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Short Communication

Comparative analysis between PUMA and CAPTURE questionnaires for chronic obstructive pulmonary disease (COPD) screening in smokers

Risa RB. Sebayang[1], Pandiaman Pandia[2*], Andika Pradana[2], Amira P. Tarigan[2] and Arlinda S. Wahyuni[3]

[1]Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [2]Division of Asthma and COPD, Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [3]Department of Community Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

*Corresponding author: pandiamanpandia81@gmail.com

Abstract

Chronic obstructive pulmonary disease (COPD) presents a significant global challenge, impacting health systems, economies, and societies. Its prevalence is anticipated to rise owing to an aging demographic. Although the PUMA and CAPTURE questionnaires are available for COPD screening, their comparative effectiveness has not been studied in Indonesia. The aim of this study was to evaluate the effectiveness of the PUMA and CAPTURE questionnaires as screening tools for COPD among smokers. A cross-sectional study was conducted at Universitas Sumatera Utara Hospital and H. Adam Malik General Hospital, Medan, Indonesia, from December 2022 to February 2023. Smokers aged over 40 or above with a history of smoking more than 100 cigarettes in their lifetime and no previous COPD diagnosis were included in the study. To collect the responses to PUMA and CAPTURE questionnaire, face-to-face interviews were conducted, followed by a spirometry test. A total of 76 smokers were included in the study; the predominant age group was 51–60 years (36.8%), with the majority being male (81.6%). Most participants began smoking at ages 15–20 years (65.8%) and had been smoking for 20–30 years (36.8%) at a moderate intensity (44.8%). Spirometry tests indicated obstructive patterns in 50 participants, with 17 classified as severe obstruction. At a cut-off score of ≥6, the PUMA questionnaire yielded a sensitivity of 72.55% and a specificity of 84%. In contrast, the CAPTURE questionnaire, with a cut-off score of ≥4, exhibited a sensitivity of 70.83% and a specificity of 64.29%. These results imply that the PUMA questionnaire could be more efficient in COPD screening compared to the CAPTURE questionnaire.

Keywords: COPD, CAPTURE, PUMA, screening, spirometry

Introduction

Chronic obstructive pulmonary disease (COPD) serves as a global burden in health, economic, and social sectors [1]. The worldwide prevalence of COPD in 2015 was 174 million cases, with an associated mortality of around 3.2 million deaths [2]. COPD was the fourth leading cause of death globally, accounting for over 3 million deaths in 2019 [3]. This prevalence is estimated to continue increasing due to the aging world population and increased exposure to COPD risk factors [4]. Structural changes in the lungs due to COPD are caused by chronic inflammation from prolonged exposure to harmful particles or gases, most often from cigarette smoke. The prevalence of COPD

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is often directly proportional to the prevalence of cigarette use [5]. Cigarette smoking is known to increase the risk of COPD 3–5 times, making it one of the most significant risk factors for COPD [6].

According to 2018 data, about three-quarters of adults with COPD remain undiagnosed. Given the chronic complications associated with COPD, such as cardiovascular disease and cancer, early detection and intervention play a crucial role in preventing an increase in the morbidity and mortality rates of COPD [7]. In particular, early-stage COPD typically manifests with only mild symptoms, which can discourage them from seeking medical attention and treatment [8]. Several screening tools have been developed to propose early detection of COPD. The PUMA (Prevalence Study and Regular Practice, Diagnosis, and Treatment Among General Practitioners in Populations at Risk of COPD in Latin America) questionnaire evaluates COPD risk through a comprehensive assessment comprising seven items. Among these, four objective items encompass COPD risk factors, including gender, age, smoking history, and prior spirometry use and three subjective items pertaining to symptoms such as dyspnea, phlegm, and cough [9]. In contrast, the CAPTURE (COPD Assessment in Primary Care to Identify Undiagnosed Respiratory Disease and Exacerbation Risk) questionnaire offers a distinctive approach, featuring five items. These cover factors such as exposure to pollution, environmentally influenced respiratory symptoms, exercise-induced respiratory limitations, fatigue, and acute respiratory illness [10]. Despite the availability and relevance of these screening tools, no previous study in Indonesia has undertaken a comparative analysis of these questionnaires. The aim of this study was to evaluate the effectiveness of the PUMA and CAPTURE questionnaires as screening tools for COPD among smokers.

Methods

Study design, setting and sampling

A cross-sectional study was carried out at Universitas Sumatera Utara Hospital and H. Adam Malik General Hospital in Medan, Indonesia, from December 2022 to February 2023. The study employed consecutive sampling. Based on the minimum sample size formula for cross-sectional study [11], a total of 76 participants were required.

