.21)	0.8
Dyspnoea				
No	13.5	1.00	1.00	0.0
Yes	27.7	2.47 (1.89; 3.23)	1.93 (1.43; 2.61)	0.7
Chronic phlegm				
No	15.7	1.00	1.00	0.0
Yes	30.3	2.33 (1.80; 3.01)	1.37 (0.99; 1.90)	0.3
Chronic cough				
No	16.7	1.00	1.00	0.0
Yes	27.2	1.86 (1.44; 2.41)	1.38 (0.99; 1.91)	0.3
Previous spirometry performed during life				
No	16.4	1.00	1.00	0.0
Yes	32.5	2.45 (1.87; 3.21)	2.04 (1.47; 2.81)	0.7

†Adjusted for all variables included in table.

BD, bronchodilator; FEV_1 forced expiratory volume in 1s; FVC, forced vital capacity.

Table 4 Points conceded for each variable in each score

Variable		Simple score	Weighted score†
Gender	Female	0	0
	Male	1	2
Age (complete years)	40–49	0	0
	50–59	1	9
	60+	2	16
Pack years smoked during life	<20	0	0
	20–30	1	1
	>30	2	7
Dyspnoea	No	0	0
	Yes	1	8
Chronic phlegm	No	0	0
	Yes	1	3
Chronic cough	No	0	0
	Yes	1	3
Previous spirometry performed during life	No	0	0
	Yes	1	5

†To build the score, we used the β coefficient of adjusted logistic regression model, multiplied by 10 and without any decimal.

that airflow obstruction was associated with smoking history, cough, dyspnoea, sputum and wheeze. Smoking showed the highest OR association with COPD, significantly greater than the unadjusted OR for any of the four respiratory symptoms evaluated. While absence of symptoms predicted the absence of COPD, the presence of symptoms poorly predicted the presence of airflow limitation in smokers at-risk for COPD. Sensitivity, specificity, predictive values and relative risk of specific respiratory symptoms for COPD compared with the absence of these symptoms were modest.[32] In our study, COPD was higher among older subjects (>50 years), with increased exposure to smoking (>30 pack-years), presence of dyspnoea and prior spirometry performed during life.

Different questionnaires have been developed for COPD case finding in primary care based on variables associated with increased or decreased risk of COPD.[23–25,33] Recently, Stanley *et al.*,[26] using the COPD Diagnostic Questionnaire, found that it did not perform well in identifying people with COPD when compared with spirometry. The ROC AUC of 0.71 being fair although higher than the one reported by other authors (sensitivity: 65%; specificity: 54%)[34] with very low accuracy (ROC AUC 0.65). Bergna *et al.*[35] developed a simple, binary response scale (yes/no) screening questionnaire (CODE questionnaire) to identify patients with COPD in a smoking population. Variables selected for the final questionnaire were based on univariate and multivariate analysis and clinical criteria (age≥50 years, smoking history≥30 pack-years, male gender, chronic cough, phlegm and dyspnoea). For a cut-off value of 3 points, sensitivity

Table 5 Sensitivity, specificity, PPV, PNV for each cut-off point of proposed score (1 point for each category variable)

Score	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	PNV % (95% CI)	NNS
Post-bronchodilator forced expiratory volume in 1 s/forced vital capacity < 0.70 as outcome					
≥1	100.0 (98.7; 100.0)	2.4 (1.5; 3.4)	20.5 (18.4; 22.7)	100.0 (86.8; 100.0)	5
≥2	99.3 (97.4; 99.9)	12.5 (10.7; 14.6)	22.2 (19.9; 24.6)	98.6 (95.0; 99.8)	5
≥3	95.3 (92.2; 97.5)	28.2 (25.5; 30.9)	25.0 (22.5; 27.8)	96.0 (93.3; 97.9)	5
≥4	87.1 (82.6; 90.8)	45.5 (52.5; 48.5)	28.7 (25.7; 31.9)	93.3 (90.9; 95.3)	5
≥5	**74.2 (68.6; 79.2)**	**64.8 (61.9; 67.6)**	**34.7 (30.9; 38.6)**	**90.9 (88.7; 92.8)**	**4**
≥6	55.2 (49.2; 61.1)	81.9 (79.6; 84.2)	43.5 (38.3; 48.4)	87.9 (85.5; 89.8)	3
≥7	34.4 (28.8; 40.3)	92.7 (91.0; 94.2)	54.2 (46.4; 61.7)	84.9 (82.7; 86.8)	3
≥8	13.3 (9.5; 17.8)	97.7 (96.6; 98.5)	58.7 (45.6; 71.0)	81.7 (79.5; 83.8)	2
≥9	2.9 (1.3; 5.6)	99.6 (99.1; 99.9)	66.7 (34.9; 90.1)	80.3 (78.1; 82.4)	2

PPV, predictive positive value; PNV, predictive negative value; NNS, number needed to screen. *In bold*: best cut-off point according to Youden's index (sensitivity + specificity).

