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Validation of IPAG Questionnaire for Chronic Obstructive Pulmonary Disease in Shimane Prefecture

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The under-recognition of chronic obstructive pulmonary disease（COPD）among general physicians might be one of the biggest hindrances to an accurate diagnosis of COPD. The international primary care airways group（IPAG）questionnaire is known to be useful for screening COPD, but its specificity is not high enough to screen Japanese cases. We carried out spirometry and interviews at general physicians' offices to determine the COPD prevalence and evaluate the usefulness of the COPD diagnostic questionnaire. A total of 882 cases were enrolled into the study. As a result of a multiple logistic analysis of the original IPAG questionnaire, the area under the receiver operating characteristic curve was found to be 0.765. However, when comparing the four items of age, smoking history, wheezing, and dyspnea on effort, the area increased to 0.786. The validated IPAG questionnaire might be a promising screening tool for Japanese older COPD cases.

Keywords: COPD, IPAG questionnaire, AUC-ROC, elderly

Abbreviations: chronic obstructive pulmonary disease（COPD）, COPD Diagnostic Questionnaire（CDQ）, forced expiratory volume in one second（FEV1）, forced vital capacity（FVC）, vital capacity（VC）, airflow limitation（AL）, Global initiative for COPD（GOLD）, international primary care airways group（IPAG）, standard deviation（SD）, body mass index（BMI）, receiver operating characteristic curve（AUC-ROC）

INTRODUCTION

The diagnosis of chronic obstructive pulmonary disease（COPD）requires the presence of airflow limitation on spirometry. The Nippon Chronic Obstructive Pulmonary Disease Epidemiology（NICE）study showed that the prevalence of airflow limitation was 8.6% in Japan［1］. Because spirometry is not commonly performed in general physicians' offices, the under-recognition of COPD among general physicians might be one of the biggest hindrances to an accurate diagnosis of COPD［2］. This problem is similar to issues observed in European countries; therefore, a questionnaire was developed to screen for COPD.

The COPD diagnostic questionnaire（CDQ）is an 8-item tool designed by the COPD Questionnaire Study Group from a cross-sectional study of primary care patients ≥40 years old from the United Kingdom and the United States with a history of smoking but no prior respiratory diagnosis. It was developed to improve the efficiency and accuracy of the COPD diagnosis in primary care by removing

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the need for spirometry in low-risk patients [3].

The present study analyzed the usefulness of this questionnaire in screening for COPD among older Japanese patients. We carried out spirometry and interviews at general physicians' offices in Shimane Prefecture in Japan to determine the COPD prevalence and evaluated the usefulness of the CDQ. Through this study, we examined the prevalence of COPD among patients with non-respiratory diseases in primary care clinics and also evaluated the usefulness of the CDQ for screening subjects.

MATERIALS AND METHODS

Study Design and Data Collection

The study protocol was conducted in patients who visited primary care clinics from October 2007 through July 2008 in Shimane Prefecture, Japan. Primary healthcare settings were recruited from amongst medical facilities in 3 different areas of Shimane Prefecture, of which 18 agreed to participate in this study. From among the patients who visited any of the 18 clinics for daily medical care, those who satisfied the inclusion criteria (≥40 years old, with diseases other than respiratory diseases, able to undergo spirometry, and provided their written informed consent) were enrolled into the study.

Laboratory technicians were allocated to each clinic for daily medical care to assess spirometry and assist in the completion of the self-reported questionnaires concerning the age, gender, clinical history, smoking status, respiratory symptoms, underlying diseases, and treatment.

Exclusion Criteria

The exclusion criteria included patients (i) with active pulmonary diseases, including COPD, asthma and tuberculosis; (ii) who had been admitted to a medical institution at the time of the examination; (iii) with a recent history of pneumonectomy or lung cancer; (iv) with pulmonary fibrosis or pneumothorax; (v) with myocardial infarction; (vi) who had undergone eye surgery (or had retinal detachment); (vii) who had been admitted to a hospital for any cardiac disorders or tuberculosis; (viii) who had nausea; and (ix) who had uncontrolled hypertension.

