Assessment of Smoking related Risks for Respiratory Symptoms among Elderly People

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Abstract

Disease risk among elderly smokers is considered to be doubled due to their smoking habits and age as compared with elderly non-smokers. The investigators conducted risk assessments of smoking for respiratory symptoms among elderly people.

A questionnaire survey on smoking habits and respiratory symptoms was conducted among 3,000 persons of 56 years of age and over who were randomly selected from suburban residents in a prefecture in Japan in October, 1997. A total 1,954 or 65.1% of individuals responded, consisting of 42.8% for men and 57.2% for women, with an average age of 73.6 years.

In addition to descriptive analysis, multiple logistic regression analysis was conducted. The results are summarized as follows:

Smokers accounted for 28.1% of men and 3.6% of women. Among all age-groups, the highest rate of smokers was observed in men of 56-69 years old (34.7%) which was lower than the national average rate for the 60-69 year-old group (56.1% of men and 14.5% of women in '97). The odds ratios and 95 percent confidence interval (95%CI) for "having phlegm every day" and "having phlegm for more than 4 days a week" among smokers were 2.06 (95%CI=1.41-3.01) and 2.77(95%CI=1.80-4.27). Significantly higher odds ratios among smokers were also observed for "wheezing" and "shortness of breath when hurrying".

Odds ratios for some respiratory symptoms including "having phlegm for more than 4 days per week" among inhalers were significantly high compared with non-smokers, whereas those among non-inhalers were not significantly different from 1.0.

Odds ratios for symptoms of phlegm and wheezing were significantly higher (Odds ratio ≥ 2.0) among heavy smokers (Brinkman Index [B. I.] >900) compared to non-smokers, while odds ratios of the same symptoms were not different from 1.0 among light smokers (B. I. ≤ 500).

Key words: respiratory symptom, elderly people, smoking, Brinkman Index, ATS-DLD78

Introduction

The proportion of elderly in the Japanese population has been rapidly increasing. As a result, a decline and impairment in physiological function among the elderly may be inevitable, and special attention should be directed towards health care for the elderly. It is known that functions of the respiratory system including the coughing reflex, swallowing reflex and ciliary

movement in the trachea decrease linearly and markedly with age. For example, it is thought that a 70-year-old person's forced expiratory volume in one second (FEV₁), an indicator of airway obstruction, decreases by 70% from his/her 20-year-old FEV₁¹⁾. It is also believed that aging itself becomes a risk factor for chronic obstructive pulmonary disease (COPD)²⁾. Due to these changes, the prevalence of respiratory symptoms among the elderly is high. C.K.W. Lai and co-workers reported that 56% of the elderly had at least one respiratory symptom and 25% often had phlegm in the morning³⁾. It is considered that having such respiratory symptoms can lower activities of daily living (ADL) among the elderly.

Obviously, the respiratory system can be affected by external

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factors such as air pollutants, occupational exposure and house dust, because the respiratory system constantly intakes ambient air. In addition, many studies have shown the serious adverse effects of smoking on the respiratory system^{4, 5)}.

Risk factors for respiratory symptoms include sex, aging, occupational exposure, residential environment, family structure and education levels, but most investigators pointed out that smoking is the greatest risk factor for respiratory symptoms^{3, 6-12)}. Elderly smokers who have been smoking for a long time are considered to have a double-increased risk of respiratory symptoms due to the combined effects of smoking and aging. Long-term negative effects of smoking among many present and past elderly smokers may be expected because most of the elderly in Japan spent their young and middle years during a period when the average rate of male smokers was over 80%¹³⁾.

The Brinkman Index (B.I.) was proposed by G.L. Brinkman as a smoking value expressing the amount of cigarettes smoked by a person¹⁴⁾. The B.I. is obtained by a product of (number of cigarettes/day) $\times$ (years smoked) and has been used in studies on smoking-related cancer¹⁵⁻¹⁷⁾. However, it has not been used in the risk assessment of respiratory symptoms. In the present study the investigators examined the association between B.I. and respiratory symptoms. The study subjects were elderly smoking persons who were 56 years of age and over (average age = 73.6) having a high risk for respiratory symptoms due to their age and smoking habit.

