Original Article

Feasibility and performance of the chronic obstructive pulmonary disease population screener and chronic obstructive pulmonary disease screening questionnaire in a Chinese physical examination center

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Background: Chronic obstructive pulmonary disease (COPD) affects up to 13% of the Chinese population, though it is under diagnosed throughout China. Screening among asymptomatic individual as part of routine health checks in China can facilitate early diagnosis and intervention to prevent disease progress. The COPD Population Screener (COPD-PS) or COPD Screening Questionnaire (COPD-SQ) has yet to be applied in Chinese physical examination centers (PECs) for COPD screening, and their feasibility and effectiveness should be clarified before full-scale implementation. This study is the first to apply the COPD-PS and COPD-SQ in a public hospital PEC in China to assess their feasibility and effectiveness and to identify their optimal cutoff values.

Methods: People aged ≥40 years who attended the Second Affiliated Hospital of Shantou University PECs from September 2021 to December 2022 were asked to complete the COPD-PS and COPD-SQ and to undergo spirometry. The optimal cutoff values of the two questionnaires at the maximal Youden index were found, and the sensitivity and specificity were calculated.

Results: Data from 198 participants were analyzed; mean [standard deviation (SD)] age of patients was 63.52 (10.94) years. Twenty-five participants (12.63%) were diagnosed with COPD. The number of COPD patients classified as Global Initiative for Chronic Obstructive Lung Disease (GOLD) grades 1 to 4 were 8, 12, 4, and 1, respectively. The area under the curves (AUCs) of the COPD-PS and COPD-SQ were 0.730 and 0.738, respectively. The optimal COPD-PS cutoff value of 4 points corresponded to a sensitivity of 72.00% and a specificity of 60.10%. The COPD-SQ optimal cutoff value of 15 points corresponded to a sensitivity of 76.00% and a specificity of 63.60%.

Conclusions: Applying the COPD-PS and COPD-SQ in Chinese PECs is feasible, cost-effective and effective. COPD-PS and COPD-SQ can facilitate the early diagnosis of COPD, and whether they can improve the participants' quality of life would benefit a further study. It is recommended that the COPD-PS or COPD-SQ questionnaires be added to the screening of the physical examination program in PECs as part

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of health checks for people over 40 years old.

Keywords: Chronic obstructive pulmonary disease (COPD); health checks; physical examination center (PEC); questionnaires; sensitivity and specificity

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Introduction

Chronic obstructive pulmonary disease (COPD) is a disease with persistent and progressive airflow limitation due to airway or alveolar abnormalities, which in turn causes respiratory symptoms (1). According to the World Health Organization, COPD has become the third leading cause of death worldwide (2). Epidemiological findings published in 2018 reported approximately 99 million patients with COPD in China, with a prevalence of 13.7% in people aged ≥40 years (3). Miravitlles *et al.* demonstrated unequivocally that undiagnosed patients with early-stage COPD already show signs of reduced quality of life and reduced activity tolerance (4). Effective screening of the population for COPD can help early diagnosis and treatment of COPD, prevent disease progression, and improve prognosis (5-7). Spirometry is considered the gold standard for COPD diagnosis; however, a large epidemiological survey of COPD in China showed that only 2.6% of patients with COPD were aware of their condition and only 9% of the patients completed a spirometry (3).

In China, health checks are considered to be a routine disease-screening activity (8), and are usually performed in physical examination centers (PECs). The choice of which PEC to have health checks is made by the individual freely. Sometimes, people with a work unit will be organized and arranged health checks at a prescriptive PEC (usually the one close to the workplace). Health checks at the PECs include anthropometrics and basic clinical investigations as indicated, for example blood test, chest radiograph and spirometry, and are used to screen for chronic diseases such as hypertension, diabetes mellitus, hyperlipidemia, and COPD. The research agenda for aging in China in the 21st century encourages older adults to actively seek physical examination to prevent or manage diseases (9), thus health checks are popular at PECs in China. There were 444 million health checks at PECs in China in 2021 whilst the penetration rate of China's health check industry was approximately 32%, and these figures are increasing year by year (10).