Study Definition

COPD was diagnosed in cases where the ratio of forced expiratory volume in 1 second (FEV1) to the forced vital capacity (FVC) was <70%. The severity of COPD was graded based on the FEV1% predicted according to the proposed guideline: Stage I ≥80%, Stage II <80% and ≥50%, Stage III <50% and ≥30%, and Stage IV <30% of the predicted value. In the recent Global Initiative for COPD (GOLD) guideline [2–4], all FEV1 values refer to the postbronchodilator FEV1, but in the present study, spirometry was performed without bronchodilators.

Spirometry was performed using a CHEST HI-101 spirometer (Chest MI, Inc., Tokyo, Japan). All subjects were asked to perform at least three FVC maneuvers and slow vital capacity (VC) maneuvers according to the recommendations of the American Thoracic Society guidelines [3–6]. The highest FEV1 and FVC values were recorded. The positive criterion for a diagnosis of airflow limitation (AL) was an FEV1/FVC ratio of <70%. In cases with an FEV1/FVC ratio of <70%, the attending physician in Shimane University Faculty of Medicine determined clinically whether or not the patient had COPD. Patients with an FEV1/FVC ratio of <70% visited a foundation hospital or university hospital to distinguish COPD from asthma.

The Evaluation of the Pulmonary Function

Prior to the study, general information on patients that might be associated with COPD, including their age, gender, smoking habit, hospital admission for pulmonary problems in childhood, and respiratory symptoms (such as cough, sputum production and breathlessness), were obtained by the International Primary Care Airways Group (IPAG) questionnaire [2–4]. We also inquired about dyspnea on effort. All interviews and examinations were performed at the clinics. The height and weight were also measured, and the body mass index (BMI) (kg/m^2) was calculated for each patient.

Statistical Analyses

Data are expressed as the mean ± standard deviation (SD) or numbers (%) of subjects. The demography characters were compared with the χ^2 test and

Table 1. IPAG questionnaire

Question	Answers	Points	Airflow limitation (Number)	Non-airflow limitation (Number)
1 How old are you?	40-49 years old	0	4	102
	50-59 years old	4	7	149
	60-69 years old	8	21	200
	≥ 70 years old	10	77	282
2 How many cigarettes do you smoke daily? (if you are an ex-smoker how many cigarettes did you smoke daily?) How many years have you smoked/did you smoke?	0-14 pack-years	0	34	445
	15-24 pack-years	2	14	80
	25-49 pack-years	3	28	128
	≥ 50 pack-years	7	33	80
3 What is your weight? What is your height? BMI = weight (kg) / height (m)^2	BMI <25.4	5	88	561
	BMI 25.4-29.7	1	18	138
	BMI >29.7	0	3	34
4 Is your cough affected by the weather?	Yes	3	11	33
	No	0	32	161
	No cough	0	66	539
5 Do you suffer from sputum production in the absence of a cold?	Yes	3	24	85
	No	0	85	595
6 Do you suffer from sputum production first thing in the morning?	Yes	0	19	90
	No	3	90	643
7 How often do you wheeze?	Never	0	55	489
	Sometimes or often	4	54	244
8 Do you have or have you ever had any allergies?	Yes	0	20	185
	No	3	89	548

McNemar's test. The area under the receiver operating characteristic curve (AUC-ROC) was used to assess the sensitivity, and specificity. A *P* value less than 0.05 was considered statistically significant. All statistical analyses were performed using the general-purpose statistical software program StatFlex Ver. 6.0 for Windows (Artech, Co., Osaka, Japan).

Clinical parameters associated with the AL status were evaluated using a multiple logistic regression analysis. A binary variable representing the AL status was set as the objective variable, and the following parameters adopted from the IPAG questionnaire were set as explanatory variables: age (0 point, 40–49; 4 points, 50–59; 8 points, 60–69; 10points, ≥70 years old), cigarette smoking history (0 point, 0–14; 2points, 15–24; 3 points, 25–49; 7 points, ≥50 pack-years), weather-dependent cough (0 point, no; 3 points, yes), sputum without cold (0 point, no; 3 points, yes), BMI (5 points, <25.4; 1 point, 25.4–29.7; 0 point, >29.7), morning sputum (0 point, no; 3 points, yes), dyspnea (0 point, no; 3 points, sometimes/often), and allergy (0 point, no; 3 points, yes) (Table 1). As an additional parameter, dyspnea on effort (0 point, no; 3 points, yes) was added to the analysis.