Table 6 Sensitivity, specificity, PPV, PNV for each cut-off point of weighted score

Score	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	PNV % (95% CI)	NNS
Post-bronchodilator forced expiratory volume in 1 s/forced vital capacity < 0.70 as outcome					
≥5	99.6 (98.0; 100.0)	8.6 (7.0; 10.4)	21.5 (19.3, 23.9)	99.0 (94.3; 100.0)	5
≥10	98.9 (96.9; 99.8)	19.9 (17.5; 22.3)	23.7 (21.3; 26.3)	98.7 (96.1; 99.7)	4
≥15	95.7 (92.6; 97.8)	30.7 (28.0; 33.5)	25.8 (23.2; 28.6)	96.6 (94.1; 98.2)	4
≥20	83.5 (78.6; 87.7)	52.2 (49.2; 55.1)	30.5 (27.3; 33.9)	92.6 (90.3; 94.6)	4
≥25	**76.3 (70.9; 81.2)**	**69.3 (66.5; 72.0)**	**38.5 (34.4; 42.7)**	**92.1 (90.0; 93.8)**	**3**
≥30	55.9 (49.9; 61.8)	85.3 (83.1; 87.3)	48.9 (43.3; 54.5)	88.5 (86.4; 90.3)	3
≥35	29.4 (24.1; 35.1)	94.6 (93.1; 95.8)	57.7 (49.2; 66.0)	84.2 (82.0; 86.2)	2
≥40	7.5 (4.6; 11.3)	98.6 (97.8; 99.2)	58.3 (40.8; 74.5)	80.9 (78.7; 83.0)	3

PPV, predictive positive value; PNV, predictive negative value; NNT, number needed to screen. *In bold:* best cut-off point according to Youden's index (sensitivity + specificity).

was 79% and specificity 46%. The authors concluded that the ability to discriminate between subjects with and without COPD was good (ROC AUC 0.75). In our opinion, this study[35] has some limitations that deserve comment: it was conducted in 10 public hospitals in Argentina (one country) with possible direct connection with respiratory medicine specialists, and subjects with a previous diagnosis of COPD, or asthma were excluded, so the patients excluded from the study may have biased the outcome. In this study, no comparison was done with a weighted model, because this type of score was not developed.

Our results allowed building a simple and a weighted score for subsequent spirometry performance with the following variables: gender, age, pack-years smoking, dyspnoea, sputum, cough and data of previous spirometry. The best cut-off point of the scores was chosen according to Youden's index (≥25 points for weighted score and ≥5 for simple score) and used to determinate the discriminatory power. The discriminatory power represented by ROC curves was moderate to good for both scores (simple score ROC AUC 0.76; weighted score ROC AUC 0.79). Using a weighted score cut-off of ≥25 points, the sensitivity and specificity were 76.3% and 69.3%, respectively; a simple score cut-off of ≥5 has a sensitivity of 74.2% and a specificity of 64.8%.A subject with a weighted score value of <25 or a simple score value of <5 has a 92% and a 91% (PNV) chance of not having COPD, respectively. A perfect combination of sensitivity and specificity is not usually feasible: the higher the sensitivity, the lower the specificity. For COPD screening, high sensitivity is probably more important than high specificity as we want to miss as few patients with COPD as possible, at the expense of diagnosing more patients 'at risk' of COPD.

Our results, are consistent with others[34,35] showing that gender, age, smoking exposure and respiratory symptoms are the main features for developing a COPD screening questionnaire. However, compared with other studies,[34,35] the accuracy of the PUMA score to discriminate between subjects with and without COPD appears to be better based on the observed ROC AUC, sensitivity, specificity, PPV and PNV values for the selected cut-off points. However, it is necessary to validate this proposed tool in other cohorts and thereby confirm its clinical usefulness for screening COPD cases.

Finally, this study has some limitations. It is possible that our results do not apply to all Latin America as the study was only done in 57 centres and the sample size varied among countries (104 eligible subjects in Uruguay; 726 in Venezuela); this was because of limited resources of countries and availability of

centres to participate. It is possible that some results did not reach statistical significance as a result of sample size and lack of power, despite the efforts made to ensure a representative sample; hence, it may be important to perform an external validity on the questionnaire as the current sample population might, in part, be selected based on convenience. Nevertheless, the procedure used was the most reasonable in view of the operational possibilities in each country. Only 6% of the study sites were from rural area, so this area does not have the same representativeness as urban. To avoid selection bias in the PUMA study, centres were selected on the basis of available lists of primary care physicians, and the study subjects were those who visited the centre spontaneously. In addition, it is important to comment that the PUMA score was developed in this cohort, so it is necessary to validate this score in other populations.

In summary, this study assesses the yield of an opportunistic case finding approach for detecting COPD cases in an at-risk population of Latin Americans in a primary care setting. The prevalence of COPD in this setting was 20.1% (post-BD $FEV_1/FVC < 0.70$). In addition, we developed a screening tool (PUMA scores) for selecting subjects for spirometry (an essential requirement for COPD diagnosis) that showed a relevant accuracy for detecting COPD using post-BD $FEV_1/FVC < 0.70$ (simple 76% and weighted 79%) and LLN (simple 73% and weighted 75%) definitions. Future validation of these tools is necessary in other cohorts to confirm its clinical usefulness for screening COPD cases.

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Disclosure Statement

Valentina Di Boscio is an employee of AstraZeneca Latin America.

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Supplementary Information

Additional Supplementary Information can be accessed via the *html* version of this article at the publisher's website:

Figure S1 Prevalence of COPD based on the post-BD $FEV_1/FVC < 0.70$ and LLN definitions.

Figure S2 Area under curve for the weighted score and COPD as outcome using post-BD $FEV_1/FVC < 0.70$ definition.

Figure S3 Area under curve for the simple score (1 point for each variable category) and COPD as outcome using post-BD LLN definition.

Table S1 Patients' baseline characteristics (total and by country) in individuals with COPD

Table S2 Logistic regression analysis (COPD as outcome, Post-BD LLN definition) for score proposal created using baseline characteristics.

Table S3 Sensitivity, specificity, PPV, PNV for each cut-off point of proposed score

Table S4 Sensitivity, specificity, PPV, PNV for each cut-off point of weighted score.