Active case detection through questionnaire screening is considered an effective means of early screening for COPD (11,12). The "Expert Consensus on Chronic Obstructive Pulmonary Disease Screening in China Counties (2020)" recommends the use of the COPD Population Screener (COPD-PS) and COPD Screening Questionnaire (COPD-SQ) for early screening of patients with COPD (13). Given the higher cost of spirometry, being able to screen more people using simple and validated questionnaires (e.g., the COPD-PS and COPD-SQ) could contribute positively and significantly to early diagnosis and maximize the benefit of spirometry both clinically and economically. Neither COPD-PS nor the COPD-SQ questionnaire has yet been applied in Chinese PECs for COPD screening although previous studies have reported the effectiveness of the COPD-PS and COPD-SQ in the general population in China (14-16). Those individuals attending health checks

Highlight box

Key findings

- Chronic obstructive pulmonary disease (COPD) Population Screener (COPD-PS) and COPD Screening Questionnaire (COPD-SQ) are both feasible and effective for COPD screening in Chinese public hospital physical examination centers (PECs). The cutoff values of two questionnaires should be changed, before they are used in PECs.

What is known and what is new?

- Previous studies have reported the effectiveness of the COPD-PS and COPD-SQ in the general population in China.
- This study is the first to apply the COPD-PS and COPD-SQ in a public hospital PEC in China to assess their feasibility and effectiveness and to identify their optimal cutoff values.

What is the implication, and what should change now?

- Applying the COPD-PS and COPD-SQ in Chinese PECs is feasible, which can facilitate the early diagnosis of COPD. It is recommended that the COPD-PS or COPD-SQ questionnaires be added to the screening of the physical examination program in PECs as part of health checks for people over 40 years old.

in PECs are different from the general population. Dryden *et al.* reviewed 39 studies from an original pool of 17,463 pieces of literature and found that whether one attends a health check or not is related to gender, marriage, race, age, economy, education level, emphasis on health, symptoms, and unhealthy lifestyles (smoking, alcohol abuse, and unhealthy diet) (17). Age, symptoms, and smoking are questions on the questionnaire that directly influence the questionnaire's scores. The economic level is closely related to question 5 in the COPD-SQ "Exposure to biomass smoke from cooking". This suggests that the questionnaire scores of those who attend health checks may differ from the general population, and the feasibility and effectiveness of the COPD-PS and COPD-SQ in Chinese PECs should be identified before a full-scale implementation. Little is known about the feasibility and effectiveness of the COPD-PS and COPD-SQ to identify individuals at risk of COPD for spirometry as part of routine health checks at PECs. This study is the first to apply the COPD-PS and COPD-SQ in a public hospital PEC in China. A diagnosis of COPD based on spirometry helped in assessing the diagnostic value of the two screening tools and their optimal cutoff values. We present this article in accordance with the SURGE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1967/rc).

Methods

This prospective study was conducted at a single center (PEC of the Second Affiliated Hospital of Shantou University Medical College). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Research Ethics Committee of the Second Affiliated Hospital of Shantou University Medical College in 2021 (No. 2021-31) and informed consent was taken from all the participants.

Demographic and anthropometric data were collected as part of the routine assessments at the health check. Participants were invited to complete screening questionnaires, and to undergo spirometry. A diagnosis of COPD was based on the spirometry findings, which the predictive performances of screening questionnaires were assessed against.

Participants

Consecutive individuals aged ≥40 years who attended the Second Affiliated Hospital of Shantou University Medical College for health checks from September 2021 to December 2022 were randomly and voluntarily assessed on site. All participants were not diagnosed with COPD and had never been screened for COPD. The sample size was estimated with reference to the following formula: $n = [Z_{\alpha/2}^2 \times \pi \times (1 - \pi)]/E^2$. The prevalence rate of people aged ≥40 years in China is 13.7% (3). If the error is allowed to be no more than 5%, π=13.7%, E=5%, and $Z_{\alpha/2}$=1.96 at the 95% confidence level, then a total of at least 181 study participants would be needed. Exclusion criteria were: (I) those with combined severe heart, liver, and kidney function abnormalities; (II) those with combined bone, muscle, and nerve diseases rendering them unable to complete spirometry; and (III) those with other lung diseases.