The selection of the explanatory parameters was performed by the backward elimination method. To evaluate the utility of the IPAG score for diagnosing the AL status, an ROC analysis was performed. The summary value representing the diagnostic accuracy was expressed as the AUC-ROC. The sensitivity and specificity of the IPAG score were evaluated by serially changing the cut-off value for the score. The goodness-of-fit of the logistic regression analyses was expressed as the AUC, which was determined by secondarily making the ROC analysis using the predicted probability of belonging to the low AL group the diagnostic parameter.

RESULTS

Patient Background Characteristics and Findings

A total of 925 subjects were initially recruited (Figure 1). Of these subjects, 43 were excluded due to incomplete medical records (32 subjects) and not satisfying the inclusion criteria (11 subjects).

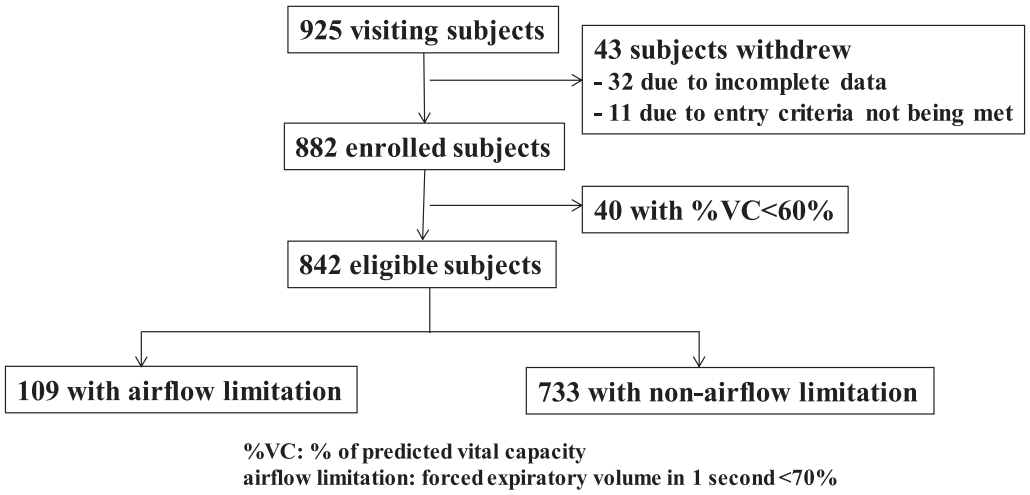

Figure 1. Enrollment of the subjects. Participant flow with the number of available patients.

