

Prevalence of Chronic Obstructive Pulmonary Disease in Japanese People on Medical Check-Up

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TAKEMURA, H., HIDA, W., SASAKI, T., SUGAWARA, T. and SEN, T. *Prevalence of Chronic Obstructive Pulmonary Disease in Japanese People on Medical Check-Up.* Tohoku J. Exp. Med., 2005, **207** (1), 41-50 — In Japan, spirometry has not been included as an item in medical check-ups for all persons. The purpose of this study was to show evidence to recommend spirometry routinely on medical check-up for the early detection of chronic obstructive pulmonary disease (COPD). There were 12,760 enrolled persons who underwent medical check-up. COPD was defined as a ratio of forced expiratory volume in one second to slow vital capacity of 70% or less. We investigated the prevalence and its characteristics of COPD in people on medical check-up. The prevalence of COPD was 3.6% in all subjects, 4.5% in males, and 1.8% in females. In the comparison between males and females, the prevalence of COPD in males of most age groups was higher than that of females, and this difference was greater with aging. Males in their 50s and over 60 years old and females over 60 years old showed remarkably high prevalences. Occupations associated with a high smoking rate such as transportation-related occupations showed a higher prevalence of COPD. These results suggest that spirometry for all persons in medical check-ups can identify many COPD patients not aware of this disease. Spirometry should be carried out routinely on medical check-up. ——— spirometry; chronic obstructive pulmonary disease; epidemiology; smoker; occupation

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Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality in the world (National Institutes of Health, National Heart, Lung, and Blood Institute 2001). The mortality from COPD has been increasing in developed countries (American Thoracic Society 1995a; British Thoracic Society 1997). In Japan, the mortality from this disease has been also in-

creasing (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labor and Welfare 2003). Moreover, it has been predicted that COPD will become the third leading cause of death in the world in 2020 (Murray and Lopez 1997). The prevalence of COPD might be underestimated (Lundback et al. 1991; Rennard et al. 2002; Takahashi et al. 2003) because mild

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COPD that is not clinically apparent is usually not diagnosed (National Institutes of Health, National Heart, Lung, and Blood Institute 2001). Very recently, it has been reported that the prevalence of COPD in Japan was at least 8.6% in the general population aged over 40 years, and that 90.6% of persons with air flow limitation had not been diagnosed as COPD (Fukuchi et al. 2004). Similarly, 52% of the British general population with COPD aged 60 to 75 years had not been previously diagnosed (Pena et al. 2000). The airflow limitation by COPD is not fully reversible and is progressive. Even if there are no subjective and/or clinical symptoms, it is important to perform spirometry as much as possible to detect COPD in the early stage.

Many Japanese people undergo medical check-up routinely even if they are healthy. In 2001, 60.4% (66.0% of male and 55.2% of female) of the general population aged over 20 years underwent medical check-up (Health and Welfare Statistics Association 2002). These persons usually undergo blood tests, blood pressure, chest x-ray and cardioelectrogram, whereas spirometry has not been included as an item in medical check-ups. To recommend spirometry routinely on medical check-up, we need to identify the prevalence of COPD in people not aware of this disease.

COPD is affected by several factors such as sex (Thom 1989; National Institutes of Health, National Heart, Lung, and Blood Institute 2001), age (Viegi 2001), smoking (Silverman and Speizer 1996), and occupation (Hnizdo et al. 2002; Marget et al. 2002). In particular, COPD is strongly associated with smoking and was thought to be the leading cause of death attributable to smoking in the world in 2000 (Ezzati and Lopez 2003). Concerning other risk factors for COPD, the role of sex still remains especially unclear. The influence of smoking on the prevalence of COPD according to sex or age is also little understood, particularly in Japanese people. Moreover, there are no studies concerning the prevalence of COPD by occupation in Japanese people.

The purpose of this retrospective study was to show evidence to recommend spirometry rou-

tinely to persons on medical check-up for early detection of COPD. Therefore, we investigated the prevalence and its characteristics of COPD in people on medical check-up.

