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REVIEW

Spirometric testing on World COPD Day

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Background: To determine the importance of spirometric testing for early detection of chronic obstructive pulmonary disease (COPD).

Methods: Spirometric testing has been performed annually on World COPD Day in Sezana from 2003. Sezana is in a semiurban region of Slovenia, with 12,000 inhabitants. The investigation was performed between January 2003 and December 2008. In total, 770 persons were enrolled (414 females and 356 males). The participants were recruited by mass media appeals. Smokers aged ≥40 years with a smoking history of ≥10 pack-years were invited to visit the local chest clinic. The participants completed a questionnaire and had spirometry performed. Subjects with a postbronchodilator forced expiratory volume in one second/forced vital capacity <0.70 were defined as having COPD, according to the Global Initiative for Chronic Obstructive Lung Disease guidelines.

Results: We identified that 16.2% of subjects had impaired lung function. Of these, 10.2% had an obstructive pattern of ventilatory impairment and 6% had a restrictive pattern. We identified 79 individuals with COPD. Subjects with COPD were >70 years in 40.5% in cases. The majority of individuals with COPD were men (74.6%), and 90% were smokers. COPD was mild in 52% of subjects, moderate in 34%, and severe in 14%. The majority of subjects had a milder stage of the disease, and 92% of those with COPD (72/79) had not been recognized to have COPD previously.

Conclusion: These results suggest that spirometry testing could detect patients with COPD in the earlier stages of the disease.

Keywords: chronic obstructive pulmonary disease, epidemiology, smoking, spirometry

Introduction

COPD is one of the leading causes of morbidity and mortality in industrialized countries worldwide, and is emerging as being increasingly important in developing countries.[1–4] Assuming that current trends in mortality continue, COPD will move from being the sixth leading cause of death worldwide in 1990 to the third in 2020.[5] Epidemiological studies in Europe have demonstrated that COPD affects about 9% of the adult population, mostly smokers.[6,7] The disease is poorly recognizable by both patients and health care providers, especially in the earlier stages.[8,9] Population-based surveys that have used spirometry have documented the underdiagnosis of COPD.[9–12] For example, a Korean survey found that 17.2% of Korean adults over the age of 45 years have mild COPD and only a minority had been diagnosed.[11] In the PLATINO study, 88.7% of COPD cases had not been previously diagnosed.[12] Underdiagnosis was related to

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severity of COPD, because milder disease is missed more often than severe disease.[11,12]

Materials and methods

Study design and population

This study was conducted at Sezana Hospital in Sezana, a town in the southwestern part of Slovenia. The aim was to evaluate the usefulness of spirometric testing for early detection of airflow obstruction. The testing was first started on World COPD Day 2003, and then we continued to perform free spirometric testing annually on this day. Our target population was the inhabitants of Sezana, current and former smokers aged ≥40 years, with a smoking history of ≥10 pack-years. Inclusion criteria were aged above 40 years and a history of smoking (>10 pack-years), exclusion criteria were the presence of any other pulmonary disease and comorbid conditions that preclude use of spirometry. Although the target population was defined as smokers aged ≥40 years, it was decided that never-smokers who were concerned about their lung health would be included in the project.

The participants were invited by mass media appeals (advertisements on TV, radio, newspapers) and billboards displayed in public places. Primary care physicians were asked to encourage eligible patients to participate in the project. The study was approved by the local hospital ethics committee, and all participants gave their written informed consent. Spirometric testing was conducted in two parts. The first part was conducted from 2004 to 2006, and the second part was conducted from 2006 to 2008.

Questionnaire data

All subjects completed a questionnaire seeking demographic and anthropometric data, history of smoking, cough, expectoration, dyspnea, and allergies.