Study subjects and criteria

This study enrolled individuals who met the following inclusion criteria: adults aged 40 years or older, with a history of smoking at least 100 cigarettes in their lifetime and had no prior diagnosis of COPD. Smokers with severe cardiovascular diseases (acute coronary syndrome or chronic heart failure), major neuromusculoskeletal disorders (stroke, Duchenne muscular dystrophy, amyotrophic lateral sclerosis (ALS) or myasthenia gravis), asthma, a history of significant surgeries (involving the chest, lungs, stomach, or brain), retinal detachment, physical or mental impairments that could affect the success of spirometry, and pregnancy, were all excluded from the study.

Data collection

Smokers' demographic information, including age, gender, smoking history, and age of smoking initiation, was collected through the initial interview. Smoking intensity was calculated based on the amount of cigarettes consumed: light smoker (<20 pack-years), moderate smoker (20–30 pack-years), and heavy smoker (>30 pack-years) [12]. Smokers were screened for COPD by completing questionnaires with the PUMA and CAPTURE screening tools through face-to-face interviews.

A spirometry examination was performed on all smokers to confirm the diagnosis of COPD using a spirometer. Data on forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) was collected to calculate the FEV1/FVC ratio [13]. The degree of obstruction (FEV1/FVC ratio <0.75) was interpreted as follows: stage I or mild (FEV1 ≥80% of the predicted value), stage II or moderate (FEV1 between 50%–79% of the predicted value), stage III or severe (FEV1 between 30%–49% of the predicted value), and stage IV or very severe (FEV1 <30% of the predicted value) [14,15].

PUMA questionnaire

The PUMA questionnaire consisted of seven items, four of which addressed the objective COPD risk factors, and the remaining three addressed other subjective symptoms. The objective items included gender (0–2 points), age (0–1 point), pack-years of smoking (0–2 points), and prior spirometry use (0–1 point). The subjective symptoms included dyspnea, sputum, and cough, and each score ranged from 0 to 1 point. The maximum possible score is 9, and those scoring 5 or higher were considered to be at risk of COPD [12].

CAPTURE questionnaire

The CAPTURE questionnaire comprised five questions that evaluated symptoms (such as breathing difficulties and fatigue), exposure to risks, and a recent history of acute respiratory diseases. The responses were totaled to produce a score between 0 (no to all five questions) and 6 (yes to all questions plus more than one respiratory event in the past year). A score of 2 or higher was considered to be at risk of COPD [16].

Statistical analysis

All data were analyzed using SPSS Statistics for Windows version 23.0 (IBM Inc., New York, USA). Univariate analysis was conducted to assess smokers' characteristics. The correlation between PUMA and CAPTURE questionnaire scores and COPD diagnoses confirmed by spirometry was assessed using the Spearman test towards the raw score of FEV1/FVC ratio. Additionally, sensitivity and specificity analyses were performed to establish the cutoff scores for the PUMA and CAPTURE questionnaires in diagnosing COPD.

Results

Characteristics of smokers

A total of 76 smokers were included in the study, as presented in **Table 1**. The majority of smokers were male (81.6%) and in the 51–60 years category (36.8%). Most smokers started smoking at age 15–20 years (65.8%) and had been smoking for 20–30 years (36.8%) with moderate intensity (44.8%). Spirometry tests revealed that 50 smokers exhibited obstructive patterns, with 17 smokers experiencing severe obstruction.

Table 1. Characteristics of smokers (n=76)

Characteristics	Frequency (percentage)
Age (years)	
40–50	14 (18.4)
51–60	28 (36.8)
61–70	21 (27.6)
>70	13 (17.1)
Gender	
Male	62 (81.6)
Female	14 (18.4)
Age smoking initiation (years)	
<15	7 (9.2)
15–20	50 (65.8)
21–25	10 (13.2)
>25	9 (11.8)
History of smoking (years)	
<20	5 (6.5)
20–30	28 (36.8)
31–40	25 (32.9)
>40	18 (23.7)
Smoking intensity	
Light smoker	11 (14.5)
Moderate smoker	34 (44.7)
Heavy smoker	31 (40.8)
Spirometry examination	
Normal	26 (34.2)
Obstruction	50 (65.8)
Obstruction degree	
No obstruction	26 (34.2)

Characteristics	Frequency (percentage)
Mild	10 (13.2)
Moderate	12 (15.8)
Severe	17 (22.4)
Very severe	11 (14.5)

Sensitivity and specificity of PUMA questionnaire as a screening test tool based on spirometry test results

With a cut-off score of ≥6, it was found that sensitivity of PUMA questionnaire was 72.55% and specificity value was 84% to detect COPD. The negative predictive value (NPV) and positive predictive value (PPV) value were 60% and 90.24%, respectively (**Table 2**).