MATERIALS AND METHODS

Subjects

The subjects were 14,503 Japanese people aged over 30 years who underwent a medical check-up at the SS30 Clinic Health Screening Center in Sendai City, Japan from 1997 to 2001. Subjects with the following characteristics were excluded: those already diagnosed as having a history of bronchial asthma, COPD or any other chronic respiratory disease ($n = 348$), those with abnormalities on chest x-ray ($n = 261$), those with no answer concerning smoking status ($n = 254$), and those who did not undergo the pulmonary function tests ($n = 880$). After exclusion, 12,760 people (8,659 males and 4,101 females) were enrolled for the data analysis.

Protocol

Questionnaires concerning occupation and current smoking status including the number of cigarettes smoked per day and smoking duration were assessed. Pulmonary function tests were administered using a flow-type spirometer (Minato Medical Science Co., Ltd., Autospiro AS-505, Osaka) by a well-trained laboratory technologist according to standard procedures (American Thoracic Society 1991, 1995b) for vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume in one second (FEV_1). These parameters were obtained from the best of each curve recorded by the maximal inspiration and maximal slow expiration procedures and the maximal inspiration and maximal forced expiration procedures.

Definition of COPD

COPD was basically as defined by the Japanese Respiratory Society (JRS) criteria, in which $FEV_1\%$ is 70% or less (Japanese Respiratory Society 1999). In the JRS criteria, $FEV_1\%$ is calculated by the ratio of FEV_1 to FVC. In our previous report (Takemura et al. 2003), however, the FVC in most subjects tended to be lower than the VC even in persons without COPD. Therefore, we calculated $FEV_1\%$ by using the ratio of FEV_1 to VC to prevent an underestimation of the prevalence of COPD.

Classifications of subjects

All data were investigated retrospectively. If the subjects underwent medical check-up several times at the same clinic during the observation period, the latest data was used for analysis. The prevalence of COPD and smoking rate were the ratio of persons with COPD and that of current smokers, respectively. Subjects were divided into four age groups as follows: 30-39 years (30s), 40-49 years (40s), 50-59 years (50s), and over 60 years (60s or older). As for the classification by smoking status, they were categorized as non-smokers, ex-smokers, and current smokers. The Brinkman index (BI) of current smokers was estimated by multiplying the current number of cigarettes smoked per day by the number of years of smoking. Current smokers were divided into less than 400 (BI < 400) and over 400 (BI \geq 400) groups.

Furthermore, subjects were divided into seven occupational groups as follows (Health and Welfare Statistics Association 2002): transportation-related occupations (mainly truck drivers), sales, executives, production and labor, specialty and technology, clerical work, and other occupations. The relationships between occupations and the prevalence of COPD were studied only in males, because female subjects could not be divided fully according to those occupations. We found differences in the mean ages among the occupational categories. Therefore, to minimize the aging effects on the prevalence of COPD in different occupations as much as possible, we selected persons whose ages ranged within the 68 percent confidence interval (40-56 years) of the mean age of all males.

Data analysis

Data for physical and respiratory variables were expressed as means \pm standard deviation (s.d.). The prevalence of COPD was characterized by the sex, age, occupation, and smoking status of the subjects. In this study, all data were collected from medical check-ups. The data analysis was carried out with consideration towards protecting individual data in accordance with guidelines for epidemiological studies. The guidelines were published by Ministry of Education, Culture, Sports, Science and Technology and Ministry of Health, Labor and Welfare (MHLW) of Japan (Ministry of Education, Culture, Sports, Science and Technology, Ministry of Health, Labor and Welfare 2002). The study was approved by the Human Research Committee of Tohoku University. For comparison of the prevalence of COPD among the groups, chi-square test was done. Pearson's

correlation coefficient was used to assess differences between smoking rate and the prevalence of COPD in the occupational groups. The significance levels for statistical analysis were set at $p < 0.05$.

RESULTS

Characteristics of subjects

The baseline characteristics of the subjects of each sex and age group are presented in Table 1. The mean value of body mass index (BMI), assessed as body weight divided by the square of body height (m^2), showed normal values irrespective of the sex or age groups. Smoking rate decreased with aging in both males and females, whereas males had a higher smoking rate than females in each age group. In all subjects, the age, BMI and smoking rate were 47.1 ± 8.1 years, 23.3 ± 3.1 kg/ m^2 , and 38.2%, respectively.

