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CAD-Q (COPD-Asthma Differentiation Questionnaire): Performance of a new diagnostic score to differentiate between COPD and asthma in adults

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Abstract

Background Chronic obstructive pulmonary disease (COPD) and asthma are the two most prevalent chronic respiratory diseases, significantly impacting public health. Utilizing clinical questionnaires to identify and differentiate patients with COPD and asthma for further diagnostic procedures has emerged as an effective strategy to address this issue. We developed a new diagnostic tool, the COPD-Asthma Differentiation Questionnaire (CAD-Q), to differentiate between COPD and asthma in adults.

Methods A cross-sectional study with diagnostic test analysis was done. Relevant clinical variables for diagnosing COPD and asthma were identified through crude Odds Ratios (OR) and a logistic regression model provided adjusted ORs. The CAD-Q, including sensitivity, specificity, predictive values, likelihood ratios, and ROC-curve, was compared to the LFQ, CDQ, PUMA, "Could it be COPD," and COPD-PS questionnaires.

Results 235 (52.9%) patients had COPD and 209 (47.1%) had asthma. A score ≥ 20 on the CAD-Q questionnaire showed a ROC-curve of 70% (95% CI: 65–75; $p < 0.001$) with a sensitivity of 83.8% (95% CI: 81.1–86.6), specificity of 47.8% (95% CI: 44.1–51.6), positive predictive value of 37.8% (95% CI: 34.2–41.5), negative predictive value of 88.7% (95% CI: 86.3–91), LR + of 1.61 (95% CI: 1.447–1.786), LR − of 0.34 (95% CI: 0.304–0.376) for diagnosing COPD. When comparing CAD-Q with other questionnaires for differentiating COPD and asthma, CAD-Q and CDQ had the highest sensitivity (83.8% and 77.9%). PUMA and "Could it be COPD" had the highest specificity (62.7% and 62.6%). CAD-Q and COPD-PS showed the highest negative predictive values (88.7% and 62.1%). CAD-Q, LFQ, and CDQ had the highest a ROC-curve (70%, 66%, and 66%).

Conclusion The CAD-Q questionnaire effectively discriminated between COPD and asthma, outperforming previous tools. These findings support further research and refinement of diagnostic tools and call for validation in diverse clinical settings.

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Keywords COPD, Asthma, Questionnaire, Diagnostic accuracy, Primary care

Introduction

Chronic obstructive pulmonary disease (COPD) and asthma are the two most prevalent chronic respiratory diseases with great impact on global public health; together they account for most of the worldwide burden of respiratory diseases [1, 2]. According to the 2019 Global Burden of Disease Study update, chronic respiratory diseases were the third leading cause of mortality, accounting for 4 million deaths worldwide; COPD was responsible for 212 million prevalent cases and 16 million incident cases. However, asthma had 262 million prevalent cases and 37 million incident cases, the main contributor to the global age-adjusted rate of prevalence and incidence of chronic respiratory diseases [3].

Despite sharing some clinical characteristics, the pathophysiological mechanisms of COPD and asthma are unique and their management and prognosis differ in the adult population, making it necessary to make an effective differential diagnosis [4, 5]; COPD is a disease that typically progresses slowly, with persistent symptoms and fixed airflow obstruction [6], while in asthma, respiratory symptoms are intermittent with periods of air obstruction caused predominantly by bronchial hyperreactivity [7, 8]. The diagnosis of these diseases is based on a combination of clinical history, respiratory symptoms such as cough, dyspnea, and wheezing, among others; functional tests and, sometimes, biomarkers [9]. However, symptom overlap between COPD and asthma can lead to misdiagnoses and, therefore, inappropriate treatments, particularly in older adults in the primary care setting [10].

There are questionnaires designed to identify individuals at risk of developing COPD based on sociodemographic and anthropometric characteristics and the presence of symptoms, such as the LFQ, CDQ, PUMA, Could it be COPD and COPD PS, questionnaires that, although they are aimed at identifying the presence of COPD, may be useful in identifying the distinguishing characteristics between COPD and asthma. The objective of this study is to develop a new clinical tool, the COPD-Asthma Differentiation Questionnaire (CAD-Q), designed to effectively distinguish between COPD and asthma in the adult population. The aim is to address existing gaps in accurately differentiating these two diseases. This new questionnaire is derived from the questionnaires used in clinical practice to identify COPD in primary care.