Tests

Spirometry was performed by an experienced certified technician at the lung function laboratory of the Hospital Sezana. Forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were recorded according to American Thoracic Society recommendations[13] using a flow screen Jaegar spirometer (Jaeger, Wuertzburg, Germany), with participants in a seated position. This spirometer fulfils the American Thoracic Society criteria.[13] After initial spirometry, a bronchodilatory test was performed with inhalation of salbutamol (GlaxoSmithKline, Montrose, United Kingdom) 100 μg four puffs to all subjects, administered via a metered-dose inhaler with a spacer. After an additional 15 minutes, postbronchodilator spirometry was performed. Two investigators independently assessed the quality of the flow-volume curves according to the criteria of the American Thoracic Society.[13] To be deemed usable for the analysis, spirometry had to meet American Thoracic Society acceptability and reproducibility criteria.

Definitions

In accordance with the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, irreversible airflow obstruction was defined as a postbronchodilator FEV_1/FVC ratio of <0.70, which corresponds to GOLD Stage I.[14,15] Airflow obstruction was classified according to the GOLD criteria. Severity of COPD is distinguished in four stages:

- Mild (GOLD Stage I) FEV_1/FVC ratio <0.70 and FEV_1 > 80% predicted
- Moderate (GOLD Stage II) FEV_1/FVC ratio <0.70 and FEV_1 50%–80% predicted
- Severe (GOLD Stage III): FEV_1/FVC ratio <0.70 and FEV_1 30%–50% predicted
- Very severe (GOLD Stage IV): FEV_1/FVC ratio <0.70 and FEV_1 < 30% predicted or FEV_1 < 50% with signs of chronic respiratory failure.

Predicted values for FEV_1 and FVC were computed using the regression equations of the European Coal and Steel Community approved by the European Respiratory Society.[16] The values for FEV_1/FVC and FEV_1 were postbronchodilator, and were expressed as a percentage of predicted. The GOLD definition of reversibility was used, ie, FEV_1 increase of 200 mL and 12% improvement above baseline FEV_1 following the administration of bronchodilator. Doctor-diagnosed COPD was defined as self-reported physician's diagnosis of chronic bronchitis, emphysema, or COPD. The number of pack-years of cigarette smoking was defined as the average number of cigarettes smoked per day divided by 20 (ie, packs per day) times the duration of smoking in years. The participants identified to have COPD were sent for further investigation and treatment at the Department of Pneumonology, Sezana Hospital.

Data presentation and statistics

Continuous variables are expressed as the mean (±standard deviation) and prevalence rates as crude and standardized gender-adjusted values. The Student's *t*-test was used to compare continuous variables, and Chi-square values were

used for testing between groups of frequencies. $P < 0.05$ was considered statistically significant.

Results

Of the 1254 individuals contacted, 110 were not eligible on the basis of age. Of the remaining 1144 eligible participants, 770 (67%) completed the questionnaire data, and had spirometry findings that met American Thoracic Society quality control criteria. These individuals constituted the final sample for the analysis. In total, 329 persons (29%) did not complete the questionnaire data, and 45 individuals (4%) completed the questionnaire data but had unusable spirometry (see Figure 1).

The final sample consisted of 356 males (46%) and 414 females (54%). The average age was 59.6 ± 14.8 years, for females 60 ± 13.6 years, and for males 58.2 ± 16.0 years. One quarter of the participants were aged 40–50 years, and almost half of them were aged 50–70 years. The remaining individuals were older than 70 years (see Table 1).

Two-hundred and seventy-eight subjects (36.1%) were current smokers, 178 (23.1%) were former smokers, and 314 (40.8%) were never-smokers. Significantly ($P < 0.001$) more males (201, 56.5%) than females (77, 18.6%) were current smokers. The opposite was found among former smokers, in that 57 males and 121 females were former smokers (16.0% versus 29.2%, $P < 0.001$). Males had an average smoking history of 26.1 ± 2 pack-years and females 16.5 ± 4 pack-years. Smoking intensity above 15 pack-years was reported by 148 (52.2%) current smokers (see Table 2).