Prevalence of COPD

As shown in Table 2, the prevalence of COPD was 3.6% in all subjects, 4.5% in males, and 1.8% in females. The prevalence of COPD was significantly higher with advanced age, particularly in males in their 50s and 60s or older, and females in their 60s or older. In most age groups, the prevalence of COPD in males was significantly higher than that in females.

COPD and smoking status

Fig. 1 shows the prevalence of COPD by smoking status in all subjects. The prevalence was 2.3% in non-smokers, 4.3% in ex-smokers, and 4.8% in current smokers. There was no significant difference in the prevalence of COPD between ex-smokers and current smokers, whereas the prevalence of COPD in these two groups was significantly higher than that in non-smokers ($p < 0.01$). The prevalences of COPD in the current smokers were 2.8% in the BI < 400 group and 5.9% in the BI \geq 400 group, and the differences between the two groups were significant ($p < 0.01$).

COPD by sex and age group according to differences in smoking status

The prevalence of COPD by age group in

TABLE 1. *Physical and respiratory variables and smoking rate of subjects*

Variables	Sex	Age group				Total
		30s	40s	50s	60s or older	
<i>N</i>	Male	1,552	3,517	2,923	667	8,659
	Female	952	1,757	1,201	191	4,101
Age (yrs.)	Male	36.3 ± 2.2	44.5 ± 2.8	54.0 ± 2.9	63.2 ± 3.3	47.7 ± 8.2
	Female	36.1 ± 2.4	44.4 ± 2.9	53.5 ± 2.7	63.2 ± 3.2	46.0 ± 7.8
Height (cm)	Male	171.6 ± 5.6	170.0 ± 5.7	167.6 ± 5.7	165.6 ± 5.7	169.1 ± 5.9
	Female	158.4 ± 5.0	157.0 ± 5.1	154.7 ± 4.8	152.5 ± 5.2	156.4 ± 5.3
BMI (kg/m ²)	Male	23.8 ± 3.3	24.0 ± 3.1	23.8 ± 2.7	23.5 ± 2.5	23.8 ± 2.9
	Female	21.0 ± 2.8	22.2 ± 3.0	22.7 ± 2.9	23.1 ± 2.9	22.1 ± 3.0
VC (ml)	Male	4,222 ± 596	3,994 ± 595	3,676 ± 564	3,400 ± 577	3,882 ± 631
	Female	2,949 ± 450	2,837 ± 421	2,629 ± 402	2,331 ± 392	2,778 ± 449
%VC (%)	Male	105.0 ± 16.9	103.9 ± 14.6	101.8 ± 14.8	100.1 ± 15.5	103.1 ± 15.2
	Female	102.8 ± 14.7	104.4 ± 14.2	103.7 ± 14.8	99.2 ± 15.6	103.6 ± 14.6
FEV ₁ (ml)	Male	3,596 ± 522	3,349 ± 517	2,988 ± 503	2,701 ± 486	3,221 ± 576
	Female	2,613 ± 394	2,447 ± 369	2,206 ± 345	1,927 ± 349	2,391 ± 409
FEV ₁ % (%)	Male	85.2 ± 6.4	83.9 ± 6.4	81.3 ± 7.2	79.7 ± 7.8	82.9 ± 7.0
	Female	88.1 ± 6.8	86.2 ± 6.6	84.0 ± 6.5	82.4 ± 7.9	85.8 ± 6.9
Smoking rate (%)	Male	56.1	54.1	45.9	30.9	49.9
	Female	19.5	13.7	10.1	3.1	13.5

Physical and respiratory data are means ± S.D.

N, number of subjects; BMI, body mass index; VC, slow vital capacity; %VC, percentage of VC for predicted value; FEV₁, forced expiratory volume in one second; FEV₁%, percentage of forced expiratory volume in one second for VC.

A predicted value for VC was calculated using equation of Baldwin (Baldwin et al. 1948).