Table 2. Sensitivity and specificity of PUMA questionnaire to detect COPD among smokers

PUMA score	Spirometry test		Total
	Obstruction	Normal	
≥6	37	4	41
<6	14	21	35
Total	51	25	76

The area under the curve (AUC) test results for PUMA questionnaire was 0.78, which indicated that the PUMA questionnaire had good performance in predicting or discriminating between positive and negative groups (**Figure 1**). The *p*-value reported was <0.001, demonstrating that the AUC was statistically significant with 95% confidence level between 0.676 to 0.891.

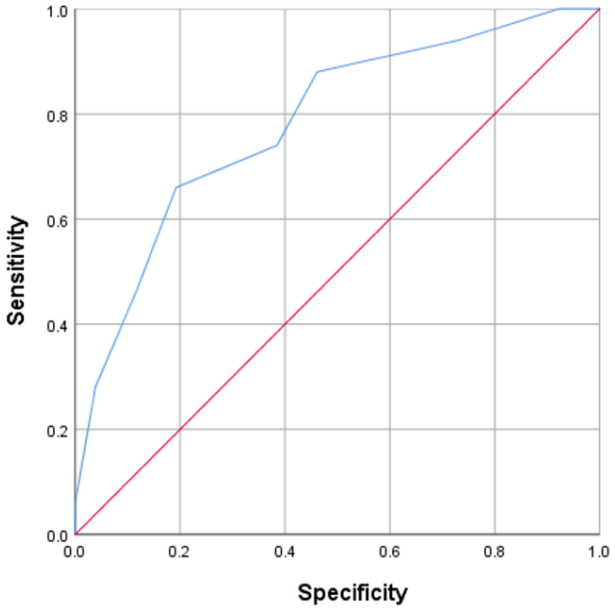

Figure 1. Receiver operating characteristic (ROC) curve for PUMA questionnaire to detect COPD among smokers.

Sensitivity and specificity of CAPTURE questionnaire as a screening test tool based on spirometry test results

At a cut-off score ≥4, the sensitivity and specificity of CAPTURE questionnaire to detect COPD showed 70.83% and 64.29%, respectively. The NPV and PPV values were 56.25% and 77.27%, respectively (**Table 3**).

Table 3. Sensitivity and specificity of CAPTURE questionnaire to detect COPD among smokers

CAPTURE score	Spirometry test		Total
	Obstruction	Normal	
≥4	34	10	44
<4	14	18	32
Total	48	28	76

The CAPTURE questionnaire had less favorable performance in predicting or distinguishing between positive and negative groups, as indicated by its AUC test result of 0.75 (**Figure 2**). The $p<0.001$ revealed that the AUC was statistically significant with 95% confidence level between 0.638 to 0.861.

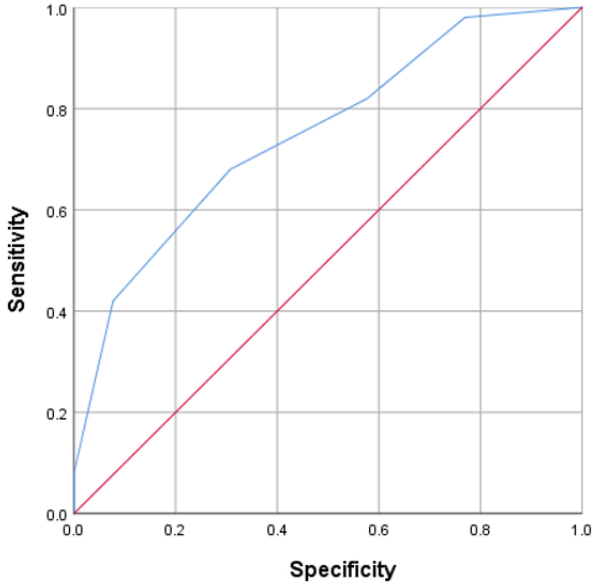

Figure 2. Receiver operating characteristic (ROC) curve for CAPTURE questionnaire to detect COPD among smokers.