Table 2. Physical and respiratory variables and smoking rate of subjects

	gender	Age group (years)					Total
		40s	50s	60s	70s	80s or older	
Number of subjects	Male	67	94	125	146	45	477
	Female	39	62	96	124	44	365
Age	Male	44.5 ± 3.1	56.0 ± 2.7	64.4 ± 2.9	74.2 ± 2.7	83.4 ± 2.8	64.7 ± 11.9
	Female	45.6 ± 2.6	55.5 ± 2.7	64.4 ± 3.1	74.5 ± 2.9	83.2 ± 3.3	66.6 ± 11.5
BMI	Male	24.2 ± 2.9	23.8 ± 3.2	23.5 ± 2.9	23.2 ± 3.1	22.0 ± 3.3	23.4 ± 3.1
	Female	22.6 ± 4.1	23.4 ± 3.3	23.7 ± 3.7	23.1 ± 3.8	22.8 ± 4.1	23.2 ± 3.7
VC (L)	Male	4.25 ± 0.66	3.67 ± 0.62	3.22 ± 0.61	2.92 ± 0.64	2.52 ± 0.53	3.30 ± 0.80
	Female	2.85 ± 0.43	2.61 ± 0.40	2.29 ± 0.45	1.99 ± 0.39	1.72 ± 0.35	2.23 ± 0.53
%VC (%)	Male	99.4 ± 12.5	94.2 ± 13.6	89.7 ± 15.0	89.7 ± 16.7	85.4 ± 16.8	91.5 ± 15.6
	Female	99.0 ± 13.1	98.0 ± 14.1	96.9 ± 17.0	93.9 ± 16.9	93.5 ± 16.6	95.9 ± 16.1
FEV1 (L)	Male	3.45 ± 0.53	2.92 ± 0.52	2.54 ± 0.52	2.20 ± 0.51	1.84 ± 0.50	2.57 ± 0.70
	Female	2.41 ± 0.33	2.17 ± 0.29	1.83 ± 0.34	1.56 ± 0.34	1.33 ± 0.27	1.80 ± 0.46
FEV1% (%)	Male	81.4 ± 6.9	79.9 ± 7.8	79.2 ± 9.3	75.8 ± 10.4	72.9 ± 14.8	78.0 ± 10.0
	Female	84.9 ± 5.9	83.8 ± 6.5	80.6 ± 8.5	78.7 ± 10.8	78.2 ± 12.2	80.7 ± 9.6
Smoking rate (%)	Male	86.6	85.1	87.2	81.5	84.4	84.7
	current	59.7	50	36.8	24.7	17.8	37.1
	former	26.8	35.1	50.4	56.8	66.6	47.6
	Female	12.8	14.5	9.4	10.5	9.1	11
	current	12.8	8.1	5.2	6.5	0	6.3
	former	0	6.4	4.2	4	9.1	4.7

We then excluded a further 40 subjects with a VC <60%. The remaining 842 subjects (477 men and 365 women) were analyzed in this report. Among these patients, 109 (12.9%) showed AL, defined as an FEV1/FVC <70%. Of the 842 eligible subjects, 56.7% were men, and 43.3% were women.

The physical and respiratory variables and smoking rate of subjects are shown in Table 2. The mean age, BMI, FEV1, FEV1%, and smoking rate were 64.7 ± 11.9 years old, 23.4 ± 3.1 kg/m^2, 2.57 ± 0.70 L, 78.0% ± 10.0%, and 84.7% in men and 66.6 ± 11.5 years old, 23.2 ± 3.7 kg/m^2, 1.80 ± 0.46 L, 80.7% ± 9.6%, 11.0% in women, respectively. The physical and respiratory variables and smoking rate of subjects with airflow limitation are shown in Table 3. The mean age, BMI, FEV1, FEV1%, and smoking rate of the subjects were 64.7 ± 11.9 years old, 23.0 ± 3.1 kg/m^2, 1.88 ± 0.61 L, 61.3% ± 7.9%, and 94.8% in men and 66.6 ± 11.5 years old, 22.5 ± 3.9 kg/m^2, 1.27 ± 0.36 L, 61.7%

Table 3. Physical and respiratory variables and smoking rate of subjects with air flow limitation

	gender	Age group (years)					Total
		40s	50s	60s	70s	80s or older	
Number of subjects	Male	3	7	17	34	15	76
	Female	1	0	4	20	8	33
BMI	Male	23.2 ± 3.0	23.8 ± 3.8	22.2 ± 2.7	23.7 ± 3.5	21.8 ± 2.2	23.0 ± 3.1
	Female	16.8	-	22.2 ± 1.2	23.2 ± 3.2	21.5 ± 6.0	22.5 ± 3.9
FEV1 (L)	Male	3.18 ± 0.07	2.41 ± 0.64	1.85 ± 0.44	1.88 ± 0.52	1.43 ± 0.45	1.88 ± 0.61
	Female	2.22	-	1.22 ± 0.44	1.26 ± 0.31	1.17 ± 0.31	1.27 ± 0.36
FEV1% (%)	Male	63.8 ± 1.7	64.9 ± 5.2	62.5 ± 5.9	61.9 ± 7.6	56.4 ± 10.3	61.3 ± 7.9
	Female	68.1	-	58.0 ± 10.7	62.9 ± 7.3	59.7 ± 10.1	61.7 ± 8.3
Smoking rate (%)	Male	100	100	100	94.1	86.7	94.8
	current	66.7	85.7	70.6	38.2	20	47.4
	former	33.3	14.3	29.4	55.9	66.7	47.4
	Female	0	-	25	25	12.5	21.2
	current	0	-	0	15	0	9.1
	former	0	-	25	10	12.5	12.1

Physical and respiratory data are presented as the means ± standard deviation.

