Identifying adults at risk of COPD who need confirmatory spirometry in primary care

Do symptom-based questions help?

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Abstract

Objective To examine the usefulness of a symptom-based case-finding questionnaire (CFQ) and the Medical Research Council (MRC) dyspnea scale in identifying which individuals with known risk factors for chronic obstructive pulmonary disease (COPD) require targeted spirometry in primary care.

Design Cross-sectional study.

Setting Three community primary care practices in Ontario.

Participants Men and women 40 years of age and older with a smoking history of 20 pack-years or more.

Main outcome measures We administered a CFQ for the presence of cough, sputum, wheeze, dyspnea, and recurrent respiratory infections (possible range of scores from 0 to 5) and applied the MRC dyspnea scale to assess the severity of COPD (possible range of scores from 1 to 5). Spirometric measures of forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) were collected, with COPD defined as a postbronchodilator FEV1/FVC of less than 0.7 and FEV1 of less than 80% of the predicted value. Using spirometric data to confirm the diagnosis of COPD, likelihood ratios, pretest and posttest probabilities, and area under a receiver operating characteristic curve were calculated for the total CFQ and MRC scores.

Results Scores for the CFQ and MRC dyspnea scale were available for 996 and 829 participants, respectively. The likelihood ratios for a total CFQ score of 3 or higher and an MRC dyspnea score of 4 or 5 were 1.82 (95% confidence interval [CI] 1.48 to 2.22) and 4.22 (95% CI 2.08 to 8.56), respectively. The likelihood ratios for a total CFQ score of 2 or less and an MRC dyspnea score of 1 were 0.75 (95% CI 0.66 to 0.85) and 0.50 (95% CI 0.39 to 0.65), respectively. Area under the receiver operating characteristic curve was 0.62 (95% CI 0.58 to 0.67; P<.001) for the total CFQ scores and 0.64 (95% CI 0.60 to 068; P<.001) for the MRC dyspnea scores.

Conclusion In adults with known risk factors, the likelihood of having moderate to severe COPD is increased in those who report 3 or more common respiratory symptoms and marked functional limitation resulting from dyspnea. However, selecting individuals for spirometry based on symptoms alone will identify less than half of those with moderate to severe COPD.

EDITOR'S KEY POINTS

- The greatest yields of confirmatory spirometry for moderate to severe chronic obstructive pulmonary disease [COPD] in adults aged 40 years and older with a smoking history of 20 pack-years or more were among those who reported 3 or more common respiratory symptoms or described marked functional limitation resulting from dyspnea.
- Symptoms alone, however, are not enough to confirm moderate to severe cases of COPD; in this study, more than half of the individuals with moderate to severe COPD would not have been detected had spirometry been limited to those who described 3 or more common respiratory symptoms on the case-finding questionnaire.

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Identifier les adultes à risque de MPOC qui ont besoin d'une confirmation par spirométrie en contexte de soins primaires

Un questionnaire portant sur les symptômes est-il utile?

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Résumé

Objectif Évaluer l'utilité d'un questionnaire de dépistage de cas (QDC) basé sur les symptômes et de l'échelle de dyspnée du Conseil des recherches médicales (CRM) pour identifier les sujets présentant des facteurs de risque connus pour une maladie pulmonaire obstructive chronique (MPOC) nécessitant une spirométrie en contexte de soins primaires.

Type d'étude Étude transversale.

Contexte Trois cliniques communautaires de soins primaires en Ontario.

Participants Hommes et femmes de 40 ans et plus avec une histoire de tabagisme d'au moins 20 ans.

Principaux paramètres à l'étude Nous avons administré le QDC en présence de toux, d'expectorations, de wheezing, de dyspnée et d'infections respiratoires récurrentes (les scores pouvant varier de 0 à 5), et utilisé l'échelle de dyspnée du CRM pour évaluer la sévérité de la MPOC (scores pouvant varier de 1 à 5). En spirométrie, on a mesuré le volume expiratoire maximal par seconde (VEMS) et la capacité vitale maximale (CVM), la MPOC étant définie comme un rapport VEMS/CVM inférieur à 0,7 et un VEMS inférieur à 80% de la valeur prédite après bronchodilatation. En utilisant les données de la spirométrie pour confirmer le diagnostic de MPOC, on a calculé les rapports de probabilité, les probabilités pré- et post-test, ainsi que la zone qui se situe sous la courbe de la fonction d'efficacité du récepteur pour les scores totaux au QDC et au CRM.