Methods

A cross-sectional study was conducted to analyze diagnostic tests in subjects who underwent pulmonary function tests as part of outpatient clinical follow-up at a tertiary care center in Colombia. Data were consecutively collected during the study period from January 2015 to March 2020. Patients provided informed consent to undergo pulmonary function tests and to permit the collection of clinical information.

Selection criteria

Patients aged 18 years or older who underwent spirometry during the 5-year study period (2015 to 2020) were included in the study. Data collection was conducted between January 2015 and March 2020, during which patients who underwent pulmonary function tests were identified. After the data collection period, patients were classified according to the 2024 Global Initiative for Chronic Obstructive Lung Disease (GOLD) and Global Initiative for Asthma (GINA) guidelines, using spirometry results and available clinical information. This classification ensured that patients meeting the updated criteria for COPD or asthma were accurately categorized. Exclusion criteria included subjects whose spirometry did not meet quality standards according to the American Thoracic Society (ATS) guidelines, those with asthma-COPD overlap (ACO), and those lacking information on the presence of respiratory symptoms. All patients included in the study provided informed consent for the use of their clinical data.

Variables

Sociodemographic variables such as age, sex, presence of respiratory symptoms, history of tobacco exposure and wood smoke, and history of atopy and allergies were identified. The spirometric variables considered included weight, height, forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), and the FEV1/FVC ratio before and after administration of a short-acting bronchodilator. The following five questionnaires were administered for comparison with the new questionnaire: Living with COPD Questionnaire (LFQ) [11, 12], COPD Diagnostic Questionnaire (CDQ) [13], Pneumonia and COPD Assessment (PUMA) [14, 15], Could it be COPD [16], and COPD Profile Scale (COPD PS) [17].

Each of these tools was developed to address the challenge of early detection and differentiation of COPD in clinical or community settings. LFQ was designed to identify individuals at risk of airflow obstruction using a five-item survey primarily validated in primary care settings [11, 12]. CDQ was developed to assess the likelihood of COPD based on symptomatology, smoking history, and age, providing a simple diagnostic tool suitable for resource-limited environments [13]. COPD-PS focuses on identifying undiagnosed cases through a

brief screener targeting symptoms and risk factors [17]. PUMA questionnaire was developed as part of a multinational study in Latin America to address the specific needs of underdiagnosed populations in this region [14, 15]. Lastly, "Could it be COPD?" is an awareness campaign-derived tool emphasizing the differentiation of COPD from other respiratory conditions, particularly in primary care [17]. This comparative approach provides a comprehensive understanding of CAD-Q performance and its potential advantages in clinical practice.

Sample size

To calculate the sample size, the method proposed by Hanley and McNeil [18] was used to estimate the area under the receiver operating characteristics curve (ROC-curve). The prevalence of COPD and the AUROC value from the study by Bouwens et al. were used [19]. For a 95% confidence interval and a precision of 5%, a minimum of 258 subjects was required.

Statistical analysis

Data was collected using the electronic data capture tool (REDCap) provided by Universidad de La Sabana [20, 21] and subsequently verified by the research team. The analysis was conducted using the statistical software SPSS (25, IBM Corp., Chicago, IL, USA) and STATA version 14. Qualitative variables were summarized using frequencies and percentages. Quantitative variables were summarized using means and standard deviations if normally distributed, or medians and interquartile ranges if non-normally distributed. Bivariate analysis between study variables and the presence of COPD or asthma was performed using the chi-square test for qualitative variables and Student's t-test or Mann-Whitney U test depending on the distribution of quantitative variables. Normality of variables was assessed using the Shapiro-Wilk test.