Materials and Methods

1. Study Subjects

Subjects for this study were both men and women aged 56 years and over, and members of a senior citizens club who lived in a Japanese suburban area. A total of 3,000 individuals were randomly selected from 5,534 members of senior citizens' clubs in 82 districts. Self-administered questionnaires were distributed among all subjects. Sampling rates were 50% in all districts, except for one, where all club members participated in the survey. Thus, the study participation rate slightly exceeded 1/2 of the entire population. The survey was conducted in October, 1997. A total of 1,954 persons responded to all questions (65.1% of response rate) out of 2,180 persons (72.7%) who returned their questionnaires. According to pre-survey results conducted by the District Director, all study subjects were healthy individuals without disability who were not hospitalized and were living normal daily life. Study subjects agreed that their responses to the questionnaire could be used for this research.

2. Questionnaire items and data analysis

The questionnaire included questions on smoking such as smoking habit, amount of smoking per day and duration of smoking, typical questions on respiratory symptoms extracted from the ATS-DLD78 questionnaire, and questions on daily living activities. We defined current smokers as persons who smoked every day and occasionally. Ex-smokers were former smokers who had quit smoking. We classified smokers into two groups according to depth of smoking. Inhalers were smokers who inhaled deeply into the lungs and non-inhalers were who did not inhale deeply into the lungs. Places of residence were classified as down town, residential and agricultural, according to the status of land utilization.

As mentioned earlier, B.I. was computed first, and then

multiple logistic regression analysis was conducted to examine the association among respiratory symptoms with B.I., smoking habit and depth of smoke inhalation. Odds ratios with 95 percent confidence intervals (95%CI) were obtained after adjusting for confounding variables including sex, age and place of residence. We evaluated trends for dose-response relationships based on ordinal values of the number of three categorized B.I. as light smokers, moderate smokers and heavy smokers. All p values were two tailed. P values of less than 0.05 were considered significant. The analyses were performed with the SAS statistical package version 6.12.

Results

As shown in Table 1, 1,954 persons completed the questionnaires which were distributed among 3,000 persons 56 years of age and over. The study sample included 42.8% men and 57.2% women whose average ages were 73.8 years old and 73.5 years old, respectively, with no statistical difference between the sexes.

Table 2 shows the distributions of subjects according to their smoking status by age and sex. The age composition of the total sample was 23.4% for 56-69 years old, 59.3% for 70-79 years old and 17.3% for 80 years old and over. Men were equally distributed among categories of current smokers, ex-smokers and nonsmokers (about 30% for each), while women were distributed differently: 3.6% current smokers, 1.8% ex-smokers and 71.4% nonsmokers. The proportions of current smokers were 34.7% for 57-69 years old, 28.3% for 70-79 years old and 19.6% for 80 years and over in men, and 5.3% for 56-69 years old, 3.1% for 70-79 years old and 2.3% for 80 years and over in women. These proportions declined as age increased in both sexes. Rates of current smokers for all ages were 28.1% for men and 3.6% for women, showing a great difference between the sexes. As for the duration of smoking in years ranging from one year to 70 years, 18.6% had been smoking for 40 years and 17.8% for 50 years. The number of cigarettes smoked per day ranged from 1 to 80 and 22.6% and 37.1% of persons smoked 10 and 20 cigarettes per day, respectively.

Prevalence of respiratory symptoms is shown by smoking status, age and sex in Table 3. Fairly high prevalence was observed in "having shortness of breath when hurrying on the level or walking up a slight hill" in all three smoking status categories. The highest prevalence (53.6%) was observed in 80 year-old and over current male smokers. The items "usually bring up phlegm" (38%, 80 years old and over in men) and "usually have a cough" (40.4%, 80 years old and over in men) showed a higher prevalence in ex-smokers. The prevalence of phlegm and wheezing were relatively high compared to symptoms of coughing in nonsmokers.

Higher prevalence was observed in smokers than nonsmokers in men on the whole. The prevalence of phlegm in "usually bring up phlegm", Markedly "bringing up phlegm more than 4 days per week" and "chronic phlegm" were higher in men than

Table 1 Survey participants

		Oldest	Youngest	Average	S.D.
	Number	(years)	(years)	(years)	(years)
Males	836 (42.8%)	93	57	73.8	± 6.2
Females	1,118 (57.2%)	90	56	73.5	± 5.9
Total	1,954 (100.0%)			73.6	± 6.0

women nonsmokers. The prevalence of both coughing and phlegm became greater as age advanced.

