

Pneumologia

Tackling the burden of underdiagnosed COPD with PUMA: Screening questionnaire approach in Indonesia's primary healthcare facilities

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Abstract

English:

Chronic obstructive pulmonary disease (COPD) remains a global challenge. Despite the expanding burden, worldwide study shows that 60%–86% of people with COPD are still not diagnosed. Proyecto Latinoamericano de Investigación en Obstrucción Pulmonar (PUMA) is known as a COPD screening tool in Latin America. This study aims to determine the sensitivity and specificity of the PUMA questionnaire as a COPD screening tool in the Indonesian population. This is a cross-sectional study in several primary care facilities in Jakarta, Indonesia, from July 2019 to January 2020. Participants with PUMA score ≥ 5 were considered high-risk COPD and proceeded to spirometry examination. COPD diagnoses were based on Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. A total of 70 high-risk COPD participants were recruited. The receiver operating curve (ROC) curve shows PUMA as a useful diagnostic tool with the area under the curve (AUC) = 0.736 ($P = 0.011$). The optimal cut-off of PUMA score for COPD diagnosis is 5 with high sensitivity (92%) and enough specificity (60%). There is no difference in PUMA scores among GOLD classifications ($P > 0.05$). PUMA score with a cut-off value ≥ 5 can be used as a good screening tool for identifying patients suspected of having COPD.

Keywords

COPD • lung obstruction • PUMA • screening • early detection

Abordarea poverii BPOC subdiagnosticate cu PUMA: abordarea chestionarului de screening în Indonezia unități de asistență medicală primară

Rezumat

Romanian:

Boala pulmonară obstructivă cronică (BPOC) continuă să reprezinte o provocare globală. În ciuda creșterii incidenței, studiile la nivel mondial indică faptul că între 60% și 86% dintre persoanele cu BPOC rămân nediate diagnosticate. Chestionarul Proyecto Latinoamericano de Investigación en Obstrucción Pulmonar (PUMA) este recunoscut ca instrument de screening pentru BPOC în America Latină. Studiul de față își propune să determine sensibilitatea și specificitatea chestionarului PUMA ca instrument de screening pentru BPOC în populația indoneziană. Acesta este un studiu transversal realizat în mai multe unități de asistență medicală primară din Jakarta, Indonezia, în perioada iulie 2019 – ianuarie 2020. Participanții cu un scor PUMA ≥ 5 au fost considerați cu risc ridicat de BPOC și au fost supuși spirometriei. Diagnosticul de BPOC a fost stabilit conform criteriilor Global Initiative for Chronic Obstructive Lung Disease (GOLD). În total, au fost incluși 70 de participanți cu risc crescut de BPOC. Curba ROC (receiver operating curve) a demonstrat că PUMA este un instrument util pentru diagnostic, aria de sub curbă (AUC) fiind de 0,736 ($P = 0,011$). Valoarea optimă de prag a scorului PUMA pentru diagnosticul BPOC este 5, având o sensibilitate ridicată (92%) și o specificitate acceptabilă (60%). Nu au existat diferențe semnificative ale scorurilor PUMA între clasele GOLD ($P > 0,05$). Astfel, scorul PUMA cu valoarea de prag ≥ 5 poate fi utilizat ca instrument eficient de screening pentru identificarea pacienților suspecți de BPOC.

Cuvinte-cheie

BPOC • sindrom obstructiv • PUMA • screening • diagnostic precoce

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Introduction

Chronic obstructive pulmonary disease (COPD) remains a global burden by causing morbidity and mortality that continuously increases in various regions. Throughout the globe, COPD accounts for 544 million cases in 2017 (1). The incidence doubled compared to the year before that reached 251 million cases, even tripled compared to 2 years prior with 174 million cases (2). World Health Organization (WHO) stated that COPD is the third leading cause of death worldwide, causing up to 3.23 million deaths in 2019 (3). COPD prevalence increases five-fold in patients >65 years old compared with patients <40 years old. In low- and middle-income countries, COPD deaths <70 years reached 90%, with no guarantee of sufficient quality of life for the remaining 10% (4). A study from South-East Asian countries estimated more than 6% prevalence of COPD in China and Vietnam (4). In Indonesia, COPD prevalence is around 5.6% which is equivalent to 4.8 million people (5). The number is estimated to increase along with elevating smokers' prevalence. In 2012, COPD prevalence in Asia Pacific recorded 6.2% with 4.5% from Indonesia (6).