The results of spirometry were within normal limits for 645 subjects (83.8%) and a pattern of ventilatory impairment was found in 125 subjects (16.2%). Among these, 79 subjects (10.2%) had airflow limitation (obstruction) and 46 subjects (6.0%) had a restrictive pattern of ventilatory impairment (see Table 3). Table 4 reports spirometry in the study participants.

COPD was diagnosed in 79 subjects (10.2%). Of these, 41 persons (52%) had the mild form (GOLD I), 27 persons (34%) had the moderate form (GOLD II), and 11 (14%) had the severe form of the disease. None had the severe stage of disease (GOLD IV). The majority of patients had mild stage of the disease (GOLD I). Fifty-nine patients with COPD (74.6%) were men (see Figure 2).

The prevalence of airways obstruction increased with age, from six patients (7.6%) in the fourth decade to 33 patients (40.5%) aged 70 years or more. The average age of the individuals with COPD was 65 years ± 4.0 (Figure 3).

Among patients with COPD, 54 patients were current smokers (68.4%), 17 patients were former smokers (21.5%), and eight patients were never-smokers (10.1%). The majority of the patients with COPD (80.3%) reported >15 pack-years of smoking. A higher proportion of male patients with COPD were current smokers, compared with female patients

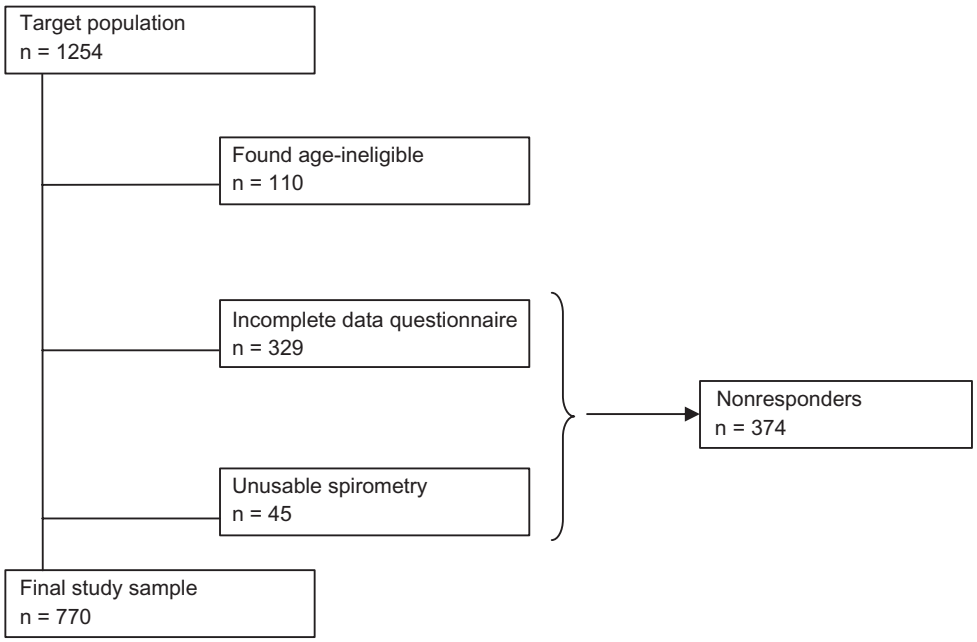

Figure 1 Flow diagram of the study population.

Table 1 Demographic characteristics of the study sample

Age/years	Male n (%)	Female n (%)	Total n (%)
40–49	116 (32.5)	81 (19.6)	197 (25.5)
50–59	59 (16.5)	93 (22.4)	152 (20.0)
60–69	75 (21.0)	122 (29.5)	197 (25.5)
70+	106 (30.0)	118 (28.5)	224 (29.0)

Notes: Chi-square value = 85,33; df = 3; $P = 0.01$. There is a statistically significant difference between male and female patients.