Résultats On a obtenu les scores au QDC de 996 participants et les cores à l'échelle de dyspnée du CRM de 829 participants. Les rapports de probabilité pour un score de 3 ou plus au QDC et de 4 ou 5 à l'échelle de dyspnée étaient de 1,82 (intervalle de confiance à 95% [IC] 1,48 à 2,22) et 4,22 (IC 2,08 à 8,56), respectivement. Les rapports de probabilité pour un score total de 2 ou moins au QDC et de 1 à l'échelle de dyspnée étaient de 1,75 (IC 0,66 à 0,85) et 0,50 (IC 0,39 à 0,65), respectivement. La zone qui se situe sous la courbe de la fonction d'efficacité du récepteur était de 0,62 (IC 0,58 à 0,67; $P < ,001$) pour les scores totaux au QDC et de 0,64 (IC 0,60 à 0,68; $P < ,001$) pour les scores à l'échelle de dyspnée du CRM.

Conclusion Parmi les adultes avec facteurs de risque connus, la probabilité de souffrir d'une MPOC modérée à sévère est augmentée chez ceux qui rapportent au moins 2 symptômes respiratoires courants et des limitations fonctionnelles marquées en raison de dyspnée. Toutefois, si on se base uniquement sur les symptômes pour diriger les patients en spirométrie, on identifiera moins de la moitié de ceux qui ont une MPOC modérée à sévère.

POINTS DE REPÈRE DU RÉDACTEUR

- C'est pour les patients qui rapportaient 3 symptômes respiratoires courants ou plus ou qui décrivaient des limitations fonctionnelles importantes en raison de dyspnée que la spirométrie avait le plus de valeur pour confirmer une maladie pulmonaire obstructive chronique (MPOC) chez des adultes de 40 ans et plus avec une histoire de tabagisme de 20 ans ou plus.
- Toutefois, les symptômes seuls ne sont pas suffisants pour confirmer les cas de MPOC modérés à sévère; dans cette étude, plus de la moitié des sujets souffrant d'une MPOC modérée à sévère n'auraient pas été identifiés si on avait limité l'emploi de la spirométrie à ceux qui mentionnaient au moins 3 symptômes respiratoires courants au questionnaire de dépistage de cas.

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Chronic obstructive pulmonary disease (COPD) is a common condition and a leading cause of morbidity and mortality.[1,2] Global epidemiologic data indicate that in adults 40 years of age and older, the prevalence of moderate to severe COPD, confirmed by spirometry, is approximately 10%.[3] In adults with known risk factors for disease development, such as a heavy smoking history, the prevalence is greater than 20%.[4,5] In the primary care setting, spirometry is underused, most likely as a consequence of the perceived impracticalities and costs associated with its widespread use.[6] This leads to substantial underdiagnosis and occasional inappropriate diagnosis of COPD.[5,7,8] Health care professionals taking a respiratory history, especially from individuals with known risk factors, are taught to ask questions about the presence of the cardinal symptoms of the disease: dyspnea on exertion, cough, sputum production, wheeze, and recurrent respiratory infections.[9] The answers to such questions contribute to the provisional diagnosis and help identify those who require spirometry as a confirmatory test.[2,10,11]

Although several case-finding questionnaires (CFQs) have been developed to target individuals who should get spirometry to confirm the diagnosis of COPD, their usefulness in the population at greatest risk is uncertain. Previous studies have reported on sample populations of modest size or did not selectively include individuals with a substantial smoking history.[12-16] The aim of this study was to determine the usefulness of a CFQ made up of 5 questions pertaining to the presence of common respiratory symptoms in identifying those with COPD among individuals with known risk factors for disease development. As dyspnea on exertion is the hallmark of COPD and professional guidelines recommend using the Medical Research Council (MRC) dyspnea scale as a way to classify the severity of COPD,[11] we also sought to examine its usefulness as a case-finding instrument. The results of this study will inform clinicians of the value of using these 2 symptom-based CFQs to guide the use of spirometry among those with known risk factors for COPD.