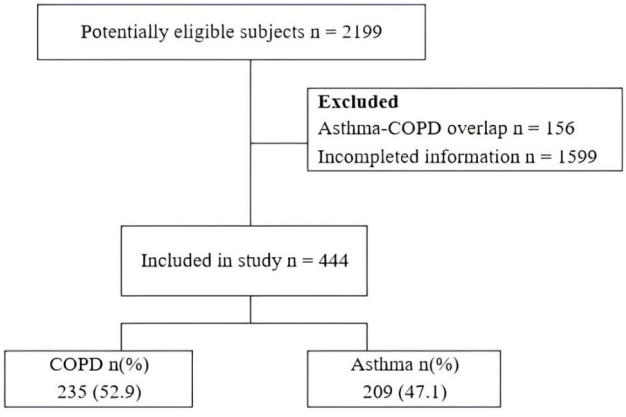

Fig. 1 Patient Flowchart. **Notes**: COPD: chronic obstructive pulmonary disease

Relevant clinical variables associated with a diagnosis of COPD and asthma were identified through analysis of crude Odds Ratios (OR) with statistical significance and 95% confidence intervals, as detailed in Supplementary Table 1. A logistic regression model was employed to determine adjusted ORs for the variables included in the questionnaire, which was developed by our research group for this study. The performance of the new questionnaire was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, negative likelihood ratio, and the ROC curve. These parameters were compared with those of the LFQ, CDQ, PUMA, "Could It Be COPD," and COPD-PS questionnaires. The optimal cut-off point for each questionnaire was determined using the Youden index. The thresholds for each questionnaire were as follows: LFQ ≤ 19 points, CDQ ≥ 17 points, PUMA ≥ 5 points, "Could It Be COPD?" ≥3 points, COPD-PS ≥ 4 points, and CAD-Q ≥ 20 points. Differences between the ROC curves were compared using the DeLong test [18]. A p-value < 0.05 was considered statistically significant for all analyses.

An ROC-curve of 0.5 indicated no discriminatory capacity, 0.51 to 0.60 indicated almost no discriminatory capacity, 0.61 to 0.69 indicated regular discriminatory capacity, 0.7 to 0.8 indicated acceptable discriminatory capacity, 0.8 to 0.9 indicated excellent discriminatory capacity, and above 0.9 indicated outstanding discriminatory capacity [18].

Results

Out of 2199 potentially eligible subjects, 444 patients who met the eligibility criteria were included finally, as depicted in Fig. 1.

General characteristics of the study population

Among the study population, 235 (52.9%) patients had COPD and 209 (47.1%) had asthma (Table 1). A total of 204 out of 444 (45.9%) were male. The overall mean age was 67.4 years (SD ± 14.7). Patients with COPD were significantly older; 72.2 years (SD ± 11.35) compared to 62.1 years (SD ± 16.15) for patients with asthma ($p < 0.001$). The mean age at onset of respiratory symptoms was 55.8 years (SD ± 20.45). Regarding exposure history, 48.4% (215/444) had a history of smoking, which was significantly more frequent in patients with COPD (53.2%) compared to those with asthma (43.1%) ($p = 0.003$). Additionally, there was a higher prevalence of atopy among asthmatic subjects compared to those with COPD: 34% vs. 19% ($p < 0.001$). Patients with COPD also experienced respiratory symptoms at a later age: 60.1 years (SD ± 18.9) versus 50.2 years (SD ± 21.05) ($p < 0.001$). Dyspnea was the most common respiratory symptom overall, reported by 70% (311/444) of patients, with no significant differences