The irreversible airway obstruction in COPD was associated with a negative impact on quality of life (4). Starting with the dependence on oxygen treatment, increased visits to emergency facilities, and furthermore to recurrent hospitalisation (4). In fact, the overall 5-year-survival of COPD patients ranges from 56% to 92%, depending on disease severity (1). In 2001, the European Respiratory Society (ERS) calculated the annual cost of COPD, which was estimated at around 38.7 billion euros (4). The huge expenses originate from 73% inability to work, 12% ambulatory care, 7.5% hospitalisation, and 7.5% medication. These significant cost problems supplement COPD burden even more (4).

Despite the expanding burden, worldwide study shows that 60%–86% of people with COPD are still not diagnosed (7). These could restrict health facilities from decreasing the disease burden through optimal management. The nationwide multisite COPD study, known as the COLD study, has 1403 participants. Among the total participants, 13.7% are undiagnosed (4). These undiagnosed cases raise a big concern, especially for people with known risk factors (8). They are important targets knowing that the chances of developing COPD could rise two-fold to five-fold (4).

The objective of screening was to detect airflow obstruction with accuracy even in patients with minimum symptoms (4). Early detection of COPD can be made by general practitioners in primary care, then followed by early interventions that may improve quality of life and survival. Experts have elaborate scoring systems to detect COPD by using spirometers. The system was known as the gold standard for assessing airflow obstruction with 97.7%

sensitivity and 91.2% specificity. However, this approach might not be suitable for all settings, considering the standard device availability and health workers' competence (5). These challenges might contribute to underdiagnosed COPD cases. Hence, sufficient screening criteria are needed to tackle the problem.

The PUMA questionnaire was developed in a multicentre and multinational study for primary care settings in Latin America (9). The implementation of this simple questionnaire, which consists of seven questions, makes it applicable for primary care settings that have limitations on undergoing COPD gold standard test (9). This approach is expected to increase the detection rate which hopefully tackles the late diagnosis burden of COPD, preserving the quality of life and clinical outcome (10). There has been no previous study on the use of PUMA scores to screen high-risk patients in primary care settings in Indonesia. This study aims to determine the sensitivity and specificity of the PUMA questionnaire as a COPD screening tool in the Indonesian population. The findings are expected to contribute to PUMA questionnaire usage in Indonesia's primary care settings.

Subjects and methods

Design and study population

This was a cross-sectional study conducted in several primary healthcare facilities. The subjects were from five different primary healthcare facilities located in the same district. Convenience sampling was implemented, and a total of 537 adult participants participated. Among them, 103 subjects were identified as high-risk participants who underwent spirometry examination. However, 3 participants failed to manoeuvre, and 30 participants did not come on the examination day, leaving a total of 70 COPD high-risk participants who completed the research procedure. Ethical approval was obtained from the Ethical Committee for Health Research, Universitas Indonesia, Persahabatan Hospital.

Participants were considered eligible if they were Indonesian Residents with the age of ≥ 40 years old and agreed to participate in the study, including the spirometry examination. Participants who have previously been diagnosed with COPD or met spirometry contradiction criteria including chest, lung, abdominal, or brain surgery; retinal detachment or eye surgery; hospitalisation for any heart complaint in the last 3 months; and inability to cooperate during the procedure were excluded from the study.

Study procedures

Patients who visited the general clinic were recruited as participants. They were screened to ensure that they met the

inclusion criteria. Eligible participants were given a detailed explanation of the study, and written consent was obtained. After collecting demographic and medical history data (hypertension, diabetes, tuberculosis, asthma, heart failure, acute coronary syndrome, hepatitis B, and hepatitis C), the participants shortly interviewed based on PUMA questionnaire components. The interview was conducted by a trained physician. Patients who met the PUMA cut-off of ≥ 5 points were referred to Persahabatan National Respiratory Referral Hospital and underwent spirometry examination the following day.

Spirometry examination was conducted by a trained physician according to standard guidelines. Portable spirometers (Spirometry System HI-801, CHEST Miyagi Factory, Japan) were calibrated before usage. Each participant completed baseline spirometry and repeated 15 min later after bronchodilator administration (400 μ g salbutamol) based on the American Thoracic Society (ATS) standard. The spirometry results were analysed twice by two competent physicians. The PUMA interview, spirometry examination, and spirometry result analysis were conducted by different physicians.

COPD diagnosis

Based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD), COPD is defined as a common, preventable, and treatable disease. It is characterised by persistent respiratory symptoms and airflow limitation that are due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases. COPD should be considered in any patient with dyspnoea, chronic cough, sputum production, and/or history of risk factor exposure. Spirometry is required to determine diagnosis. The presence of forced expiratory volume in 1 s (FEV_1)/forced vital capacity (FVC) < 0.70 post-bronchodilator confirms the presence of persistent airflow limitation.