METHODS

A cross-sectional study was performed following approval by the Research Ethics Committee at the University of Toronto in Ontario and the Sault Ste Marie Group Health Centre. Data for this study were collected as part of a larger project that aimed to determine the prevalence of COPD in adults who had visited primary care practices. Written informed consent was obtained from each participant before data collection. A detailed description of the methods has been provided elsewhere.[5]

Study criteria and recruitment

Participants were recruited from 3 community health practices in Ontario whose staff were familiar with spirometric assessment of airflow obstruction. Individuals were identified from an electronic database of clinic attendees or were approached directly at the time of their arrival at the clinics. Potentially suitable participants completed a brief screening questionnaire with the clinic receptionist regarding age, smoking history, and previous diagnosis of a respiratory condition. The reason for their clinic visit was not a study criterion. Adults aged 40 years or older with a smoking history of 20 pack-years or more, who were able to communicate in English, ambulatory, and willing to participate, were scheduled for assessment within 4 weeks of completing the screening questionnaire.

Assessment session

Participants completed an interviewer-administered CFQ that ascertained the presence of common respiratory symptoms (**Table 1**), for which the results were tallied (1 point for each yes response). They were also asked to report their functional limitations resulting from dyspnea using the MRC dyspnea scale (**Table 2**),[11] for which each participant fell into 1 of the 5 categories. Spirometry was performed by an experienced technologist, and COPD was defined as a postbronchodilator ratio of forced

Table 1. Case-finding questionnaire: *Patients score 1 point for each yes answer, for a maximum total of 5 points.*

NO.	QUESTION
1	Do you cough regularly?
2	Do you cough up phlegm (sputum) regularly?
3	Do even simple chores make you short of breath?
4	Do you wheeze when you exert yourself or at night?
5	Do you get frequent colds that persist longer than those of other people you know?

Table 2. Medical Research Council dyspnea scale

SCORE*	DESCRIPTION
1	Not troubled by shortness of breath except during strenuous exercise
2	Troubled by shortness of breath when hurrying on the level or walking up a slight hill
3	Walks slower that people of the same age on the level because of shortness of breath or has to stop for breath when walking at own pace on the level
4	Stops for breath after walking about 100 yards or after a few minutes on level ground
5	Too short of breath to leave the house or experiences shortness of breath when dressing or undressing

*Patients fall into 1 of the 5 categories, depending on severity of condition.
Data from O'Donnell et al.[11]

Table 3. Characteristics of study sample: *N = 1003.*

CHARACTERISTIC	PATIENTS WITH COPD* (N = 208)	PATIENTS WITHOUT COPD* (N = 795)
Mean (SD) age, y	64.9 (9.8)	59.1 (10.5)
Sex, male:female	103:105	418:377
Mean (SD) FEV_1/FVC	0.56 (0.11)	0.74 (0.07)
Mean (SD) FEV_1, % of predicted	61.5 (14.4)	89.0 (13.2)
Mean (SD) pack-year exposure	40.1 (18.3)	33.0 (14.0)
Current smokers, n (%)	96 (46.2)	337 (42.4)
Self-revealed diagnosis of COPD, n (%)†	67 (32.7)	43 (5.6)

COPD—chronic obstructive pulmonary disease, FEV_1—forced expiratory volume in 1 second, FVC—forced vital capacity.
*According to results of spirometry testing.
†Data were available for 205 inviduals with COPD and 774 individuals without COPD.

expiratory volume in 1 second (FEV_1) to forced vital capacity (FVC) of less than 0.7 and FEV_1 of less than 80% of the predicted value[17] (ie, the Global Initiative for Chronic Obstructive Lung Disease definition of stage 2 COPD[2,18]). For the purposes of this study, those who did not meet these criteria were classified as not having COPD.

Spirometry was performed using the EasyOne model (NDD Medical Technologies, Andover, Mass) according to international guidelines, with the participants sitting upright and wearing nose clips.[19] Individuals with medical contraindications to spirometry were excluded from the study.[3]

The quality of spirometric data was ensured through standardized training procedures for all staff involved with data collection and through a review of all tracings by the central data collection site.[20] Spirometry was delayed by 1 month for any individual describing a recent respiratory infection. Borderline results derived from tracings of dubious quality were repeated.