Odds ratios with 95% confidence intervals after adjusting for sex, age and places of residence are presented as the results of multiple logistic regression analysis in Tables 4-6. Odds ratios indicating the association between smoking habit and respiratory symptoms are shown in Table 4. When the odds ratio for nonsmokers was defined as 1.00, odds ratios for "bringing up phlegm for more than 4 days per week" and for "usually bring up phlegm" were 2.77 (95%CI=1.80-4.27) and 2.06 (95%CI=1.41-3.01), respectively, at $p<0.01$ among current smokers. In addition, significant odds ratios ($p<0.05$) among current smokers were 1.70 (95%CI=1.05-2.72) for "wheezing", 1.57 (95%CI=1.11-2.22) for "shortness of breath when hurrying". Among ex-smokers, a significant odds ratio was 1.57 (95%CI=1.07-2.29) for "usually have a cough" at $p<0.05$. However, odds ratios for other symptoms did not reach a significant level.

Odds ratios to examine the association between the depth of smoke inhalation and respiratory symptoms are shown in Table 5. Compared with 1.00 for the odds ratio among nonsmokers, an odds ratio for "having phlegm more than 4 days per week" among deep smoke-inhalers (who inhale smoke deeply into the lungs) was 2.10 (95%CI=1.40-3.16), the highest odds ratio among current smokers. Among the same group, significant odds ratios were also observed: 1.53 (95%CI=1.07-2.21) for "usually bring up phlegm" and 1.49 (95%CI=1.03-2.15) for "usually have a cough" at $p<0.05$. No high odds ratios for other respiratory symptoms were observed, even among deep smoke inhalers. On the other hand, among shallow smoke-inhalers (who do not inhale smoke deeply into the lungs) odds ratios were relatively low, which ranging from 0.36 (95%CI=0.08-1.08) to 1.34 (95%CI=0.88-2.03).

The association between B.I. and respiratory symptoms is exhibited in Table 6. In order to divide the number of smokers equally into three groups, smokers were categorized according to B.I. scores: light smokers for a B.I. less than 500; moderate smokers for 501-900; and heavy smokers for greater than 900. As compared with nonsmokers (B.I.=0), significantly high odds ratios (greater than 2.00, $p<0.01$) in the heavy-smokers group appeared in "usually bringing up phlegm", "bringing up phlegm

for more than 4 days per week", "chronic phlegm" and "having an attack of wheezing". The same group also had an odds ratio, 1.83 (95%CI=1.13-2.93) ($p<0.05$), in "usually have a cough" and 1.67 (95%CI=1.06-2.61) ($p<0.05$), in "shortness of breath when hurrying". In the moderate-smokers group, a significant odds ratio was found only in "usually bringing up phlegm" (odds ratio=1.80, 95%CI=1.15-2.80) and "bringing up phlegm more than 4 days per week" (odds ratio=1.89, 95%CI=1.15-3.07). No significant odds ratios (ranging from 0.46 [95%CI=0.11-1.39] to 1.53 [95%CI=0.57-3.66]) appeared in the light-smokers group.

Trend tests were conducted for B.I.. With regard to B.I., a dose-response relationship was observed in 5 items of respiratory symptoms including "usually bring up phlegm" ($p=0.0002$), "bringing up phlegm more than 4 days per week" ($p=0.0004$), "chronic phlegm" ($p=0.002$), "having an attack of wheezing" ($p=0.003$) and "usually having a cough" ($p=0.009$).

Discussion

There are two major problems related to the respiratory system in the elderly: a decline in pulmonary function with aging, and an increase in the prevalence of respiratory symptoms. In addition, smoking among the elderly can increase the risk for onset of chronic obstructive lung disease.

Some studies pointed out that more information on the association between aging and respiratory symptoms is needed⁹⁾, but many studies have already found such an association^{3, 8, 11, 18)}. On the other hand, a positive association between smoking and respiratory symptoms has been accepted by most researchers: the association between smoking and mortality and morbidity¹⁹⁾, harmful effects of smoking on respiratory disease, cardiovascular disease, cancer and DNA²⁰⁻²⁴⁾. The elderly male in this study went through their lives in 1960s, when the rate of smoking among adult males was greater than 80%¹³⁾, and thus we expect a peak of mortality due to the late effects of smoking among this group following the peak of the smoking epidemic 30-40 years ago²⁵⁾. We are concerned about the fact that many deaths due to chronic obstructive lung disease have occurred already among elderly males in Japan²⁶⁾.