PUMA questionnaire

PUMA questionnaire was developed as a screening tool for selecting subjects who needed spirometry tests because of suspicion towards COPD. The acronym PUMA came from its original study name which stands for Prevalence Study and Regular Practice, Diagnosis and Treatment, Among General Practitioners in Populations at Risk of COPD in Latin America. It was a multicentre study located in four countries: Argentina, Colombia, Venezuela, and Uruguay. The outcome of the study was screening tools for detecting COPD according to different diagnostic criteria.

The questionnaire has seven questions consisting of four objective questions about COPD risk factors: gender (0–2 points), age, pack-years smoking (0–2 points), and previous spirometry examination. The other three questions were related to subjective symptoms including dyspnoea, sputum, and cough that ranged from 0 to

1 point. A patient with a score of ≥ 5 is suggested for spirometry examination due to COPD risk. The highest total score is 9. The PUMA questionnaire that was used in this study had been translated into Bahasa Indonesia by a pulmonology consultant and underwent internal validation. All patients indicated that the PUMA score was clear and understandable, and did not have additional comments on its format and consistency.

Statistical analysis

Descriptive statistics were used to summarise the demographics and spirometry characteristics of the patients. The cut-off scores were picked after calculating the sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) using a receiver operating curve (ROC). The optimal cut-off point was calculated using the Youden index. An Analysis of Variance (ANOVA) test was performed to compare the mean of PUMA scores across GOLD categories of COPD.

Results

A total of 70 people participated in this study from July 2019 to January 2020. In general, the majority of participants were male ($n = 65$), comprising 93% of the population, while the remaining 7% were female participants ($n = 5$). The age of the participants was predominantly > 60 years old, making up 60% of the participants; the other age groups were 24% aged 50–59 years and 16% aged 40–49 years. The majority of participants reported complaints of dyspnoea (66%), chronic cough (54%), and chronic phlegm (49%). The most frequently observed comorbid condition was hypertension (30%), followed by diabetes mellitus (26%). The participants in this study had a history of smoking, with the distribution being as follows: 20% ($n = 14$) smoked < 20 packs per year, 36% ($n = 25$) smoked 20–30 packs per year, and 44% ($n = 31$) smoked > 30 packs per year. Additionally, 23% of participants had previously undergone a spirometry examination (Table 1). The study subjects underwent spirometry testing following PUMA score screening. Table 2 shows spirometry results on the high-risk COPD groups. The bronchodilator test was only given to participants with obstruction results on the pre-bronchodilator examination. The results for FVC showed a mean of 2640 mL and a predicted FVC of 85.6%. The FVC values in this study are still within a normal predicted percentage. Other spirometry results include FEV_1 pre-bronchodilator administration with a mean of 2565 mL, FEV_1 post-bronchodilator administration with a mean of 2616 mL, and a predicted FEV_1 percentage of 84.1%. Nevertheless, the FEV_1 percentages in this study remained within normal limits ($> 80\%$). The FEV_1 /FVC in this study was 80.4 pre-

Table 1. Baseline characteristics

Characteristic	High-risk COPD (n = 70)	Mean ± SD/n (%)
Height (cm)		163.3 ± 6.7
Weight (kg)		64.5 ± 12.8
Gender	Female	5 (7%)
	Male	65 (93%)
Age	40–49 years old	11 (16%)
	50–59 years old	17 (24%)
	≥60 years old	42 (60%)
Smoking status	<20 pack-years	14 (20%)
	20–30 pack-years	25 (36%)
	>30 pack-years	31 (44%)
Dyspnoea	No	24 (34%)
	Yes	46 (66%)
Chronic phlegm	No	36 (51%)
	Yes	34 (49%)
Chronic cough	No	32 (46%)
	Yes	38 (54%)
Previous spirometry	No	54 (77%)
	Yes	16 (23%)
PUMA score	2	1 (1%)
	3	5 (7%)
	4	14 (20%)
	5	16 (23%)
	6	14 (20%)
	7	12 (17%)
	8	6 (9%)
	9	2 (3%)
Bronchodilator usage	No	64 (91%)
	Yes	6 (9%)
Comorbidity	No	32 (46%)
	Yes	38 (54%)
Hypertension	No	49 (70%)
	Yes	21 (30%)
Diabetes mellitus	No	52 (74%)
	Yes	18 (26%)
Tuberculosis	No	68 (97%)
	Yes	2 (3%)
Asthma	No	67 (96%)
	Yes	3 (4%)
	No	67 (96%)
Congestive Heart failure	Yes	3 (4%)
	No	67 (96%)
Acute Coronary syndrome	Yes	3 (4%)
Hepatitis B	No	69 (99%)
	Yes	1 (1%)
Hepatitis C	No	69 (99%)
	Yes	1 (1%)

COPD, Chronic obstructive pulmonary disease; SD, Standard Deviation.