Data analysis

The total (sum) score for the CFQ was calculated with possible scores ranging from 0 (indicating that the participant answered no to every item) to 5 (indicating that the participant answered yes to every item). Using the spirometric data to confirm the diagnosis of COPD, likelihood ratios and 95% confidence intervals [CIs] were calculated. Pretest and posttest probabilities were calculated using the likelihood ratios. Area under the receiver operating characteristic (ROC) curve was determined. In order to examine whether one symptom was more useful than the others in finding cases of COPD, likelihood ratios associated with a positive response to each to individual item of the CFQ were also calculated.

Similar analyses were completed for each score on the MRC dyspnea scale following exclusion of those individuals who reported a limited capacity to walk primarily as a consequence of a musculoskeletal comorbid condition. Those *P* values less than or equal to .05 were considered significant.

A sample of 1003 individuals was available for the analyses presented in this report. This sample was derived from our study on COPD prevalence among the high-risk population[5] and provided a precision of just above or below 7% of the estimated area under the ROC curve.

RESULTS

Table 3 summarizes the characteristics of the 1003 individuals for whom technically satisfactory spirometric data were obtained. Of these, responses to the CFQ and MRC dyspnea scale were available for 996 (99.3%) and 829 (82.7%) participants, respectively. The prevalence of COPD in our sample was 20.7%.[5]

Table 4 summarizes the responses to the CFQ, expressed as total scores, grouped according to participants' spirometry results, and the associated likelihood ratios. Total CFQ scores of 3 or more were associated with a likelihood ratio of 1.82 (95% CI 1.48 to 2.22) and an increase in the probability of COPD from 20.7% to

Table 4. Results of the CFQ and associated likelihood ratios for each score

CFQ SCORE	TOTAL (N = 996*), N (%)	PATIENTS WITH COPD† N = 205) N (%)	PATIENTS WITHOUT COPD† (N = 791), N (%)	LIKELIHOOD RATIO (95% CI)
0	317 (31.8)	45 (22.0)	272 (34.4)	0.64 (0.48-0.84)
1	224 (22.5)	34 (16.6)	190 (24.0)	0.69 (0.50-0.96)
2	180 (18.1)	38 (18.5)	142 (18.0)	1.03 (0.75-1.43)
3	155 (15.6)	45 (22.0)	110 (13.9)	1.58 (1.16-2.15)
4	85 (8.5)	27 (13.2)	58 (7.3)	1.80 (1.17-2.76)
5	35 (3.5)	16 (7.8)	19 (2.4)	3.25 (1.70-6.21)

CFQ—case-finding questionnaire, CI—confidence interval, COPD—chronic obstructive pulmonary disease
*Of the 1003 participants, 7 provided technically unsatisfactory responses to the questions on the CFQ and their scores were excluded from further analysis.
†According to results of spirometry testing.

32.2% (95% CI 27.9% to 36.7%). A total score of 2 or less on the CFQ was associated with a likelihood ratio of 0.75 (95% CI 0.66 to 0.85) and a decrease in the probability of COPD from 20.7% to 16.4% (95% CI 14.7% to 18.2%). The area under the ROC curve was 0.62 (95% CI 0.58 to 0.67; $P<.001$) (**Figure 1**). A positive response to any single question on the CFQ was associated with a modest increase in the likelihood ratios, ranging between 1.38 (for wheeze) and 1.54 (for dyspnea).