The study participants were 1,954 elderly residents who were an average age of 73.6 years old. They were stratified into three

Table 2 Distribution of participants by smoking status and age

Smoking Status	Age in years			Total
	~ 69	70 ~ 79	80 ~	
Current Smokers	(M) ^a 68 (34.7) ^b	135 (28.3)	32 (19.6)	235 (28.1)
	(F) ^a 15 (5.3)	21 (3.1)	4 (2.3)	40 (3.6)
	83 (18.2)	156 (13.5)	36 (10.6)	275 (14.1)
Ex-smokers	(M) 51 (26.0)	70 (35.6)	61 (37.4)	282 (33.7)
	(F) 3 (1.1)	15 (2.2)	2 (1.1)	20 (1.8)
	54 (11.8)	185 (16.0)	63 (18.6)	302 (15.5)
Nonsmokers	(M) 64 (32.7)	145 (30.4)	55 (33.7)	264 (31.6)
	(F) 206 (78.9)	479 (70.3)	113 (64.2)	798 (71.4)
	270 (59.1)	624 (53.9)	168 (49.6)	1061 (54.3)
No Answers	(M) 13 (6.6)	27 (5.7)	15 (9.2)	55 (6.6)
	(F) 37 (14.2)	166 (24.4)	57 (32.4)	260 (23.3)
	50 (10.9)	193 (16.7)	72 (21.2)	315 (16.1)
Total	(M) 196 (23.4)	477 (57.1)	163 (19.5)	836 (100.0)
	(F) 261 (23.3)	681 (60.9)	176 (15.7)	1118 (100.0)
	457 (23.4)	1158 (59.3)	339 (17.3)	1954 (100.0)

^a M. Males, F: Females

^b Numbers in parenthesis are %

Table 3 Prevalence of respiratory symptoms by smoking status, age and sex

[Smoking status] Symptoms	Males			Females		
	~ 69yrs %	70 ~ 79 %	80 ~ %	~ 69 %	70 ~ 79 %	80 ~ %
[Current smokers]						
A. Coughing						
1. usually	19.0	27.0	23.1	50.0	10.5	0.0
2. ≥ 4 days/week	10.0	19.0	21.4	27.3	5.3	0.0
3. chronic cough	6.6	2.6	6.9	27.3	0.0	0.0
B. Phlegm						
4. usually	40.7	34.6	37.0	30.0	18.8	0.0
5. ≥ 4 days/week	29.9	28.2	25.9	30.0	25.0	0.0
6. chronic phlegm	6.8	7.1	7.7	10.0	0.0	0.0
C. Wheezing						
7. attack of wheezing	10.9	15.5	23.1	62.5	23.5	0.0
8. when having a cold	12.7	9.4	23.1	66.7	29.4	0.0
D. Shortness of breath						
9. hurrying on the level	32.1	36.8	53.6	44.4	50.0	33.3
[Ex-smokers]						
A. Coughing						
1. usually	14.3	25.3	40.4	33.3	23.1	0.0
2. ≥ 4 days/week	8.2	11.3	29.1	33.3	13.3	0.0
3. chronic cough	0.0	.9	.3	33.3	0.0	0.0
B. Phlegm						
4. usually	10.4	24.4	38.0	33.3	7.7	0.0
5. ≥ 4 days/week	8.3	17.1	33.3	33.3	15.4	0.0
6. chronic phlegm	0.0	5.6	7.8	0.0	0.0	0.0
C. Wheezing						
7. attack of wheezing	6.4	9.9	16.0	33.3	0.0	0.0
8. when having a cold	6.4	12.1	18.4	33.3	7.7	0.0
D. Shortness of breath						
9. hurrying on the level	22.2	35.8	40.4	66.7	61.5	0.0
[Nonsmokers]						
A. Coughing						
1. usually	19.4	15.5	18.8	15.3	17.9	22.0
2. ≥ 4 days/week	14.8	11.9	0.4	8.3	11.2	8.0
3. chronic cough	4.9	2.3	3.9	0.5	3.4	3.0
B. Phlegm						
4. usually	17.5	22.2	13.3	8.1	11.4	10.6
5. ≥ 4 days/week	12.5	14.2	17.0	5.7	7.0	8.2
6. chronic phlegm	5.0	4.9	4.3	0.6	1.8	2.3
C. Wheezing						
7. attack of wheezing	8.8	14.8	11.4	9.2	9.9	9.9
8. when having a cold	11.9	15.6	17.4	11.9	12.9	8.4
D. Shortness of breath						
9. hurrying on the level	19.0	29.5	41.3	27.5	41.5	45.4