Screening questionnaires

The COPD-PS and COPD-SQ (*Tables 1*,*2*) were completed by the participants on site. The COPD-PS is a screening questionnaire that was developed by Martinez *et al.* in 2008, containing five questions on age, smoking, shortness of breath, coughing, and decreased activity, with a total score of over 5 being considered indicative of potential COPD (18). The COPD-SQ is a modified screening questionnaire that has been validated by Chinese scholars for the Chinese population with the addition of questions on biofuel exposure and a family history of COPD. A total score of COPD-SQ over 16 indicates suspicion of COPD and requires spirometry for confirmation (19).

Spirometry

All participants underwent spirometry with bronchodilator response (MicroLoop Spiro USB spirometer, Micro, England) for free as per the European Respiratory Society standards. All participants inhaled 400 μg salbutamol and after 30 minutes performed at least three blowouts to complete spirometry (20). COPD was classified as the postbronchodilator forced expiratory volume in the first second (FEV_1) to forced vital capacity (FVC) ratio of <0.70. Severity of COPD was classified by FEV_1% predicted values as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) report; GOLD1 to GOLD4 with boundaries of ≥80%, <80%, <50%, and <30%, respectively (12).

Statistical analysis

SPSS 25.0 software (IBM Corp., Armonk, NY, USA)

Table 1 Characteristics of participants who completed the COPD-PS

Questions and answers	Scores	COPD, n (%)	Non-COPD, n (%)	Total, n (%)
During the past 4 weeks, how much of the time did you feel short of breath?				
None of the time/a little of the time	0	12 (48.0)	129 (74.6)	141 (71.2)
Some of the time	1	11 (44.0)	40 (23.1)	51 (25.8)
Most of the time/all of the time	2	2 (8.0)	4 (2.3)	6 (3.0)
Do you ever cough up any "stuff", such as mucus or phlegm?				
No, never/occasionally, colds	0	9 (36.0)	95 (54.9)	104 (52.5)
A few days a month/most days in the week	1	11 (44.0)	71 (41.0)	82 (41.4)
Yes, every day	2	5 (20.0)	7 (4.0)	12 (6.1)
Please select the answer that best describes yourself in the past 12 months. I do less than I used to because of my breathing problems				
Strongly disagree/disagree/unsure	0	17 (68.0)	162 (93.6)	179 (90.4)
Agree	1	6 (24.0)	11 (6.4)	17 (8.6)
Strongly agree	2	2 (8.0)	0 (0.0)	2 (1.0)
Have you smoked at least 100 cigarettes over your entire life?				
No	0	7 (28.0)	99 (57.2)	106 (53.5)
Yes	2	18 (72.0)	74 (42.8)	92 (46.5)
How old are you?				
Aged 35 to 49 years	0	3 (12.0)	25 (14.5)	28 (14.1)
Aged 50 to 59 years	1	4 (16.0)	40 (23.1)	44 (22.2)
Aged 60 to 69 years/aged 70+ years	2	18 (72.0)	108 (62.4)	126 (63.6)

COPD-PS, COPD Population Screener; COPD, chronic obstructive pulmonary disease.

was used for data analysis. Participants were excluded from analysis if <40 years of age, there was incomplete questionnaire data, or if there was noncompliance with the spirometry. The difference in the scores of COPD-PS or COPD-SQ between COPD participants and non-COPD participants was calculated. Data with a normal distribution are presented as mean and standard deviation (SD), and were compared with the Student *t*-test (two-tailed). Data with a nonnormal distribution are presented as median and interquartile range (IQR), and were compared using nonparametric tests. Receiver operator characteristic (ROC) curves and the area under the curve (AUC) were used to assess the predictive performance of COPD-PS and COPD-SQ. The optimal cutoff values were identified with the maximal Youden index (Youden index = sensitivity + specificity – 1). Sensitivity, specificity, negative likelihood ratio (LR^-), positive likelihood ratio (LR^+), positive predictive value (PPV), negative predictive value (NPV), and false positive rate (FPR) were calculated to evaluate the feasibility and performance of the questionnaires. Differences in AUC, optimal cutoff value, sensitivity, and specificity between different genders were competed.