Table 1 General characteristics of the population

	General population *n* = 444	COPD *n* = 235	Asthma *n* = 209	*p* value	
Age in years, mean (sd)	67.4 (14.7)	72.2 (11.35)	62.1 (16.15)	< 0.001	
Male sex, n (%)	204 (45.9)	116 (49.4)	88 (42.1)	0.126	
Years of study, mean (sd)	8.2 (5.66)	6.8 (5.46)	9.7 (5.52)	< 0.001	
History of exposure					
Smoking history, n (%)	215 (48.4)	125 (53.2)	90 (43.1)	0.033	
Age at onset of smoking, mean (sd)	18 (5.52)	17.6 (5.48)	18.6 (5.55)	0.050	
Age at ending of smoking, mean (sd)	43 (16.26)	44.5 (16.2)	41.1 (16.22)	0.027	
Cigarettes per day, mean (sd)	12 (12.14)	12.9 (11.82)	10.9 (12.54)	0.082	
Pack year, mean (sd)	18 (25.62)	20.4 (27.14)	14.7 (23.2)	0.018	
Passive smoker, n (%)	82 (18.5)	43 (18.3)	39 (18.7)	0.922	
Number of cigarettes per day of the person who smokes, mean (sd)	13.6 (11.83)	13.7 (11.09)	13.5 (12.85)	0.927	
Years of cohabitation with the person who smokes, mean (sd)	23.3 (15.65)	27 (14.36)	18.8 (16.19)	< 0.001	
Exposure to wood smoke, n (%)	286 (64.4)	164 (69.8)	122 (58.4)	0.012	
Hours of exposure to wood smoke per day, mean (sd)	6.1 (4.61)	6.4 (4.53)	5.6 (4.71)	0.099	
Years of exposure to wood smoke, mean (sd)	22.5 (17.54)	25.3 (18.94)	18.8 (14.77)	< 0.001	
Medical History, n (%)					
COPD. chronic bronchitis or emphysema.	159 (35.8)	120 (51.1)	39 (18.7)	< 0.001	
Asthma	91 (20.5)	31 (13.2)	60 (28.7)	< 0.001	
History of atopy	95 (25.5)	40 (19)	55 (34)	< 0.001	
Symptoms, n(%)					
Respiratory symptoms	398 (89.6)	211 (89.8)	187 (89.5)	0.914	
Cough and expectoration	185 (42.1)	110 (39.5)	75 (49.2)	0.264	
Dyspnea	311 (70)	167 (71.1)	144 (68.9)	0.619	
Wheezing	172 (38.7)	84 (35.7)	88 (42.1)	0.170	
Age of symptom onset, mean (sd)		55.8 (20.45)	60.1 (18.9)	50.2 (21.05)	< 0.001

Notes: n: number; sd: standard deviation; COPD: chronic obstructive pulmonary disease

observed in the presence of wheezing ($p = 0.170$) or productive cough ($p = 0.264$) between the two groups.

Spirometric characteristics of the population

The mean post-bronchodilator FEV1/FVC ratio was 59.9% (SD ± 9.68) in subjects with COPD and 78.7% (SD ± 6.54) in subjects with asthma ($p < 0.001$) (Supplementary Table 2). Asthmatic subjects tended to have a higher body weight compared to those with COPD, 71.5 kg (SD ± 13) versus 68.5 kg (SD ± 14.38) ($p = 0.025$), with no significant differences observed in height ($p = 0.264$). The post-bronchodilator FEV1 was 1.7 L (SD ± 0.7) in COPD patients compared to 2.4 L (SD ± 0.66) in asthma patients ($p < 0.001$), with a higher expected percentage change in asthmatics: 18.8% (SD ± 8.04) versus 8.4% (SD ± 11.91) ($p < 0.001$).

Construction and performance of the new CAD-Q questionnaire

Table 2 describes the variables included in the new questionnaire, CAD-Q; each variable is scored between 0 and 2 points, except for age, obtained through OR analysis. The CAD-Q questionnaire can score between 0 and 30 points. The questionnaire distinguishes between COPD with high scores and asthma with low scores. A score ≥ 20 on the CAD-Q questionnaire showed an ROC-curve of 0.70 (95% CI: 0.65–0.75; $p < 0.001$) with a sensitivity (Se) of 83.8% (95% CI: 81.1–86.6), specificity (Sp) of 47.8% (95% CI: 44.1–51.6), PPV of 37.8% (95% CI: 34.2–41.5), NPV of 88.7% (95% CI: 86.3–91), positive likelihood ratio (LR+) of 1.61 (95% CI: 1.447–1.786), negative likelihood ratio (LR–) of 0.34 (95% CI: 0.304–0.376) for diagnosing COPD (Fig. 2).