Table 4. Results of a multiple logistic regression analysis Objective variable: airflow limitation+; n = 842

Table 4-a

Parameter (score)	z-value	P-value
age	5.132	<0.01
smoking cigarette	5.791	<0.01
BMI	1.677	0.0935
weather dependent cough	1.927	0.054
sputum without cold	0.222	0.824
morning sputum	0.203	0.839
wheezing	3.353	<0.01
allergy	0.883	0.3774

Table 4-b

Parameter (score)	z-value	P-value
age	5.242	<0.01
smoking cigarette	5.923	<0.01
wheezing	3.305	<0.01

Table 4-c

Parameter (score)	z-value	P-value
age	5.433	<0.01
smoking cigarette	5.842	<0.01
wheezing	2.206	0.0274
dyspnea on efforts	4.313	<0.01

± 8.3%, and 21.2% in women, respectively. The rate of AL was 15.9% in men and 9.0% in women. According to the GOLD guidelines, the numbers of patients with Stage I (FEV1 ≥80% predicted), II (50% ≤FEV1 <80% predicted), III (30 ≤FEV1 <50% predicted), and IV (FEV1 <30% predicted) were 47.4%, 44.7%, 7.9%, and 0% in men and 30.3%, 60.6%, 9.1%, and 0% in women, respectively. The rate of AL increased with age in both men and women. A total of 627 people were positive for the questionnaire with a score of ≥17 (627/842, 74.5%). The sensitivity and specificity were calculated as 94.1% and 34.1%, respectively.

Results of a Multiple Logistic Regression Analysis

The results of the logistic regression analysis before and after the backward elimination procedure are shown in Table 4 in three steps. From the initial result, it is obvious that the scores for sputum without a cold, morning sputum, and allergy were not relevant to the AL status, judging from the low z-value and high *p*-value (Table 4-a). The results of the second analysis after the extraction of three parameters (age, smoking history, and wheezing) were found to be highly significant for the prediction of the AL status. However, the BMI and weather-dependent cough only showed marginal significance, so they were deleted for the final analysis. The results shown in Table 4-b indicate that the three parameters (age, smoking history, and wheezing) were relevant for our dataset. The goodness-of-fit of the logistic regression analysis, expressed as the AUC, was 0.765 with the inclusion of the above-mentioned three parameters (Figure 2A). The original