Results

Participants characteristics

A total of 255 participants completed the questionnaires, and data from 198 (77.65%) participants were included for analysis. Thirty-one, 19, and 7 participants were excluded for <40 years of age, incomplete questionnaire data, and spirometry not meeting criteria respectively. The gender differences between excluded and included participants were not statistically significant. Excluding the 31 participants with age <40 years, the difference in their age composition was not statistically significant. Of the 198 participants, the age ranged from 40 to 92 years, and 132 (66.67%) were male [the age and body mass index

Table 2 Characteristics of participants who completed the COPD-SQ

Questions and answers	Scores	COPD, n (%)	Non-COPD, n (%)	Total, n (%)
Age (years)				
40–49	0	3 (12.0)	25 (14.5)	28 (14.1)
50–59	4	4 (16.0)	40 (23.1)	44 (22.2)
60–69	8	7 (28.0)	61 (35.3)	68 (34.3)
≥70	11	11 (44.0)	47 (27.2)	58 (29.3)
BMI (kg/m^2)				
<18.5	7	1 (4.0)	8 (4.6)	9 (4.5)
18.5–23.9	4	20 (80.0)	81 (46.8)	101 (51.0)
24.0–27.9	1	4 (16.0)	69 (39.9)	73 (36.9)
≥28	0	0 (0.0)	15 (8.7)	15 (7.6)
Smoking amount (pack-years)				
Never smoking	0	7 (28.0)	97 (56.1)	104 (52.5)
1–14.9	2	2 (8.0)	5 (2.9)	7 (3.5)
15–29.9	4	4 (16.0)	29 (16.8)	33 (16.7)
≥30	5	12 (48.0)	42 (24.3)	54 (27.3)
Family history of respiratory disease				
Yes	3	9 (36.0)	15 (8.7)	24 (12.1)
No	0	16 (64.0)	158 (91.3)	174 (87.9)
Exposure to biomass smoke from cooking				
Yes	1	8 (32.0)	22 (12.7)	30 (15.2)
No	0	17 (68.0)	151 (87.3)	168 (84.8)
Cough				
Yes	5	7 (28.0)	21 (12.1)	28 (14.1)
No	0	18 (72.0)	152 (87.9)	170 (85.9)
Degree of dyspnea[†]				
1	0	16 (64.0)	143 (82.7)	159 (80.3)
2	3	7 (28.0)	30 (17.3)	37 (18.7)
3–5	6	2 (8.0)	0 (0.0)	2 (1.0)

[†], 1, I don't have a problem of breathlessness except during strenuous exercise; 2, I experienced shortness of breath when I was hurrying on flat ground or walking up a small slope; 3, I walk more slowly than people of the same age on flat ground due to breathlessness or have to stop for breath when I'm walking at my own pace on flat ground; 4, I have to stop for breath after walking on flat ground for about 100 meters or after a few minutes; 5, I am too breathless to leave the house or become breathless when I dress or undress. COPD-SQ, COPD Screening Questionnaire; COPD, chronic obstructive pulmonary disease; BMI, body mass index.

(BMI) details are shown in *Table 2*]. Twenty-five participants (12.63%) were diagnosed with COPD due to spirometry results of FEV_1/FVC <70%.