TABLE 2. *Prevalence (%) of COPD in subjects on medical check-up*

	Age group				Total
	30s	40s	50s	60s or older	
All subjects	1.5	2.0	5.6 ^{##,§§}	10.3 ^{##,§§,††}	3.6
Male	1.5	2.4 [#]	6.9 ^{##,§§}	11.5 ^{##,§§,††}	4.5
Female	1.5	1.2	2.3 [§]	5.8 ^{##,§§,††}	1.8
<i>p</i> value (M vs F)	N.S.	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.05	<i>p</i> < 0.01

N.S., no significant. [#] *p* < 0.05, ^{##} *p* < 0.01 vs 30s; [§] *p* < 0.05, ^{§§} *p* < 0.01 vs 40s; ^{††} *p* < 0.01 vs 50s; significant differences between the groups.

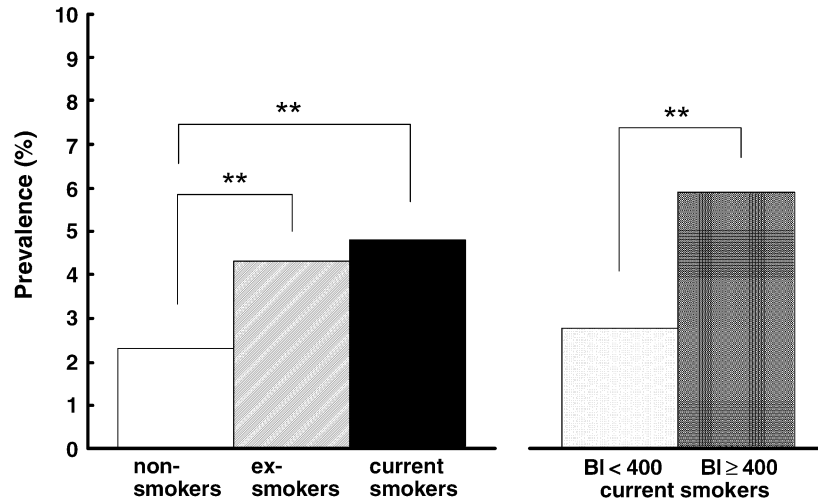


Fig. 1. Prevalence of COPD by smoking status in all subjects.

The number of subjects was 5,496 non-smokers, 2,391 ex-smokers, and 4,873 current smokers. Of the current smokers, 1,699 and 3,174 were in the BI < 400 and BI \geq 400 groups, respectively. BI, Brinkman index; ** $p < 0.01$; significant differences between the groups.

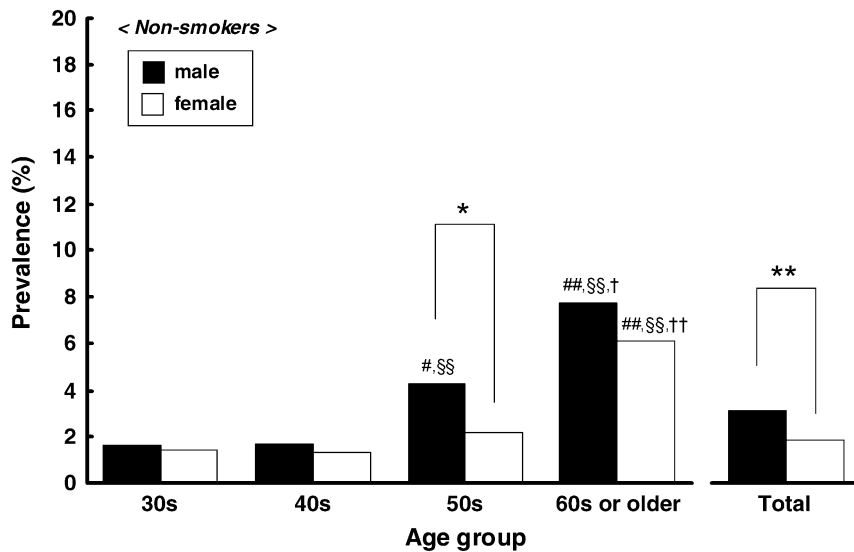


Fig. 2. Prevalence of COPD by age group in non-smokers.

The number of male and female subjects in their 30s was 439 and 719, with 774 and 1,422 in their 40s, 696 and 1,047 in their 50s, and 218 and 181 in their 60s or older, respectively. * $p < 0.05$, ** $p < 0.01$; significant difference between males and females. # $p < 0.05$, ## $p < 0.01$ vs 30s; §§ $p < 0.01$ vs 40s; † $p < 0.05$, †† $p < 0.01$ vs 50s; significant differences from each age group.

non-smokers is shown in Fig. 2. In males, the prevalence of COPD in the 30s and 40s was 1.6% and 1.7%, respectively and increased with aging. The prevalence in the 50s and 60s or older was significantly higher than in the 30s and 40s. In females, a significantly higher prevalence of

COPD was found in the 60s or older compared with the other three age groups.