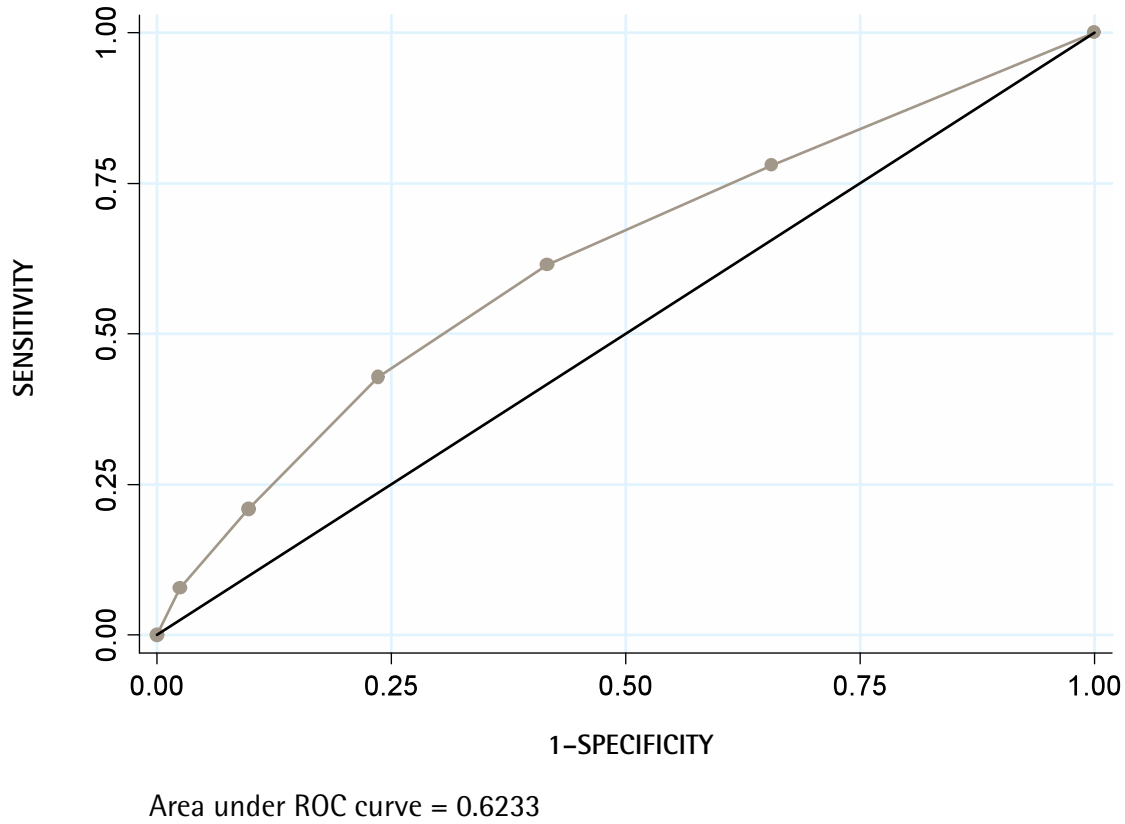
The likelihood ratios for each MRC score are presented in **Table 5.** An MRC score of 2, 4, or 5 was associated with an increased risk of COPD. The likelihood ratio for MRC dyspnea scores of 4 and 5 was 4.22 (95% CI 2.08 to 8.56), and scoring 4 or 5 was associated with an increase in the probability of COPD from 20.7% to 52.5% (95% CI 35.2% to 69.1%). An MRC score of 3 was of indeterminate significance. An MRC score of 1 was associated with a decrease in the probability of COPD from 20.7% to 11.6% (95% CI 9.3% to 14.5%). The area under the ROC curve for MRC dyspnea scores was 0.64 (95% CI 0.60 to 0.68; $P<.001$) (**Figure 2**).

Table 5. Results of the MRC scale and associated likelihood ratios for each score

MRC DYSPNEA SCALE SCORE	TOTAL (N = 829), N (%)	PATIENTS WITH COPD† (N = 168), N (%)	PATIENTS WITHOUT COPD† (N = 661), N (%)	LIKELIHOOD RATIO (95% CI)
1	389 (46.9)	44 (26.2)	345 (52.2)	0.50 (0.39-0.65)
2	320 (38.6)	88 (52.4)	232 (35.1)	1.49 (1.25-1.78)
3	91 (11.0)	21 (12.5)	70 (10.6)	1.18 (0.75-1.86)
4	22 (2.7)	11 (6.5)	11 (1.7)	3.93 (1.74-8.92)
5	7 (0.8)	4 (2.4)	3 (0.5)	5.25 (1.19-23.22)