Screening questionnaires and spirometry

COPD-PS and COPD-SD were completed by 198 (77.65% out of 255) participants, and the COPD-PS

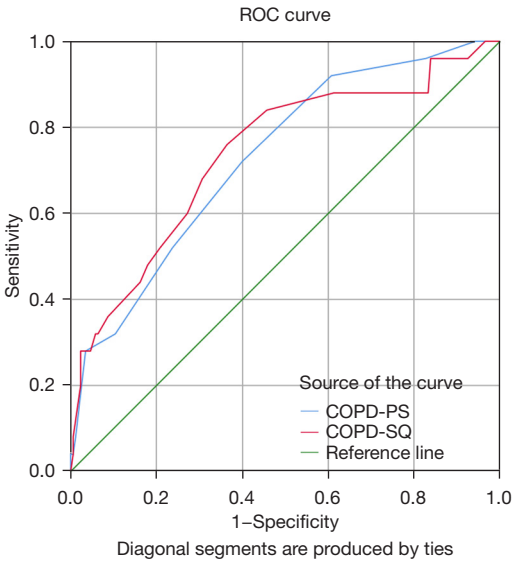

Figure 1 Comparison of ROC curves of the COPD-PS and COPD-SQ. ROC, receiver operating characteristic; COPD-PS, COPD Population Screener; COPD, chronic obstructive pulmonary disease; COPD-SQ, COPD Screening Questionnaire.

and COPD-SD scores are summarized in *Tables 1*,*2*. The questionnaire scores in participants with COPD were significantly higher than participants without COPD; mean ± SD COPD-PS scores were 4.88±2.09 *vs.* 3.17±1.80 (P<0.001), and mean ± SD COPD-SQ scores were 19.68±7.41 *vs.* 12.79±6.00, respectively (P<0.001). Twenty-five participants (12.63%) were diagnosed with COPD; the number of COPD patients classified as GOLD1 to GOLD4 were 8, 12, 4, and 1, respectively. The mean ± SD or mean COPD-PS scores from GOLD1 to GOLD4 were 3.38±1.60, 4.67±1.30, 8.00±1.41, and 7, respectively. The mean ± SD or mean COPD-SQ scores from GOLD1 to GOLD4 were 12.88±6.47, 18.83±5.57, 27.75±2.36, and 27, respectively.

Performance of COPD-PS and COPD-SQ

The ROC curves of the two questionnaires (*Figure 1*) showed that the AUCs (95% confidence interval) of the COPD-PS and COPD-SQ were 0.730 (0.628–0.832) and 0.738 (0.627–0.850), respectively. The COPD-PS with a cutoff value of 4 points corresponded to a maximum Youden index value of 0.321 (sensitivity =72.00% and specificity =60.10%). A total of 87 participants reported COPD-PS scores ≥4, and 18 of 87 (20.69%) were diagnosed with COPD based on spirometry. In contrast, only 7 of 111 (6.31%) participants with COPD-PS scores <4 were diagnosed with COPD after spirometry. For the previously reported cut-off value of COPD-PS score ≥5, the Youden index, sensitivity, and specificity were 0.283, 52.00%, and 76.30%, respectively (18). The COPD-SQ with an optimal cutoff value of 15 points corresponded to a maximum Youden index of 0.396, sensitivity of 76.00%, and specificity of 63.60%. A total of 82 individuals reported COPD-SQ scores ≥15, and 19 of 82 (23.17%) were diagnosed with COPD based on spirometry. In contrast, only 6 of 116 (5.17%) participants with COPD-SQ scores <15 were diagnosed with COPD. When a COPD-SQ cutoff value 16 was used, the corresponding Youden index, sensitivity, and specificity were 0.374, 68.00%, and 69.40%, respectively. The LR^+, LR^-, and FPR of the optimal cutoff values are summarized in *Table 3*. The PPV of the two questionnaires was only approximately 20%, but the NPV was relatively high, exceeding 90% for both questionnaire types.

Gender had an effect on the results for the two screening questionnaires (*Table 4*). Both AUCs of two screening questionnaires in males are lower than that in females. Optimal cutoff values are 7 and 15 in males, 3 and 14 in females. The corresponding sensitivities for males are lower than for females, while the corresponding specificity (94.59%) of COPD-PS for males is higher than for females (66.13%).

Discussion

To our knowledge, this is the first study to apply the COPD-PS and COPD-SQ questionnaires in conjunction with spirometry to screen for COPD in a public hospital PEC in China. We demonstrated that the sensitivity and specificity of the two questionnaires applying in PECs for the screening of COPD were high and that their applications were feasible and effective. In addition, we report the optimal cutoff values applied in PECs.