(71.2% versus 60%, $P < 0.001$). Gender differences also existed in terms of mean pack-years. Men were more intensive smokers than women (36 ± 10 pack-years versus 19 ± 10 pack-years, $P < 0.001$, Figure 4).

The prevalence of COPD among females was 4.8% and was 16.6% among males. The prevalence of COPD in current smokers was 19.4%, 9.6% in former smokers, and 2.6% in never-smokers. Seventy-three of 79 with COPD had not been recognized prior to this survey. We identified 92% of patients with COPD, but previous diagnosis of COPD by a doctor was reported by only six patients (8%).

Discussion

The key findings of this survey are that 9.5% of the participants had previously undetected COPD, and over half of the individuals identified to have COPD (52%) had a mild form of this disease. However, this study does have several limitations. One is the smallness of the sample size and that the recruitment was based on voluntary participation, so was not representative of the population of Slovenia. The other limitation is that the use of the fixed ratio ($FEV_1/FVC < 0.7$) as the cutoff point for airflow obstruction, as recommended by GOLD, has the potential for misclassification at older ages. The present GOLD guidelines endorse the use of the fixed ratio, while recognizing that there is potential for misclassification.

A meta-analysis of epidemiological investigations, based on spirometry testing, has shown a COPD prevalence in the developed world of 8.9% (7.4%–10.7%).[17] The COPD prevalence in our cohort (10.2%) is consistent with the reported COPD prevalence in other epidemiological surveys worldwide,[17–22] although the comparison of prevalence rates for COPD is very difficult because the studies have used different methodologies.[18–24]

Several candidate populations for a screening strategy by means of spirometry have been advocated in the available literature.[25–29] In our survey of spirometric testing, we used the strategy of Zielinski and Bednarek for the target population, the manner of recruiting the participants, the type of spirometer, regression equations for computing FEV_1 and FVC, and the criteria for defining COPD.[25] The prevalence of COPD in current smokers in this study was 19.4%, which is in accordance with other international epidemiological studies.[10,30]

The gender-standardized COPD prevalence in our survey was 15.7% for men and 5.5% for woman, which can be explained with the difference in smoking intensity. Given the increasing smoking rate among women in recent decades, one may expect that the prevalence of airflow obstruction in female smokers will rise in the near future.[31]

Although tobacco smoking is the main risk factor for COPD, other factors could be involved in its development.[26] However, the prevalence of COPD in our survey among never-smokers was low at 2.6%. Some studies that have detected the prevalence of COPD included never-smokers, in which case the prevalence was 20.4%–30%,[11,32] and other studies excluded never-smokers.[12]

Our investigation shows that the prevalence of airway obstruction increased with age, with the highest prevalence

Table 3 Pulmonary function in the study participants

Pulmonary function	Male		Female		Total		t-value	*P* value
	M	SD	M	SD	M	SD		
FEV_1 (L)	3.30	1.2	3.1	1	3.22	1.12	2.281	0.023*
FEV_1 (% of predicted)	0.99	17.2	0.97	19.8	0.98	18.63	1.651	0.099
FVC (L)	4.40	2.0	4.09	1.9	4.25	2.01	2.163	0.031*
FEV_1/FVC ratio	75.16	7.4	75.6	10.0	75.4	8.91	–0.725	0.468

Note: *Statistically significant difference.
Abbreviations: FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; SD, standard deviation.

Table 2 Smoking status of the study participants

Smokers	Male n (%)	Female n (%)	Total n (%)
Current	201 (56.5)	77 (18.6)	278 (36.1)
Former	57 (16.0)	121 (29.2)	178 (23.1)
Never	98 (27.5)	216 (52.2)	314 (40.8)

Notes: Chi-square value = 118,97; df = 2; $P = 0.01$. There is a statistically significant difference between male and female patients.