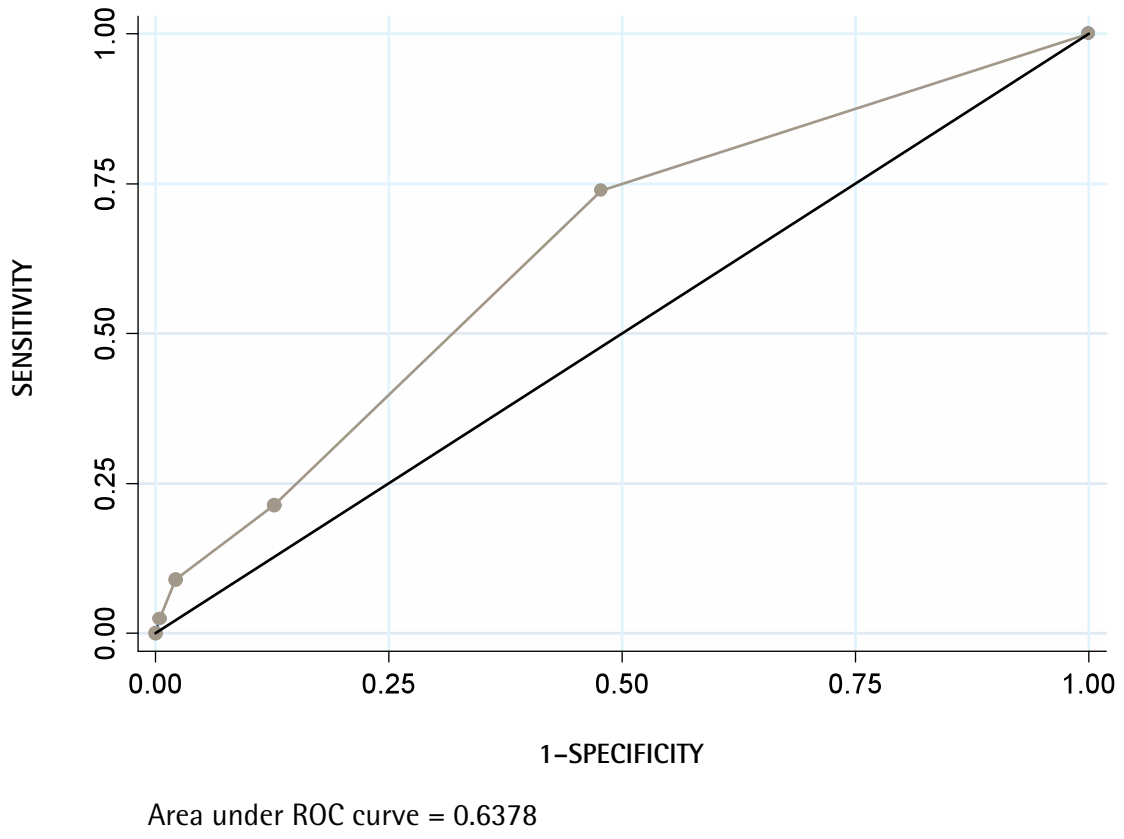
CI—confidence interval, COPD—chronic obstructive pulmonary disease, MRC—Medical Research Council.
*Of the 1003 participants, 174 reported a limited capacity to walk primarily as a consequence of a musculoskeletal comorbid condition and their scores on the MRC scale were excluded from further analysis.
†According to results of spirometry testing.

Figure 1. Receiver operating characteristic curve for total scores on the case-finding questionnaire



ROC—receiver operating characteristic.

Figure 2. Receiver operating characteristic curve for Medical Research Council dyspnea scale scores



ROC—receiver operating characteristic.

DISCUSSION

This study examined associations between the presence of common respiratory symptoms and the results of spirometry testing among adults with known risk factors for COPD in primary care settings. It is important to note that among individuals considered to be at risk of COPD, the presence of 3 or more common respiratory symptoms or a score of 4 or 5 on the MRC dyspnea scale was associated with an increase in the likelihood of having moderate to severe COPD. The presence of 2 or fewer common respiratory symptoms or a score of 1 on the MRC dyspnea scale was associated with a decreased likelihood of having this level of COPD. No one individual common respiratory symptom was of more use than another in identifying cases.