Table 4 Odds ratios (OR) with confidence intervals (CI) showing the associations between smoking status and respiratory symptoms

Symptoms	Current smokers OR (95%CI)	Ex-smokers OR (95%CI)
A. Coughing		
1. usually	1.47 (1.00-2.17)	1.57 (1.07-2.29)*
2. ≥ 4 days/week	1.54 (0.96-2.43)	1.30 (0.81-2.06)
3. chronic cough	1.91 (0.83-4.30)	1.43 (0.59-3.34)
B. Phlegm		
4. usually	2.06 (1.41-3.01)**	1.11 (0.74-1.64)
5. ≥ 4 days/week	2.77 (1.80-4.27)**	1.53 (0.97-2.41)
6. chronic phlegm	1.50 (0.71-3.15)	0.94 (0.42-2.04)
C. Wheezing		
7. attack of wheezing	1.70 (1.05-2.72)*	0.91 (0.53-1.53)
8. when having a cold	1.30 (0.81-2.08)	0.96 (0.58-1.57)
D. Shortness of Breath		
9. hurrying on the level	1.57 (1.11-2.22)*	1.28 (0.91-1.82)

* p<0.05, ** p<0.01, adjusted for age, sex and place of residence compared to non-smokers

groups according to their smoking status: current smokers, ex-smokers and nonsmokers. Comparisons of rates of current smokers between the present survey and a nationwide survey¹³⁾ show that the rates were 22.3% (the nationwide sample for 60-69 years old) vs. 18.2% (sample in this survey for those 56-69 years old) and 17.8% vs. 12.8% for those 70 years old and over in both sexes combined. There were no differences in rates of current smokers between the results of our survey and the nationwide survey among women, whereas the rates of current smokers among men in our survey were 7-9% lower than those of the nationwide survey: 42.2% vs. 34.7% for 60-69 year old and 35.3% vs. 26.1% for those 70 years old and over.

We attempted to assess the risk to respiratory systems due to smoking using the B.I. G.L.Brinkman et al. stratified smokers into three groups by applying cutting points B.I.=200 and 600 in their study¹⁴⁾. The B.I. in our study, on the other hand, was considered to be greater than that in Brinkman's study, because the average age of our study sample was much higher. Although

we divided the sample into three groups as Brinkman did, our B.I. cutting points were higher: 500 and 900, which made the number of subjects distribute evenly among the three groups.

We computed multiple logistic regression models adjusting for age, sex and places of residence, because some researchers reported an association among respiratory symptoms with age and sex^{8, 11, 18, 27}.

Our results show that the prevalence of "having shortness of breath when hurrying on the level or walking up a slight hill" was highest (53.6%, current smokers in men 80 years old and over) among the responses to questions (Table 3). The prevalence of all symptoms of male nonsmokers was higher than in women on the whole. S. R. Leeder, et al.³² and P.L. Enright¹⁸ reported that the prevalence of respiratory symptoms among nonsmoking men was higher than among nonsmoking women. It was observed that the prevalence of respiratory symptoms among men and nonsmoking women became higher as age advanced. This is considered to be due to the effects of aging.

Place of residence is considered to be a confounding factor, because environmental factors around the residential area can affect respiratory symptoms^{6, 28}. The survey area faces the Pacific Ocean to the east, contains a large agricultural field and has factories with assembly lines to produce electric appliances. There is moderate traffic volume on the major roads in the same survey

area, but no high ambient air pollution levels or automobile gas emissions were recorded at monitoring stations.²⁹⁻³¹ Regardless, we controlled for the residential area to examine effects of smoking on respiratory symptoms without its confounding effects.