Table 2. Spirometry examination on high-risk COPD

Variables	Mean ± SD/median (min–max)	N
VC (mL)	2640.57 ± 754.36	70
VC predicted	3038 (338–6952)	70
VC% predicted	85.6 (41.1–426)	70
Highest FVC pre-bronchodilator (mL)	2565 ± 776	70
FVC post-bronchodilator	2616 ± 720	65
FVC predicted (mL)	3032 (1020–6952)	70
FVC% predicted	84.1 (39.9–335.3)	70
FEV ₁ pre-bronchodilator	1987 ± 732	70
FEV ₁ predicted	2244 (211–5902)	70
FEV ₁ post-bronchodilator	2032 ± 696	65
% FEV ₁ pre-bronchodilator	87.8 (33.6–393.4)	70
% FEV ₁ post-bronchodilator	95 (39–483)	65
FEV ₁ /FVC pre-bronchodilator	80.4 (44.9–95.7)	70
FEV ₁ /FVC post-bronchodilator	81 (44–99)	66
Highest PEF	6.06 ± 2.3	70
PFE post-bronchodilator	6 ± 2	65
FEV ₁ change (%)	4 (0–27)	65
FEV ₁ change (mL)	80 (0–430)	65

COPD, FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity; PEF, Peak Expiratory Flow; PFE, Peak Flow Expiratory; SD, Standard Deviation; VC, Vital Capacity.

bronchodilator and 81 for testing post-bronchodilator administration, and these values were within normal limits as per the criteria.

The ROC curve of the PUMA score can be seen as a screening tool for COPD compared to the standard spirometry (Figure 1). The blue line represents the performance of the PUMA score. The blue line that is placed above the red line demonstrates better capability of PUMA score compared to random guessing. According to this study, the PUMA score proved to be a useful screening tool for COPD (area under the curve [AUC] = 0.736, $P = 0.011$) compared to random guessing. The statistical analysis result shows 5 as the best cut-off of PUMA score for COPD diagnosis. The cut-off gives high sensitivity (92%) along with enough specificity (60%) (Table 3). It can be observed that there is no difference in PUMA scores among GOLD classifications ($P > 0.05$). This is also evident as all patients with COPD classified as GOLD 1, 2, and 3 have a PUMA score of ≥5. (Table 4).

Discussion and conclusion

This is the first validation study of the PUMA screening tool for COPD screening in Indonesian primary healthcare settings. The clinical presentation in high-risk COPD groups is aligned

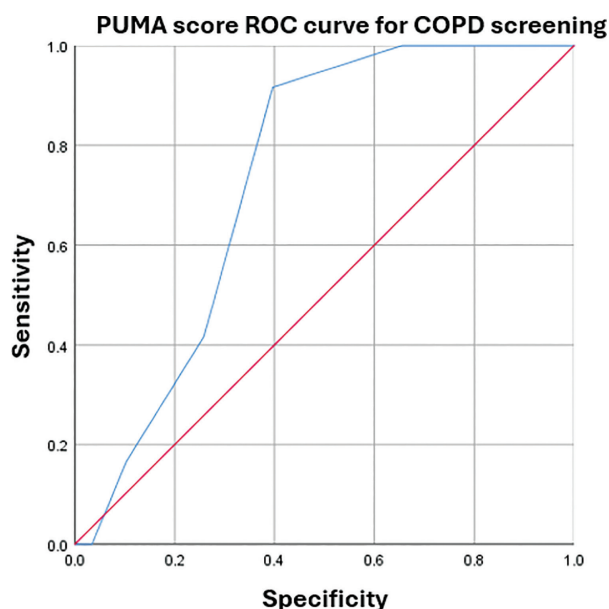


Figure 1. ROC curve of PUMA score for COPD diagnosis. COPD, chronic obstructive pulmonary disease; ROC, receiver operating curve.

Table 3. PUMA questionnaire performance on COPD diagnosis

Category	Sensitivity (%)	Specificity (%)
≥1	0	100
≥2	0	97
≥3	17	90
≥4	42	74
≥5	92	60
≥6	100	34
≥7	100	10
≥8	100	2
≥9	100	0

COPD, chronic obstructive pulmonary disease.

The bold values in Table 3 indicate the best cut-off of PUMA score for COPD diagnosis which gives high sensitivity (92%) along with enough specificity (60%).