Comparison with other questionnaires for COPD and asthma diagnosis

When contrasting the operating characteristics of CAD-Q with LFQ, CDQ, PUMA, "Could it be COPD," and COPD-PS questionnaires to differentiate between COPD and asthma, CAD-Q and CDQ showed the highest sensitivity: CAD-Q (83.8%, 95% CI: 81.1–86.6) and CDQ (77.9%, 95% CI: 74-81.7). Overall, the specificity was acceptable, with PUMA and "Could it be COPD" having the highest specificity: 62.7% (95% CI: 58.2–67.2) and 62.6% (95% CI: 56.8–68.4), respectively. The highest negative predictive values were observed in CAD-Q (88.7%, 95% CI: 86.3–91) and COPD-PS (62.1%, 95% CI: 47.8–76.5). The questionnaires with the highest ROC-curves were CAD-Q (0.70, 95% CI: 0.65–0.75, $p < 0.001$), LFQ (0.66, 95% CI: 0.60–0.71, $p < 0.001$), and CDQ (0.66,

Table 2 CAD-Q questionnaire

Variable	Score
Age	
> 40 years	15
Sex	
Male	1
Female	0
Smoking	
Pack year > 30	2
Pack year < 30	0
Wood smoke exposure	
Yes	2
No	0
Dyspnea	
Most of the time/All the time	2
Sometimes	1
Never/Rarely	0
Cough	
Every day	2
Some days of the month/Almost every day of the week	1
Never / Only with colds	0
Atopy	
Yes	0
No	2
Allergies	
Yes	0
No	2
Symptoms onset	
> 55 years	2

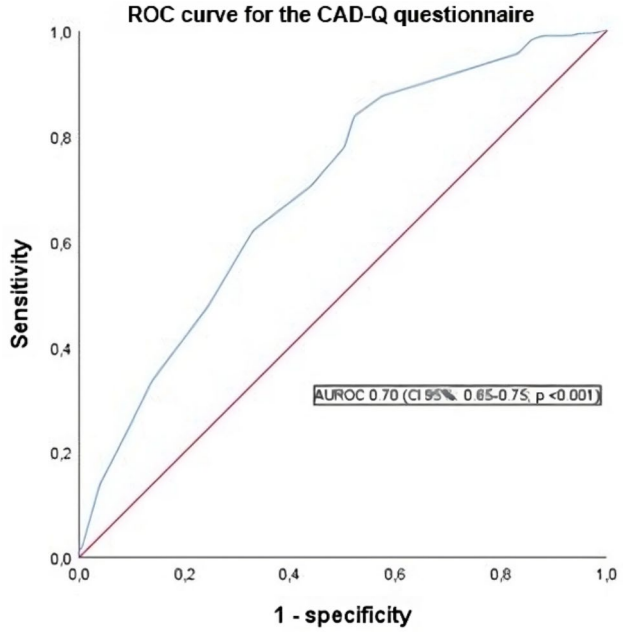

Fig. 2 ROC curve for the CAD-Q questionnaire

95% CI: 0.61–0.71, $p < 0.001$). The DeLong test showed a statistically significant difference between the ROC curves of the 6 questionnaires ($p = 0.036$). (Tables 3 and Fig. 3).

Subanalysis of the age variable in the CAD-Q

The ROC-curve of the CAD-Q with only the age variable was 0.68 (95% CI: 0.64–0.73) (Fig. 4). In contrast, the ROC-curve of the CAD-Q without the age variable was 0.67 (95% CI: 0.62–0.72) (Fig. 5).

Discussion

This study evaluated the diagnostic performance of a new questionnaire, CAD-Q, constructed from clinical variables for diagnosing COPD and asthma. It also compared its performance with validated COPD diagnostic questionnaires. The CAD-Q demonstrated an acceptable ROC curve, high sensitivity, and high NPV in differentiating between patients with suspected COPD and asthma, showing superior performance compared to COPD risk questionnaires. Clinical variables such as age, age of onset of respiratory symptoms, and history of atopy appear to be useful in distinguishing between these two diseases. Questionnaires based on clinical questions remain valuable for the recognition of different diseases, even when their performance is acceptable.