The prevalence of COPD by age group in current smokers is shown in Fig. 3. In males, the prevalence of COPD was similar to that in non-smokers in the 30s and 40s groups, and signifi-

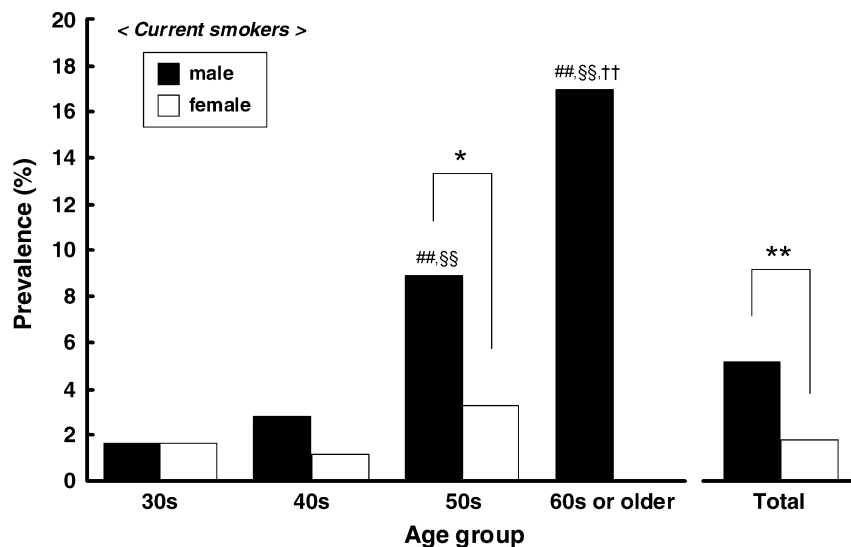


Fig. 3. Prevalence of COPD by age group in current smokers.

The number of male and female subjects in their 30s was 871 and 186, with 1,901 and 241 in their 40s, 1,341 and 121 in their 50s, and 206 and 6 in their 60s or older, respectively. There were 6 female subjects over 60 years in age and none of them had COPD. * $p < 0.05$, ** $p < 0.01$; significant difference between males and females. ## $p < 0.01$ vs 30s; \$\$ $p < 0.01$ vs 40s; †† $p < 0.01$ vs 50s; significant differences from each age group.

cantly increased in the 50s and 60s or older groups. In females, the prevalence of COPD appeared not to increase with aging. In the comparison between sexes, the males showed a significantly higher prevalence than the females in their

50s and all non-smokers and current smokers.

COPD and occupation

The baseline characteristics and prevalence of COPD by occupation for the male age groups

TABLE 3. Baseline characteristics and prevalence of COPD by occupation in given age group of male

Variables	Occupation						
	Transportation-related occupations	Sales	Executives	Production and labor	Specialty and technology	Clerical work	Other occupations
<i>N</i>	76	1313	2461	553	303	624	419
Age (yrs.)	47.3 ± 4.7	46.6 ± 4.8	48.6 ± 4.6	47.2 ± 4.8	46.1 ± 5.1	47.5 ± 4.8	47.7 ± 4.7
BMI (kg/m ²)	23.7 ± 3.1	24.0 ± 3.0	24.0 ± 2.8	23.5 ± 2.9	23.7 ± 2.8	23.6 ± 3.1	23.9 ± 3.1
VC (ml)	3,814 ± 521	3,904 ± 610	3,878 ± 585	3,853 ± 610	3,958 ± 588	3,903 ± 607	3,928 ± 597
%VC (%)	101.3 ± 13.0	102.7 ± 13.8	103.5 ± 16.0	102.3 ± 14.2	104.1 ± 13.5	103.5 ± 13.9	104.4 ± 13.8
FEV ₁ (ml)	3,161 ± 468	3,239 ± 544	3,207 ± 522	3,206 ± 533	3,306 ± 509	3,255 ± 556	3,266 ± 528
FEV ₁ % (%)	83.1 ± 7.4	83.1 ± 6.8	82.8 ± 6.5	83.3 ± 6.8	83.7 ± 6.2	83.4 ± 7.0	83.3 ± 7.0
Smoking rate (%)	64.5	53.5	51.3	54.6	47.2	49.5	46.8
Prevalence (%)	5.3	4.6	4.1	3.3	3.3	3.2	3.3

Physical and respiratory data are means ± standard deviation.