The application of the COPD-PS and COPD-SQ in Chinese PECs may offer several benefits. First, it can reduce the cost of COPD screening. Spirometry is considered the gold standard for COPD diagnosis, and its price is approximately China Yuan (CNY) 384 in China per person. Although COPD-PS and COPD-SQ are not included in medical institutions' fees currently, they do not require trained healthcare professionals nor the application of equipment or consumables. A study pointed out that the price of another questionnaire (Chinese Symptom-

Table 3 ROC curve and diagnostic values of two COPD screening questionnaires in PECs

Cutoff value	COPD-PS		COPD-SQ	
	4	5	15	16
AUC	0.73	–	0.74	–
Sensitivity (%)	72.00	52.00	76.00	68.00
Specificity (%)	60.10	76.30	63.60	69.40
LR^+	1.80	2.19	2.08	2.22
LR^-	0.47	0.78	0.65	0.71
PPV (%)	20.69	24.07	23.17	24.29
NPV (%)	93.69	91.67	94.83	93.75
FPR (%)	39.88	23.70	36.42	30.64

ROC, receiver operating characteristic; COPD, chronic obstructive pulmonary disease; PEC, physical examination center; COPD-PS, COPD Population Screener; COPD-SQ, COPD Screening Questionnaire; AUC, area under the curve; LR^+, positive likelihood ratio; LR^-, negative likelihood ratio; PPV, positive predictive value; NPV, negative predictive value; FPR, false positive rate.

Table 4 Gender disparity on COPD-PS and COPD-SQ

Questionnaires	COPD-PS		COPD-SQ	
	Male	Female	Male	Female
Score, mean ± SD	3.93±1.91	2.29±1.39	14.58±6.78	11.42±5.29
AUC	0.675	0.792	0.689	0.885
Optimal cutoff value	7	3	15	14
Sensitivity (%)	28.57	75.00	71.43	100.00
Specificity (%)	94.59	66.13	58.56	72.58

COPD-PS, COPD Population Screener; COPD-SQ, COPD Screening Questionnaire; SD, standard deviation; AUC, area under the curve.

Based Questionnaire) for screening COPD is CNY13.3. COPD-PS and COPD-SQ consist of fewer questions than the Chinese Symptom-Based Questionnaire, which lead to a lower cost. Applying COPD-PS or COPD-SQ for initial screening in a PEC can identify individuals at risk for COPD and then routing spirometry, instead of routing spirometry for all attendees. Besides, the questionnaires can induce the question-behavior effect. People who are asked to complete a questionnaire show behavioral changes relative to the control group (21). One study found that participants responding to drinking-related questionnaires showed reduced alcohol use, as participants may become aware of their excessive alcohol intake during their interaction with the questionnaire (22). Routine use of COPD-PS and COPD-SQ may even promote risk avoidance among non-COPD individuals.

The US Preventive Services Task Force recommends against screening for COPD in asymptomatic adults because there is no evidence that it improves clinical outcomes (23). Questionnaire-based screening for COPD has not been widely implemented in most health economies. Several studies have demonstrated that questionnaire-based screening can improve the diagnosis of early COPD, raise awareness of the negative effects of smoking, help prevent the disease, and increase motivation to quit smoking (19,24,25). A study in China found that people at risk for COPD (undiagnosed) had lower productivity and lower health-related quality of life than those without COPD and those with a COPD diagnosis (26). In this study, questionnaire-based screening for COPD was carried out among asymptomatic individuals as part of health checks, which promoted the early diagnosis of COPD and increased motivation to quit smoking; however, whether this will ultimately improve the quality of life of these early COPD

patients should be clarified by long-term follow-up.