The CAD-Q was specifically developed to differentiate between COPD and asthma, making it a valuable and novel tool, especially in primary care settings where distinguishing between these two diseases is essential for implementing appropriate pharmacological management and determining prognosis [10]. By integrating symptoms from existing questionnaires, the CAD-Q retains the robustness and validity of previous methods while adding significant diagnostic value. Notably, the CAD-Q demonstrates a high NPV of 88.7% (95% CI: 86.3–91), meaning that a score below 20 points strongly suggests a low probability of COPD and a higher likelihood of asthma. This high NPV makes the CAD-Q a useful tool for ruling out COPD, particularly in primary care settings where confirmatory tests such as spirometry may not be readily available. However, the low PPV of 37.8% (95% CI: 34.2–41.5) indicates that a significant proportion of individuals with scores ≥ 20 may not actually have COPD. This reflects the moderate specificity (47.8%) of the CAD-Q and highlights the impact of disease prevalence on PPV. While a positive result raises suspicion of COPD, it requires confirmatory testing to establish the diagnosis. This limitation underscores that the CAD-Q is not a standalone diagnostic tool but rather a screening instrument designed to identify individuals at risk who need further evaluation.

The study by Bouwens et al. [19] evaluated the most useful elements for differentiating asthma from COPD in

Table 3 Comparison with other questionnaires for the differentiation of COPD and Asthma

	Se (CI 95%)	Sp (CI 95%)	PPV (CI 95%)	NPV (CI 95%)	LR+ (CI 95%)	LR- (CI 95%)	ROC-curve (CI 95%)	*p* value	DeLong Test
LFQ* ≤19 points	21.3 (17.5–25.1)	57.9 (53.3–62.5)	36.2 (31.8–40.7)	39.5 (35-44.1)	0.47 (0.319–0.705)	1.21 (0.815–1.801)	0.66 (0.6–0.71)	< 0.001	
CDQ ≥ 17 points	77.9 (74-81.7)	39.7 (35.2–44.3)	59.2 (54.7–63.8)	61.5 (57–66)	1.29 (1.138–1.466)	0.56 (0.491–0.632)	0.66 (0.61–0.71)	< 0.001	
PUMA ≥ 5 points	60.4 (55.9–65)	62.7 (58.2–67.2)	64.5 (60.1–69)	58.5 (53.9–63.1)	1.62 (1.327–1.975)	0.63 (0.518–0.77)	0.65 (0.6–0.7)	< 0.001	0.036
COULD It Be COPD ≥ 3 points	55.6 (49.7–61.6)	62.6 (56.8–68.4)	56.3 (50.3–62.3)	62 (56.1–67.8)	1.49 (1.141–1.939)	0.71 (0.544–0.924)	0.61 (0.55–0.66)	< 0.001	
COPD PS ≥ 4 points	71.5 (67.3–84.8)	52.6 (37.9–67.4)	62.9 (48.6–77.2)	62.1 (47.8–76.5)	1.51 (1.286–1.77)	0.54 (0.462–0.635)	0.65 (0.6–0.7)	< 0.001	
CAD-Q ≥ 20 points	83.8 (81.1–86.6)	47.8 (44.1–51.6)	37.8 (34.2–41.5)	88.7 (86.3–91)	1.61 (1.447–1.786)	0.34 (0.304–0.376)	0.7 (0.65–0.75)	< 0.001	

Notes: Se, sensitivity; Sp, specificity; PPV, positive predictive value; NPV, negative predictive value; LR+, positive likelihood ratio; LR−, negative likelihood ratio; ROC-curve, area under the receiver operating characteristic curve

*The LFQ questionnaire is calculated in reverse since its score is contrary to the other questionnaires

Fig. 3 ROC curve comparing questionnaires

Fig. 4 ROC curve for the CAD-Q questionnaire (age-only)

primary care, creating three diagnostic scenarios based on the availability of tests: Scenario 1 used only clinical information, Scenario 2 added spirometry results, and Scenario 3 included additional pulmonary function tests, such as the carbon dioxide diffusion capacity and the bronchial hyperreactivity test. The results showed that Scenario 1, which included variables such as age, sex, smoking, atopy, and respiratory symptoms, achieved an ROC curve of 0.84. These variables are also included in the CADQ. In comparison, our CADQ questionnaire has a ROC curve of 0.70, which, although lower than that reported by Bouwens, still has adequate discriminatory power.