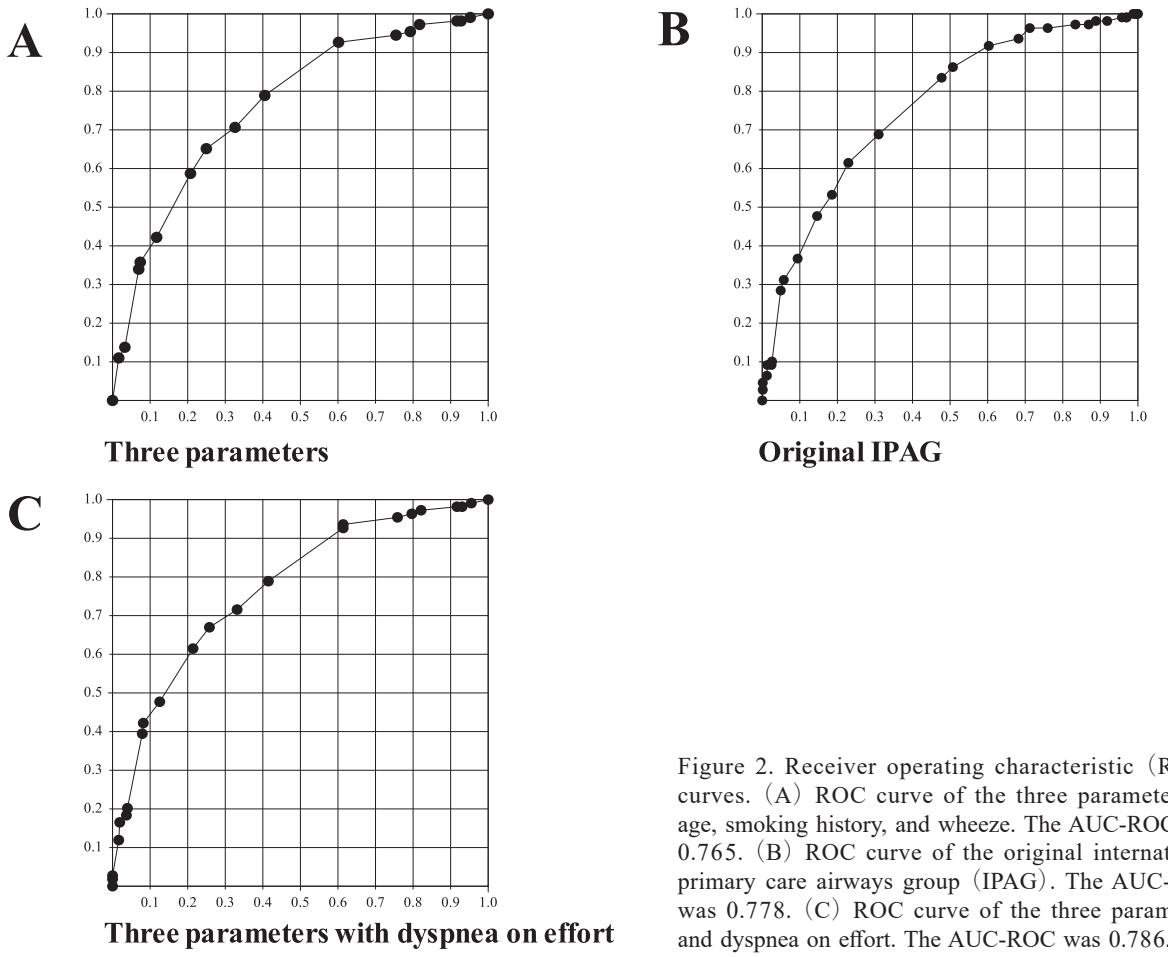

Figure 2. Receiver operating characteristic（ROC）curves.（A）ROC curve of the three parameters of age, smoking history, and wheeze. The AUC-ROC was 0.765.（B）ROC curve of the original international primary care airways group（IPAG）. The AUC-ROC was 0.778.（C）ROC curve of the three parameters and dyspnea on effort. The AUC-ROC was 0.786.

AUC for the analysis including all parameters was 0.778（Figure 2B）. The reduction in the AUC after eliminating less-significant parameters was very slight. We then added the parameter of dyspnea on effort to the three chosen parameters（Table 4-c, Figure 2C）and found that the AUC was higher（0.786）than that shown in Figures 2A and 2B.

DISCUSSION

In the present study, we showed that the modified-IPAG questionnaire had a higher sensitivity and specificity for older Japanese patients with COPD than the original IPAG questionnaire. To our knowledge, this is the first report showing the importance of a questionnaire concerning dyspnea on effort in older COPD patients. We conducted prospective COPD screening by adding unique questionnaire items to the IPAG questionnaire in order to create a questionnaire for the early diagnosis of COPD that would be suitable for areas where many older people live. Our study indicated that airflow limitation was present in 12.9% of all subjects ≥40 years old, including 15.9% of men and 9.0% of women. Airflow limitation was found in 91.7%（100/109 persons）of subjects with GOLD stage I and II in our study. These subjects were adults ≥40 years old without a COPD diagnosis or bronchial asthma who consulted a primary care physician, indicating that many cases of early-stage COPD are easily overlooked.

Based on a standard cut-off value of 17, while the COPD diagnosis rate using the IPAG questionnaire indicated a sensitivity of 96.3%, the specificity was as low as 28.8%. Using all items of the IPAG questionnaire, the AUC of the ROC curve（Figure 2B）was found to be 0.778 according to a multiple logistic analysis, which was not completely satisfactory. The AUC of the ROC curve（Figure 2A）was measured only under the three items of age, smoking history, and wheezing frequency after deleting the item of BMI, which did not contribute to

the determination of the presence of airflow limitation, coughing due to weather, sputum without cold symptoms, morning sputum, and allergy. The AUC of the ROC curve was 0.765, indicating a slight decrease, and the ability to discriminate the presence of airflow limitation showed almost no decrease (Tables 1 and 4). As a result of the multiple logistic analysis with additional question items that we added independently, the AUC of the ROC curve (Figure 2C) increased to 0.786 in the 4-item questionnaire (age, smoking history, wheezing, and dyspnea on effort). Therefore, we propose this COPD questionnaire (COPD-SUCCESS) based on these four items be applied (Table 4-c).