N, number of subjects; BMI, body mass index; VC, slow vital capacity; %VC, percentage of VC for predicted value; FEV₁, forced expiratory volume in one second; FEV₁%, percentage of forced expiratory volume in one second for VC; Prevalence, Prevalence of COPD.

A predicted value for VC was calculated using equation of Baldwin (Baldwin et al. 1948).

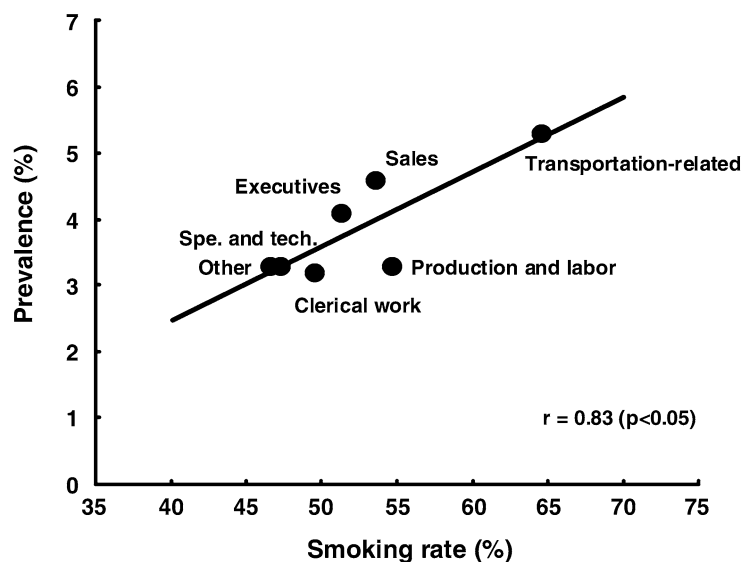


Fig. 4. Relationship between smoking rate and the prevalence of COPD by occupation of males. Spe. and tech., Specialty and technology; Other, Other occupations.

are shown in Table 3. In total, 5,749 male subjects were selected for analysis. There were no significant differences in the mean values of age and BMI among the seven occupational groups. The smoking rate was 64.5% in transportation-related occupations, 53.5% in sales, 51.3% in executives, 54.6% in production and labor, 47.2% in specialty and technology, 46.8% in other occupations, and 49.5% in clerical work. Similarly, the prevalence of COPD in these occupations was 5.3%, 4.6%, 4.1%, 3.3%, 3.3%, 3.3%, and 3.2%, respectively.

Fig. 4 shows the relationship between the smoking rate and the prevalence of COPD by occupation. The smoking rate was correlated with the prevalence of COPD ($r = 0.83$, $p < 0.05$). The occupations with higher smoking rates tended to show higher prevalences.

DISCUSSION

This study retrospectively examined the prevalence and characteristics of COPD in Japanese people who underwent a medical check-up. We found that (1) the prevalence of COPD was 3.6% in all subjects, 4.5% in males, and 1.8% in females, and spirometry for all persons on medical check-up can identify many COPD pa-

tients who would not otherwise recognize this disease; (2) there was a high prevalence of COPD in males, current smokers (particularly the $BI \geq 400$ group), advanced age groups (males in their 50s and 60s or older and females in their 60s or older), and outside occupations such as transportation-related occupations.