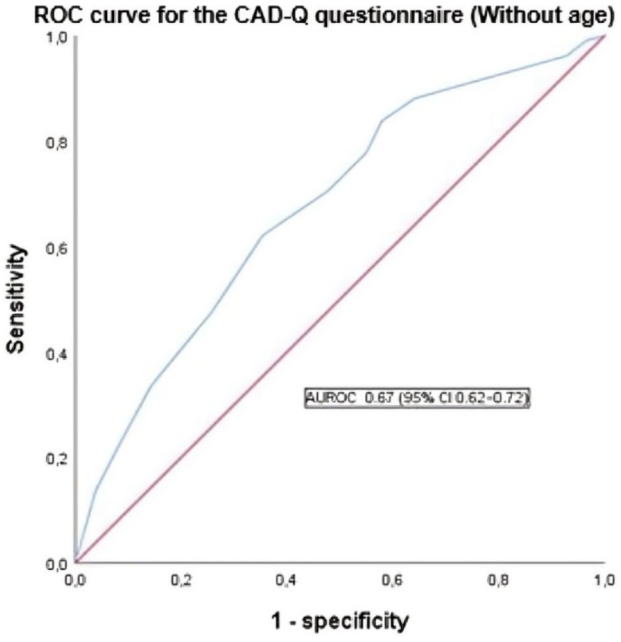

Fig. 5 ROC curve for the CAD-Q questionnaire (without age)

Our findings align with other studies that evaluated the ability to use questionnaires based solely on clinical information to distinguish between COPD and asthma. Beeh et al. developed a questionnaire based on age of symptom onset, smoking history, history of atopy, and quality of cough, with an ROC curve of 0.95 and a sensitivity of 87.6%, concluding that a questionnaire based on clinical history questions can help differentiate between asthma and COPD in daily clinical practice [22]. Similarly, Tinkelman et al. created a questionnaire with information on age, smoking, respiratory symptoms, among others, which demonstrated an ROC curve of 0.84 and a sensitivity of 72% [23]. Although our CADQ questionnaire has a lower ROC curve, its sensitivity is like that found by Beeh et al. and higher than that found by Tinkelman, suggesting that this proposed clinical questionnaire would work well in primary care settings to detect COPD cases and differentiate them from asthma. The diagnostic performance found for the CADQ differs from those described in observational studies [19, 22, 23], possibly due to less compromised pulmonary function in our population, which has higher FEV1 and FVC.

We conducted a sub-analysis to evaluate the impact of age on the performance of the CAD-Q. While age alone contributes to the differentiation of COPD and asthma, the CAD-Q is not simply a sum of individual scores; it is a robust tool that incorporates various clinical factors to enhance the discrimination between these conditions. The inclusion of age, with its specific weighting, reflects its significant role in the underlying statistical model, ensuring that all variables collectively enhance the tool's predictive accuracy [10, 15, 16, 18]. The ROC-curve analysis further supports this, showing that the CAD-Q with age and other variables (ROC-curve = 0.70) outperforms both the version with age alone (ROC-curve = 0.68) and the version without age (ROC-curve = 0.67). These results highlight the importance of retaining age in the model, emphasizing its role in the CAD-Q and its interaction with other clinical variables [10, 15, 16].

Our findings underscore that clinical questionnaires remain useful tools in the initial recognition and differentiation of respiratory diseases such as COPD [24] and asthma in clinical practice. The applicability of these questionnaires, constructed with simple and accessible clinical variables, demonstrates their value in the initial evaluation of these diseases in primary care [25], given their high sensitivities. However, complementary studies, such as spirometry, are necessary.