The COPD diagnosis rate using the IPAG questionnaire for Japanese has a reported sensitivity of 0.939 and specificity of 0.404. The lower specificity is attributed to the following reasons: the average BMI for people over 30 years old is 23.4 for men and 22.8 for women (according to the 2000 Ministry of Health, Labor and Welfare's survey in Japan), indicating that the BMI settings on the IPAG questionnaire are unsuited for Japanese people. According to a study by Kawayama et al. [4] on the IPAG questionnaire targeting Japanese people, although the age, smoking index, and wheezing are important, it is necessary to examine them based on the physical constitution of Japanese people because questions regarding cough and sputum are not very useful, with no difference in the BMI. Arimura et al. [5] conducted respiratory function tests and COPD questionnaire surveys among 186 people (average age: 45 years old, 128 people ≥40 years old) who underwent a health examination. Judging from the results of the respiratory function tests, airflow limitation (FEV1/FVC <70%) was observed in 3.8% of all patients, including 5.5% among those ≥ 40 years old. The area under the ROC curve in the COPD questionnaire was 0.67 based on the respiratory function test. With a cut-off value of 17 points recommended by the IPAG of the COPD questionnaire, the sensitivity was 14.3% and the specificity was 83.2%, whereas if it was 14 points, the sensitivity was 85.7%, and the specificity was 59.2%. It was indicated that the COPD questionnaire of IPAG for health examinations could be used by lowering the cut-off value because the questionnaire did not provide sufficient discriminative power at the recommended cut-off value (17 points). Sichletidis et al. [6] reported that it was possible to increase the specificity by using the IPAG questionnaire together with Piko-6, which is a simple respiratory function tester, or increasing the cut-off value of the IPAG questionnaire to 19 points.

To date, we have investigated COPD discovery by changing the cut-off of the IPAG questionnaire. However, in the present study, we conducted a logistic analysis in order to select question items useful for COPD discovery from the IPAG questionnaire and created a new COPD questionnaire by adding items other than those found on the original IPAG questionnaire. This new COPD questionnaire includes four items for which questions are expected to be able to be asked efficiently in a short period of time. As the next step, we plan to perform validation studies using the new COPD questionnaire and demonstrate the usefulness of our modified IPAG questionnaire.

There are three limitations associated with this study. First, bronchodilators are not used before the respiratory function test, so the respiratory function test does not meet the COPD diagnostic criteria. Second, we did not perform imaging diagnoses using chest computed tomography, so the exclusion of other diseases that might cause airflow limitation was deemed insufficient. Third, the exclusion of asthma was limited to each subject's declaration during a history interview, so the exclusion of asthma was also considered to be insufficient. However, we do not feel that these limitations are likely to affect the interpretation of our results concerning the utility of this screening test.

CONCLUSION

The present study showed that the specificity of the original IPAG questionnaire for the screening of COPD in older Japanese subjects was lower than expected. Our modified IPAG questionnaire might be a promising tool for screening older COPD cases.

Ethical approval

The study was approved by the institutional review board of Shimane University Faculty of Medicine

（number 300, date Aug/7/2007）.

Author contribution

All authors contributed to the study conception and design data collection analysis were performed by Shunichi Hamaguchi and Takeshi Isobe. The first draft of the manuscript written by Shunichi Hamaguchi and all authors commented on the manuscript. All authors read and approved the final manuscript.

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Conflicts of interest

All authors except Takeshi Isobe confirm that there are no conflicts of interest to declare.

Takeshi Isobe has honoraria（500,000 JPY or more annually from one commercial entity）by Boehringer Ingelheim, AstraZeneca and Pizer.

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