We calculated $FEV_1\%$ by the ratio of FEV_1 to VC to diagnose COPD. $FEV_1\%$ is also expressed as the ratio of FEV_1 to FVC. A consensus is still lacking concerning the methods for calculating $FEV_1\%$. Several guidelines (Japanese Respiratory Society 1999; National Institutes of Health, National Heart, Lung, and Blood Institute 2001) for COPD propose FVC, while there are other guidelines (Siafakas et al. 1995; British Thoracic Society 1997) that recommend VC. We compared FVC and VC of the subjects in this study. Subjects whose VC was higher than FVC were found in 65.3%. Furthermore, in 28.9% of all subjects FVC was more than 5% lower than VC. In contrast, there were few cases in which FVC was higher than VC. This reason is that, although pulmonary function tests were done by standard and accurate procedures, the subjects might not have exhaled completely in the measurement of FVC.

According to the patient survey conducted by MHLW of Japan in 1999, the prevalence of COPD was only 0.2% (Ministry of Health, Labor and Welfare 1999). This figure was based on the number of patients who underwent treatment for COPD in a hospital or clinic. However, recent studies concerning the prevalence of COPD in Japan showed higher values than those in the previous report by MHLW. The first report is the Nippon COPD epidemiological (NICE) study, which showed that at least 8.6% of the general population suffered from COPD (Fukuchi et al. 2004). The second report is the paper by Takahashi et al. (2003), who reported that 27% of the patients with COPD were found among patients treated for diseases other than chronic respiratory disease in primary care settings. The present study would support the latter two papers. However, the prevalence of COPD in the present study was lower than that in the NICE study. The age distribution of the subjects was different between the NICE study and our study. The prevalence of COPD was higher in the advanced age group (over 60 years) in both studies. In the NICE study, 43.1% of all subjects were over 60 years. However, the percentage of subjects of these age groups in our study was only 6.7%. Furthermore, subjects in the 30s with a lower prevalence were not included in the NICE study. These two reasons may explain the lower prevalence of COPD in the present study than that in the NICE study. It is important to recognize that there may be many unrecognized COPD patients in Japan. Our data also suggest that spirometry should be undertaken for all persons on medical check-up in order to identify COPD patients in the early stage.

COPD is recognized as an inflammatory disease of lungs to environmental factors such as air pollution and occupational exposure, as well as smoking status, age and genetic predisposition (Barnes 2000; Scanlon et al. 2000; National Institutes of Health, National Heart, Lung, and Blood Institute 2001; Ichinose 2003). The present study showed higher prevalence of COPD in advanced age groups, males, and current smokers.

In a previous study, it was reported that the

risk of lung cancer in current smokers with $BI \geq 400$ was higher than that in $BI < 400$ group (Sobti et al. 2003). However, whether there is a correlation between the development of COPD and BI still remains unclear. Therefore, we referred to the previous study and used $BI = 400$ to divide current smokers into two groups. Among current smokers, the prevalence of COPD was significantly higher according to the number of cigarettes consumed.

Furthermore, we also found COPD in 1.5~2.0% of young adults. A recent study performed in Europe showed that a considerable percentage (3.6%) of young adults suffered from COPD (de Marco et al. 2004). Therefore, we have to consider the possible presence of COPD even in young adults.

In the United States, it has been reported that the prevalence of COPD among 14 occupational groups was different; the highest prevalence of COPD was 13.4% in the armed forces, and the lowest prevalence was 4.9% in office workers (Hnizdo et al. 2002). We also investigated the prevalence of COPD by occupational groups in Japanese people. Our data showed that the smoking rate by occupational groups was significantly correlated with the prevalence of COPD. Particularly, outdoor occupations such as those related to transportation showed higher values in both the prevalence of COPD and smoking rate. In contrast, indoor occupations such as those involving clerical work showed relatively lower values. These data may show only the influence of smoking on the prevalence of COPD, because the high prevalence of COPD in certain occupation is associated with the high smoking rate. Some occupational environments are likely to involve a risk of COPD (Hendrick 1996), although the risk may be less than that from smoking (American Thoracic Society 1996; Viegi 2001).

Smoking cessation slows down the progression of the disease process in COPD (Hida et al. 2002). Therefore, to reduce the prevalence of COPD, particularly in Japan, it is important to recommend smoking cessation to current smokers. More importantly, young persons should be encouraged not to begin smoking while they are

in school.

In conclusion, there are many potential patients with COPD in Japan, and spirometry for all persons on medical check-up would be able to identify such patients who do not recognize this disease. Spirometry should be carried out routinely on medical check-up for the early detection of COPD.

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