Although individuals with known risk factors for COPD who reported 3 or more common respiratory symptoms had an increased likelihood of having spirometry results suggestive of COPD (ie, results equivalent to the Global Initiative for Chronic Obstructive Lung Disease definition of stage 2 COPD or higher), the magnitude of this increase was modest, with the likelihood ratio equal to 1.82. In our cohort, limiting the use of spirometry to those who described 3 or more common respiratory symptoms (275 of 996, 27.6%) would have resulted in the detection of less than half of the individuals with moderate to severe COPD (88 of 205, 42.9%). The observation that no one symptom was more useful than another in guiding use of spirometry to detect COPD in primary care supports earlier work that noted similar proportions of current and former smokers aged 40 years and older who had symptoms such as cough and sputum irrespective of whether or not they had COPD.[14] This reflects an overlap in symptoms featured in CFQs relating to conditions other than COPD, such as asthma, gastroesophageal reflux disease, and heart failure, and suggests that in primary care, CFQs and spirometry should be used to provide complementary information. Our results suggest that the number, rather than the type, of respiratory symptoms reported by adults with known risk factors for disease development

was of moderate assistance in guiding the use of spirometry to confirm the diagnosis of COPD.

The MRC dyspnea scale is frequently used to categorize functional disability in COPD[21,22] as well as to provide important prognostic information.[23] Although our data showed that an MRC dyspnea score of 2 was associated with an increased likelihood of having the disease, only scores of 4 and 5 were associated with likelihood ratios that are likely to be meaningful in the clinical setting. In other words, the MRC dyspnea scale is only useful for finding cases of COPD once the condition results in marked functional limitation. If spirometry had been limited to those with MRC dyspnea scores 4 or 5 (29 of 829, 3.5%) less than 10% of individuals with COPD would have been detected (15 of 168, 8.9%). This limited capacity of MRC dyspnea scores to guide the use of targeted spirometry confirms the report by Price and colleagues,[24] who noted similar proportions of individuals in a primary care setting with and without COPD for each MRC dyspnea score. As recent work has suggested that language of breathlessness might differentiate COPD from age-matched adults,[25] it might be that future case-finding questions should focus on qualitative aspects of the sensation, rather than simply the magnitude of functional limitation it imposes.

The area under the ROC curve for both the total CFQ scores and the MRC dyspnea scores was less than the 0.80 reported by Calverley and colleagues,[26] who used a CFQ that included age, smoking status, pack-year exposure, body mass index, and previous diagnosis of obstructive lung disease. Notably, the addition of respiratory symptoms to this questionnaire did not improve its capacity to find cases, suggesting that risk factors, body anthropometrics, and a self-reported previous diagnosis are more useful than symptom-based questions in isolation.[26] Our data suggest that in individuals with 2 important risk factors for disease development, the presence of 3 or more respiratory symptoms will increase the yield of COPD cases found using spirometry.

A limitation of this study relates to the exclusion of the 174 (17.3%) individuals from analysis by the MRC dyspnea scale who reported difficulty walking as a consequence of musculoskeletal pain. Strengths of the study include our large sample size, derived prospectively from urban, suburban, and rural populations, and a rigorous, standardized approach to data collection.

Conclusion

For adults aged 40 years and older with a smoking history of 20 pack-years or more, the greatest yields of confirmatory spirometry for moderate to severe COPD are among individuals who report 3 or more common respiratory symptoms on the CFQ, or describe marked functional limitation resulting from dyspnea (4 or 5 on the MRC dyspnea scale). These observations serve to emphasize the limitations of relying exclusively on the presence of symptoms to screen for chronic health conditions such as COPD.

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Contributors

Dr Hill participated in the interpretation of the study results and wrote the manuscript. **Dr Hodder** contributed to the study design, interpretation of the study results, and editing the manuscript. **Ms Blouin** coordinated data collection for this study and participated in the interpretation of the study results and editing the manuscript. **Ms Heels-Ansdell** performed all data analysis and contributed to the interpretation of the results and editing the manuscript. **Dr Guyatt** contributed to the study design, interpretation of the results, and editing the manuscript. **Dr Goldstein** contributed to the study design, interpretation of the results, and editing the manuscript. All authors have reviewed and approved the final version of the manuscript.

Competing interests

None declared

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