Odds ratios for "usually having a cough" were 1.47 (95%CI=1.00-2.17) in current smokers and 1.57 (95%CI=1.07-2.29) in ex-smokers (as compared with 1.0 in nonsmokers). High odds ratios were observed in current smokers: 2.06 (95%CI=1.41-3.01) for "usually bringing up phlegm", 2.77 (95%CI=1.80-4.27) for "bringing up phlegm for more than 4 days per week", 1.70 (95%CI=1.05-2.72) for "having an attack of wheezing" and 1.57 (95%CI=1.11-2.22) for "having shortness of breath when hurrying on the level". Odds ratios for two symptoms related to phlegm in current smokers were twice as high as those in nonsmokers, but those related to coughing were not high even in current smokers. Among young smokers, it is known that even their short-term smoking experience increases symptoms of coughing and having phlegm.^{33, 34} Thus, greater effects on such symptoms might be expected among the elderly who have smoked for a long time.

Among ex-smokers only a significant odds ratio was found for "usually having a cough". S.R. Leeder, et al.³² reported that respiratory conditions among second-time ex-smokers who had not smoked for three years improved to the same level as those among life-time non-smokers. L. Dow, et al.¹¹ stated that only the prevalence of morning phlegm remained high among ex-smokers, while M.D. Lebowitz et al.³⁵ reported that among ex-smokers the prevalence of respiratory symptoms decreased, but the prevalence of respiratory disease confirmed by physicians remained at the same level.

There may be a limit to the expected effects of quitting smoking on respiratory symptoms because odds ratios among ex-smokers in our study were significantly higher for "usually having a cough" and fairly high (odds ratio=1.43-1.53) for some other symptoms. However, a detailed investigation on duration of quitting smoking and other factors during smoking will be needed to establish the causes of these high odds ratios among ex-smokers.

We also stratified the sample into inhalers and non-inhalers based on whether or not persons inhaled smoke into the lung. The association between inhalation and respiratory symptoms

Table 5 Odds ratios (OR) with confidence intervals (CI) for inhalers and non-inhalers

Symptoms	Inhalers	Non-inhalers
A. Coughing		
1. usually	1.49 (1.03-2.15)*	1.07 (0.70-1.60)
2. ≥ 4 days/week	1.30 (0.84-2.01)	0.77 (0.44-1.29)
3. chronic cough	1.78 (0.82-3.88)	0.64 (0.18-1.78)
B. Phlegm		
4. usually	1.53 (1.07-2.21)*	1.34 (0.88-2.03)
5. ≥ 4 days/week	2.10 (1.40-3.16)**	1.11 (0.66-1.81)
6. chronic phlegm	1.61 (0.83-3.20)	0.36 (0.08-1.08)
C. Wheezing		
7. attack of wheezing	1.48 (0.92-2.37)	1.03 (0.57-1.76)
8. when having a cold	0.99 (0.62-1.58)	0.94 (0.55-1.55)
D. Shortness of Breath		
9. hurrying on the level	1.28 (0.91-1.78)	1.05 (0.72-1.51)

* $p < 0.05$, ** $p < 0.01$, adjusted for age, sex and place of residence compared to non-smokers.

Table 6 Odds ratios (OR) with confidence intervals (CI) showing the associations between the Brinkman Index and respiratory symptoms

Symptoms / B. I. ^a	2 ~ 500 (Light s. ^b) OR (95%CI)	501 ~ 900 (Moderate s.) OR (95%CI)	901 ~ (Heavy s.) OR (95%CI)	p value for trend test
A. Coughing				
1. usually	1.22 (0.78-1.87)	1.41 (0.88-2.22)	1.83 (1.13-2.93)*	0.009
2. ≥ 4 days/week	1.30 (0.77-2.12)	1.19 (0.66-2.07)	1.66 (0.93-2.90)	0.094
3. chronic cough	1.53 (0.57-3.66)	1.87 (0.68-4.72)	2.17 (0.74-5.74)	0.087
B. Phlegm				
4. usually	1.18 (0.75-1.81)	1.80 (1.15-2.80)**	2.20 (1.36-3.53)**	0.0002
5. ≥ 4 days/week	1.00 (0.59-1.66)	1.89 (1.15-3.07)*	2.54 (1.51-4.22)**	0.0001
6. chronic phlegm	0.46 (0.11-1.39)	1.71 (0.70-3.93)	3.47 (1.57-7.54)**	0.002
C. Wheezing				
7. attack of wheezing	0.72 (0.36-1.34)	1.12 (0.58-2.05)	2.68 (1.52-4.65)**	0.003
10. when having a cold	1.12 (0.65-1.88)	0.89 (0.46-1.63)	1.35 (0.71-2.44)	0.536
D. Shortness of Breath				
11. hurrying on the level	1.01 (0.68-1.48)	1.11 (0.72-1.70)	1.67 (1.06-2.61)*	0.054