Table 4 Spirometry in the study participants

Spirometry	Male n (%)	Female n (%)	Total n (%)
Normal	283 (79.4)	362 (87.4)	645 (83.8)
Airflow limitation	56 (15.7)	23 (5.5)	79 (10.2)
Restriction	17 (14.9)	29 (7.1)	46 (6.0)

Notes: Chi-square value = 22,35; df = 2; $P = 0.01$. There is a statistically significant difference between male and female patients.

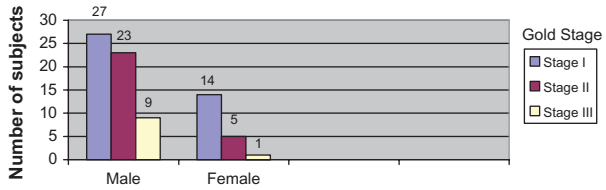

Figure 2 Classification of chronic obstructive pulmonary disease patients according to GOLD stage.
Abbreviation: GOLD, Global Initiative for Chronic Obstructive Lung Disease.

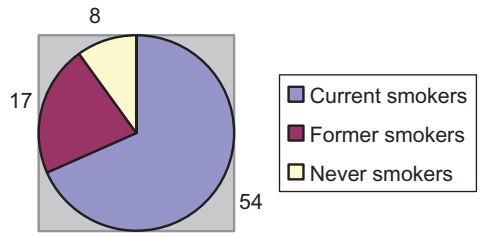

Figure 4 Smoking status among patients with chronic obstructive pulmonary disease.

seen in men and women >70 years of age, which is similar to data obtained by other investigators.[11,12] This fact must be considered with caution, because we and other investigators have used fixed ratio $FEV_1/FVC < 0.7$ as the cutoff point for airflow obstruction.

In the present study, one-third of patients (31.6%) with COPD were aged 40–60 years, indicating the importance of the disease in the working population.[33] Tzanakis et al detected nearly 40% of individuals with COPD aged 40–60 years.[34]

Although the proportion of subjects younger than 50 years with COPD is obviously lower than that of older individuals, we detected 7.6% such individuals. These rates are of interest because they represent a cohort of patients with a presumably long life expectancy, and a considerable contribution to the burden of the disease.[35]

An important finding of our study is that there was a huge gap between physician diagnosis of COPD and the presence of airflow obstruction defined by spirometry. Ninety-two percent of our subjects did not report a prior physician diagnosis of COPD. Our participants were recruited so that they were self-selected and came to our hospital on a voluntary basis and were included in this study. Therefore, this rate (92%) most likely does not accurately represent the actual rate of undetected COPD in the target population, and did not provide population-based prevalence estimates. This discrepancy between physician diagnosis and obstruction defined by spirometry has also been reported by other investigators.[32]

Fourteen percent of our patients without a prior diagnosis of COPD had severe stages of the disease. Mannino et al reported that, among their participants, 63.3% of COPD cases was detected for the first time, and 44% of the patients who were detected had severe disease according to the GOLD classification.[10] One of the reasons for the late detection of the disease is that the patients did not recognize the symptoms of the illness early enough.[36] In order to improve early detection of COPD, spirometry as a routine investigation has been implemented in primary care settings in many countries.[37–39]

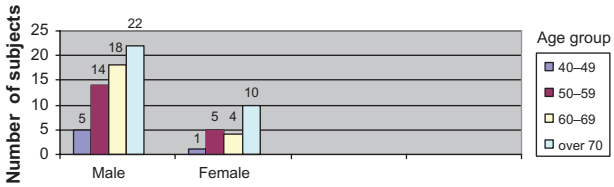

Figure 3 Classification of patients with chronic obstructive pulmonary disease by age group.

Conclusion

These results demonstrate that COPD, albeit in a mild form, was detected in one of every 10 tested patients. They also suggest that, with spirometry testing, patients with COPD could be detected in the earlier stages of the disease.

Disclosure

The authors report no conflicts of interest in this work.

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