Analysis of comparison on PUMA and CAPTURE questionnaire as screening test tools based on spirometry test results

The Spearman's rho correlation between the PUMA questionnaire scores and spirometry outcomes (FEV1/FVC ratio) was 0.645, suggesting a moderate positive relationship, which was statistically significant ($p<0.001$). The CAPTURE questionnaire scores also showed a moderate positive correlation with spirometry test results (FEV1/FVC ratio), indicated by a Spearman's rho value of 0.576, which was statistically significant ($p<0.001$). Notably, the correlation for the PUMA questionnaire was slightly stronger compared to the CAPTURE questionnaire. Furthermore, the correlation between the PUMA and CAPTURE questionnaires was 0.636, demonstrating a moderate positive relationship between the two, which was also statistically significant ($p<0.001$) (**Table 4**).

Table 4. Spearman's rho correlation between PUMA, CAPTURE, and spirometry test results

Variables	PUMA		CAPTURE		FEV1/FVC ratio	
	Spearman's rho	*p*-value	Spearman's rho	*p*-value	Spearman's rho	*p*-value
PUMA	1	-	0.636	<0.001	0.645	<0.001
CAPTURE	0.636	<0.001	1	-	0.576	<0.001
FEV1/FVC ratio	0.645	<0.001	0.576	<0.001	1	-

Discussion

Our study found most smokers were predominantly male, with a significant proportion falling within the 51–60 age group, consistent with findings from other studies [17,18]. The majority of participants started to smoke between the ages of 15 and 20 and had a smoking history spanning 20 to 30 years, primarily at a moderate intensity. This finding aligns with the global trend associating COPD prevalence with a long smoking history, despite the declining smoking trend in some regions [19-21]. Spirometry tests highlighted obstructive patterns in two-thirds of the smokers, with a notable fraction exhibiting severe obstruction. This emphasizes the abundant presence of COPD risk factors in this population, reflecting the worldwide pattern of COPD primarily affecting smokers [1,4].

The sensitivity and specificity of the PUMA questionnaire at a cut-off score of ≥6 was 72.55% and 84%, respectively, with an impressive PPV of 90.24% and a moderate NPV of 60%. Our study

established a cut-off value similar to the value proposed by a previous study [12], which had a sensitivity of 76.5% and specificity of 63.3%. The previous study showed that PUMA scores of ≥5 offered higher sensitivity (91.2%) but lower specificity (42.6%), influenced by factors such as age and smoking prevalence [12]. The AUC of 0.783 highlights the PUMA questionnaire's effectiveness in distinguishing COPD from non-COPD cases among smokers, showing better predictive accuracy than the CAPTURE questionnaire. At a lower cut-off score of ≥4, yielded a sensitivity of 70.83% and a specificity of 64.29%. A previous study showed that CAPTURE only had a 48.2% sensitivity and a specificity of 88.6% [10].

The statistically significant moderate positive correlation between questionnaire scores and spirometry outcomes (Spearman's rho 0.645 for PUMA and 0.576 for CAPTURE) further validates the reliability of these questionnaires in a clinical setting. The slightly stronger correlation of the PUMA questionnaire with spirometry results, as opposed to the CAPTURE questionnaire, suggests that PUMA might be more closely aligned with the spirometry results leading to definitions of COPD, possibly due to its comprehensive assessment of both COPD risk factors and symptoms [22,23].

The moderate positive correlation between the PUMA and CAPTURE questionnaires (Spearman's rho 0.636) indicated that while both tools are aligned in their assessment of COPD risk, they might be targeting slightly different aspects of COPD risk factors and symptoms [12,24]. We found that The CAPTURE questionnaire's optimal cut-off was identified as 4, with a sensitivity of 48.2% and specificity of 88.6% for detecting clinically significant, undiagnosed COPD. Other studies underline that while CAPTURE has high specificity, its low sensitivity may miss many cases, pointing to the need for further research to enhance the tool's performance [23,25]. This could imply that a combination of these tools could provide a more nuanced screening approach, catering to the diverse presentations of COPD in various populations.

However, it is important to acknowledge the limitations inherent in correlational analyses, which preclude the establishment of causality. Additionally, the moderate NPV observed, particularly with the PUMA questionnaire, warrants careful consideration when interpreting negative screening results, emphasizing the need for further diagnostic confirmation in clinical practice.

Conclusion

At a cut-off score of ≥6, the PUMA questionnaire demonstrated a sensitivity of 72.55% and a specificity of 84%. Meanwhile, with a cut-off score of ≥4, the CAPTURE questionnaire achieved a sensitivity of 70.83% and a specificity of 64.29%. This suggests that the PUMA questionnaire may be a more effective tool for COPD screening compared to the CAPTURE questionnaire.

Ethics approval

This study was approved by Ethical Committee of Universitas Sumatera Utara, Medan, Indonesia, on June 20, 2023, No: 522/KEPK/USU/2023. The samples provided the consent to participate in the study.

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this research are available from the corresponding author on request.

How to cite

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