This study was conducted from September 2021 to December 2022 during the coronavirus disease 2019 (COVID-19) pandemic phase. However, Shantou has not been much affected by COVID-19 because of the country's well-established segregation policy. At the end of 2022, the city's resident population in Shantou city was 6,641,900 (27). A total of only 327 cases of Covid were cumulatively diagnosed in the whole Shantou city during the study period of 487 days (28). One patient with COPD GOLD4 had higher COPD-PS and COPD-SQ scores than the corresponding mean scores of GOLD3 patients for these questionnaires. In this study, the AUC results of the COPD-PS and COPD-SQ questionnaires were 0.73 and 0.78, respectively, with LR^+ of 1.8 and 2.08, which are relatively moderate. However, these were not much different from the results of the original questionnaires applying in general population, which were 0.81 and 0.753, and 3.56 and 3.30, respectively. These two questionnaires are still endorsed and recommended by the "Expert Consensus on Chronic Obstructive Pulmonary Disease Screening in China Counties (2020)" (13). Pan *et al.* examined the accuracy of six screening test, including four questionnaires, microspirometry (COPD-6) and peak flow, and found that airflow measurement devices for microspirometry and peak flow generally performed better than questionnaires with a higher sensitivities and specificities (29). We found that the optimum cutoff values for COPD diagnosis in males are higher than that in females for the same screening questionnaire, which are the same as a previous study in China (14). This may be caused by differences in smoking rates and weight.

This study found that when the two questionnaires were used in the PEC, changing the cutoff values to 4 and 15 improved the effectiveness of COPD screening, which are similar to and validate the previously study in China (optimal cutoff values are 4 and 16) or Italy (optimal cutoff values are 4 and 17) (14,30). The last item on the COPD-SQ is "Exposure to biomass smoke from cooking". The PEC in this study is located in a coastal town in southern China in a subtropical region with little need for heating. In contrast, with the development of the Chinese economy, coal stoves or firewood cooking have been gradually replaced and become less common in towns and are only sometimes observed in certain rural mountainous areas. It can be surmised that the scores of the questionnaires may also change with economic development. These two cutoff values were lower than the original cutoff values applying in the healthy population setting. The Youden indices of the two questionnaires increased after the cutoff value was changed. Although the specificities were slightly reduced, their sensitivities were significantly increased. A study by Dryden *et al.* proved that people who did not attend health checks paid less attention to their health (17). In contrast, people who attended health checks were more concerned about their health and were more willing to eliminate symptoms of discomfort. Symptoms are an important part of the questionnaire. Liu *et al.* showed that older adults in China who received general health checks had higher health literacy; moreover, those who never smoked and who had higher health self-assessment scores also had higher health literacy (31). Both the COPD-PS and COPD-SQ include questions about smoking and health self-assessment. Hence, both factors may at least partly contribute to the lower cutoff values identified in our study.

The most important limitation of the study is the limited population sample size and only in one PEC, though the prevalence is similar to the national reported prevalence. The performance and optimal cut-off values of the COPD-PS and COPD-SQ would benefit from further assessment in larger multi-center studies in more countries in the future. All the participants could assess on site randomly and voluntarily, which lead to selection bias inevitably. Patients who are more concerned about their health or consider themselves to be at high risk for COPD will be more likely to participate in this screening. It was also noted that a small proportion of patients have difficulty in completing the questionnaire due to illiteracy and require the help of the introducing operator. This always increases the risk of introducing operator bias in the study.

We recommend adding COPD-PS or COPD-SQ questionnaire screening to the physical examination programs as part of health checks for middle-aged and older adults over 40 years of age. Although COPD-PS only has five questions, it would be easier, more cost-effective, and less time consuming to use in the Chinese PECs setting. COPD-SQ has higher AUC, sensitivity, and specificity, which indicated the better performance of COPD screening. If the questionnaire indicates a person at risk for COPD, then lung function tests should be performed to clarify the diagnosis.

Conclusions

This study demonstrated that both the COPD-PS and COPD-SQ are feasible and effective for COPD screening in Chinese public hospital PECs. It is recommended to

reduce the cutoff values of two questionnaires to 4 and 15, respectively, before they are used in PECs.

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Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1967/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1967/dss

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Research Ethics Committee of the Second Affiliated Hospital of Shantou University Medical College in 2021 (No. 2021-31) and informed consent was taken from all the participants.

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