* $p < 0.05$, ** $p < 0.01$, adjusted for age, sex and place of residence compared to non-smokers

^a B.I. : Brinkman Index

^b s. smokers

will be discussed later, but it is known that there is a great difference in the amount of chemical absorption from cigarette smoke between inhalers and non-inhalers³⁶⁾. Considering that residues in inhaled smoke, as compared with main stream smoke were 99% acetaldehyde, and 96% particulate matter, inhalers can receive direct effects from main stream smoke. The inhalation of smoke into the lung has been pointed out as a high risk factor for bladder cancer, which has been studied for its association with such inhaling behavior³⁷⁾. As shown in our results (Table 5), the inhaler group had significantly high odds ratios for "bring up phlegm for more than 4 days per week" (odds ratio=2.10, 95%CI=1.40-3.16), "usually have a cough" and "usually bring up phlegm". The non-inhaler group, on the other hand, had no significantly high odds ratios. Thus, our results imply an association between smoke inhalation and respiratory symptoms.

Next, we discuss the association between B.I. and respiratory symptoms. B.I. has been used as a means to measure the effects of smoking on respiratory disease and its risk factors: the negative association between B.I. and forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), or peak expiratory flow rate PEFR^{5, 38)}; the evaluation of cancer high-risk groups using B.I.^{15, 16, 39, 40)}; the effects of B.I. on abnormalities in hematologic examinations⁴¹⁾; the effects of B.I. on the p53 tumor control gene²¹⁾; and the effects of B.I. on IgE levels⁴²⁾.

Our results show that (1) the heavy smoker group had high odds ratios (higher than 2.00) for 3 symptoms related to phlegm including "chronic phlegm" and high odds ratios for "having an attack of wheezing", "shortness of breath when hurrying" and "usually have a cough"; (2) the moderate smoker group had significantly high odds ratios for "usually bringing up phlegm" and "bringing up phlegm more than 4 days per week"; and (3) the light smoker group did not have any significant odds ratios. Brinkman et al. pointed out that heavy smokers decreased their FEV value, which was inversely proportional to their ages.¹⁴⁾ Our results indicate that odds ratios for respiratory symptoms among heavy smokers were much higher than among other groups. We discussed the association between respiratory symptoms and smoking habits, inhalers and non-inhalers, and the number of cigarettes smoked. Although aging is one of the critical factors for

respiratory symptoms, our analysis focused on the effects of smoking on such symptoms. Our results show that there were dose-response relationships between respiratory symptoms and B.I., and additionally the heavy smoker group, who were determined by B.I., had higher odds ratios. If respiratory symptoms become serious, daily living activities can be very restricted. No one can avoid the increased risk of respiratory symptoms due to aging, but the risk due to smoking is avoidable. Thus, we must educate smokers to quit smoking or reduce the number of cigarettes smoked per day.

Conclusion

We examined the association between smoking and respiratory symptoms among 1,954 persons (836 men, 1,118 women, 73.6 years old of their average age). The results are summarized as follows:

1. The prevalence of respiratory symptoms was higher in men than in women and became higher as their ages advanced.
2. Significantly high odds ratios among current smokers appeared for 4 symptoms including phlegm, wheezing and shortness of breath. This implied that the effects of quitting on the respiratory system have some limitations because the odds ratio for coughing in ex-smokers was significantly high.
3. Depth of smoke inhalation was associated with respiratory symptoms and non-inhalers did not have any significant odds ratios.
4. Heavy smokers (B.I.>900) had significantly high odds ratios for 6 symptoms, particularly symptoms related to phlegm, whereas light smokers (B.I.<500) had no significant odds ratios.

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