Table 4. PUMA score difference according to COPD severity

	COPD severity (GOLD)			P-value
	1 (n = 4)	2 (n = 4)	3 (n = 4)	
PUMA score, mean ± SD	7 ± 1	6 ± 1	7 ± 1	P > 0.05
<5, n (%)	0 (0)	0 (0)	0 (0)	
≥5, n (%)	4 (100)	4 (100)	4 (100)	

COPD, chronic obstructive pulmonary disease; GOLD, Global Initiative for Chronic Obstructive Lung Disease.

with COPD symptom findings, which are shortness of breath (66%), chronic cough (54%), and chronic sputum production (49%). All participants in this study have a history of smoking, categorised into three different groups (Table 1). These data

indicate that smoking is one of the indicators that should be considered in identifying the risk of COPD. Smoking can influence the onset and severity of COPD depending on cigarette consumption level. The higher the cigarette consumption, the faster the onset of COPD and the more severe the symptoms (11). Additionally, smoking is associated with various health complications such as cardiovascular and metabolic diseases (12).

The spirometry results in the study showed normal predicted percentages. However, the mean volume values for each spirometry component were lower than normal. This could be due to various factors such as age, gender, anthropometric measurements, ethnicity, fitness level, and smoking (13, 14). Gender has an influence on lung size, airway diameter, and number of bronchioles, which are higher in males compared with females. Anthropometric measurements also affect these three components (15). Obesity increases fat mass, which can compress the thoracic cavity and reduce lung volume (16). Conversely, athletes may experience increased lung volumes despite gaining muscle mass and weight (17). Age affects elasticity and lung compliance, especially after 35 years old. Structurally, this results in decreased alveolar recoil and increased lung stiffness. The majority of subjects in this study were >40 years old, indicating decreased compliance and structural changes. Additionally, smoking and comorbid conditions, particularly hypertension and diabetes, contribute to increased resistance and decreased lung compliance due to ongoing inflammation (18–20).

The obtained PUMA scores were compared to diagnostic standards for COPD based on the GOLD. Based on these data, an AUC of 0.736 ($P = 0.011$) was obtained. This indicates that the PUMA score has a moderate level of accuracy. In a study by Au-Doung et al. (9), it was found that the PUMA score has a moderate accuracy level compared to other standards, with an AUC of 0.753. The AUC level in this study also aligns with research conducted by López Varela et al. (8), which reported an AUC of 0.76. This indicates that the use of the PUMA score with the national guideline provides accuracy levels consistent with previous studies and can be used for the diagnosis of COPD.

The obtained PUMA scores were also analysed for sensitivity and specificity in diagnosing COPD according to GOLD guidelines. Based on the data, the best cut-off value was found to be a score of ≥5. At this cut-off value, the sensitivity was 92% and the specificity was 60%. These values are similar to the cut-off values used for the PUMA score in the Latin American Project for the Investigation of Obstructive Lung Disease (PLATINO) study, where the scoring tool originates (8). However, different results were found in a study by Au-Doung et al. (9), which identified a best cut-off value of 6 with a sensitivity of 76.3% and specificity of 63.3%. The choice of cut-off value in that study was

influenced by smoking status, age, and higher spirometry utilisation, requiring a higher score threshold. With very high sensitivity, any patient scoring at least 5 on the PUMA score would require further spirometry testing to confirm suspected COPD. Although the sensitivity of the PUMA score is high, its specificity for diagnosing COPD is not sufficient. However, the PUMA score remains suitable for screening COPD because it prioritises high sensitivity to identify individuals at risk for COPD, who would then undergo further diagnosis and prompt management (8, 21).

The PUMA questionnaire was made for COPD early detection in first-line care. This study aligned with the purpose by taking samples from primary care setting patients. Additionally, this is the first study to evaluate the PUMA questionnaire in Indonesia. However, it should be noted that this study predominantly included male subjects aged ≥ 40 years old, so our findings may need further investigation in younger patients. Additionally, the small sample size may affect the creation of ROC curves and the results of sensitivity and specificity tests. Nevertheless, despite these limitations, the use of the PUMA score can greatly assist in identifying patients who would benefit most from spirometry testing, particularly for COPD diagnosis.

In conclusion, this study shows that PUMA score with a cut-off value ≥ 5 can be used as a good screening tool for identifying patients suspected of having COPD. Further studies with larger samples, multiple centres, and healthy controls will be beneficial for PUMA evaluation, specifically in Indonesia. It is important to note that this score is not suitable for diagnosis and would result in many false positives if used as a diagnostic tool.

Funding

None declared.

Conflict of interest

None declared.

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