Limitations

Among the limitations of this study are its single-center design, which may limit the generalization of the findings to other populations, as well as potential transcription errors and incomplete information, which could affect the accuracy of the results. However, measures were implemented to minimize information bias, such as training the staff responsible for collecting medical data. Another important limitation is that the study was not prospective or double-blind. The conclusions presented are based on observational data, so caution should be exercised when interpreting the findings. Future studies should consider prospective and double-blind designs to provide more robust and comparative evidence, which would strengthen the validity of the conclusions and allow for a more comprehensive understanding of the topic.

In this study, we acknowledge the limitation of not having a separate validation cohort, which is crucial for minimizing potential bias and improving the generalizability of our findings [18]. The retrospective design, reliance on existing data, resource constraints, and practical challenges in accessing additional patient populations during the study period prevented the establishment of an independent validation cohort. While this study serves as an initial derivation cohort for the development and evaluation of the CAD-Q questionnaire, we recognize the importance of future prospective studies with separate validation cohorts. These studies will help confirm and expand upon our results across diverse clinical settings.

Furthermore, this study did not include patients with a diagnosis of ACO, a complex and relevant clinical population, which leaves an unexplored "gray area" and limits our understanding of how questionnaires could differentiate between asthma, COPD, and ACO in real-world clinical practice [24, 26, 27]. Despite these limitations, the findings provide a solid initial evaluation of the CAD-Q

questionnaire, emphasizing the need for prospective studies with separate validation cohorts to confirm and expand these results in various clinical settings, including the analysis of patients with ACO.

Conclusion

The results obtained from the CADQ questionnaire demonstrate a good capacity to discriminate between patients with COPD and asthma in our study population; its overall performance is superior compared to previously validated questionnaires for identifying COPD. These results encourage more research and refinement of available diagnostic tools and more robust studies to validate and expand our findings in diverse clinical contexts.

Abbreviations

CAD-Q	COPD-Asthma Differentiation Questionnaire
COPD	Chronic obstructive pulmonary disease
LFQ	Lung Function Questionnaire
CDQ	COPD Diagnostic Questionnaire
COPD-PS	COPD Population Screener questionnaire
GOLD	Global Initiative for Chronic Obstructive Lung Disease
GINA	Global Initiative for Asthma
ATS	American Thoracic Society
ACO	Asthma-COPD Overlap
FVC	Forced Vital Capacity
FEV1	Forced Expiratory Volume in the first second
SPSS	Statistical Package for the Social Sciences
ROC-curve	Area Under the Receiver Operating Characteristic Curve
OR	Odds Ratios
Se	Sensitivity
Sp	Specificity
PPV	Positive Predictive Value
NPV	Negative Predictive Value
LR+	Positive Likelihood Ratio
LR-	negative likelihood ratio
CI	Confidence interval

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12890-025-03492-5.

Supplementary Material 1

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The study was carried out at the Universidad de La Sabana.

Author contributions

ALF, ETQ, ARB, BP, JC, KF, MM, IM, AC, NV, GB, MF, JS, JLH, GD, DP, and HE contributed to the conception and design. ALF, ETQ, and ARB supervised the whole process. ETQ, and ARB contributed to data collection. ALF, ETQ, ARB, and BP analyzed and interpreted the patient data. ETQ, and ARB wrote major parts of the manuscript. ETQ, and ARB revised the manuscript. All authors read and approved the final manuscript.

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Data availability

The databases from this study are available upon reasonable request. Please, contact the corresponding author to request access.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the principles of the current Helsinki Declaration, as well as local, regional, and international regulations pertaining to clinical research, including Colombian Law on Biomedical Research. Ethical approval was obtained from the Medical Ethics Committee of the Clínica Universidad de La Sabana (approval number 20220602). The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because this study is a retrospective study.

Consent to participate

Not applicable.

Consent to publish

Not applicable.

Competing interests

The authors declare no competing interests.

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