

# HEALTH SURVEY OF WORKERS OF AN ALUMINUM PLANT IN CHINA

## III Respiratory Symptoms and Ventilatory Functions

by

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**SUMMARY:** The respiratory symptoms and ventilatory lung functions of the production-line workers (F-exposed) at an aluminum plant in China have been studied. The data were compared with those obtained from the office workers (controls). F-exposed groups had a higher prevalence of respiratory symptoms than controls and their complaints of phlegm were significantly increased in the older subjects. Whereas several cases of chronic bronchitis were observed in the F-exposed groups, none could be found in the controls. The expiratory flow rate at 25% of the vital capacity/height (V25/HT), which is sensitive in the detection of small airway obstruction, was decreased.

**KEY WORDS:** Aluminum refinery workers; Health survey; Respiratory symptoms; Ventilatory lung function.

### Introduction

Inhaled airborne fluorides, particularly gaseous fluorides such as HF, as they come in contact with the respiratory tract, may act as highly irritative and reactive materials, thus directly affecting the respiratory system. As a part of the health survey conducted on workers of an aluminum refinery in China reported previously (1), we carried out a study on the respiratory symptoms and ventilatory functions of the workers at the plant, where airborne F levels in the work environment were at or below the TLV of ACGIH. The data were then correlated with the history of exposure to fluoride.

### Materials and Methods

The participants in this study (99 F-exposed and 47 controls) were the same as reported previously (1). The F-exposed group was further divided into four age-groups, A, B, C, and D and age-matched controls were used for comparison. To obtain information concerning respiratory symptoms, interviews were conducted by participating Chinese physicians at the time of examination using the British Medical Research Council (BMRC)-approved questionnaire (2). Ventilatory function tests were carried out by following the flow-

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volume curves drawn on a spirometer, model Microspiro HI-229 (manufactured by Chest, Tokyo).

### Results

The prevalence of respiratory symptoms was generally higher in the F-exposed groups than in the controls (Table 1). The highest number of subjects with the symptoms was found in Group D, the oldest among the F-exposed groups. Significant differences were observed between Group D and its counterpart concerning phlegm: 11 workers in Group D were diagnosed as belonging to grade 2, compared to none in the control. In grade 2, phlegm is manifested in the morning, during daytime, and at night on most days, for as long as three months in the winter each year (3). Moreover, whereas none of the office workers had chronic bronchitis syndrome, seven of the F-exposed group were found to have this disorder.

The percent vital capacity (%VC) shown by the F-exposed group was high as a whole, but the expiratory flow rate at 25% of the vital capacity/height ( $\dot{V}_{25}/HT$ ) was found to be generally lowered. Whereas five cases of ventilatory lung disfunction, all of obstructive disorders, were identified in Group D, there were also five such cases in the control group, four with obstructive disorders and one with mixed disorders. Although the means of FEV1.0% and  $\dot{V}_{25}/HT$  were found to decrease with length of F-exposure, there were no significant differences between the F-exposed and the control group.

Table 1  
Prevalence of Respiratory Symptoms

Group	N	Age	Cough Grade		Phlegm Grade		Persistent cough and phlegm	Chronic bronchitis syndrome
			1	2	1	2		
A	29	26.7 ±1.8	2 <sup>a</sup> (6.9)	3 (10.3)	2 (6.9)	3 (10.3)	3 (10.3)	1 (3.4)
Control	14	26.5 ±2.1	2 (14.3)	1 (7.1)	1 (7.1)	2 (14.3)	3 (21.4)	0 (0)
B	22	32.0 ±1.4	0 (0)	0 (0)	1 (4.5)	1 (4.5)	0 (0)	0 (0)
C	19	36.9 ±1.3	2 (10.5)	1 (5.3)	2 (10.5)	3 (15.8)	2 (10.5)	2 (10.5)
Control	16	36.2 ±2.5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
D	29	50.4 ±3.0	3 (10.3)	8 (27.6)	1 (3.4)	11 (37.9)	9 (31.0)	4 (13.8)
Control	17	48.5 ±3.2	0 (0)	2 (11.8)	1 (5.9)	0 (0)	1 (5.9)	0 (0)

<sup>a</sup> Number of cases. Values in parentheses indicate prevalence rate.

Table 2  
 Ventilatory Lung Function

Group	n	Age (yr)	Height (cm)	%VC (%)	FEV1.0% (%)	PF (L/s)	$\dot{V}_{50}$ (L/s)	$\dot{V}_{25}$ (L/s)	$\dot{V}_{25}/Ht$
A	29	26.7 $\pm$ 1.8 <sup>a</sup>	162.8 $\pm$ 6.2	106.9 $\pm$ 12.1	85.1 $\pm$ 7.6	7.99 $\pm$ 1.40	3.97 $\pm$ 1.30	1.82 $\pm$ 0.69	1.12 $\pm$ 0.42
Control	14	26.5 $\pm$ 2.1	164.3 $\pm$ 5.2	100.8 $\pm$ 8.7	86.2 $\pm$ 6.6	7.62 $\pm$ 1.31	3.95 $\pm$ 1.01	1.91 $\pm$ 0.59	1.17 $\pm$ 0.37
B	22	32.0 $\pm$ 1.4	166.7 $\pm$ 4.1	106.9 $\pm$ 9.8	80.7 $\pm$ 5.4	7.23 $\pm$ 1.31	3.61 $\pm$ 1.33	1.49 $\pm$ 0.58	0.90 $\pm$ 0.35
C	19	36.9 $\pm$ 1.3	166.2 $\pm$ 4.0	107.3 $\pm$ 14.2	81.8 $\pm$ 4.8	7.78 $\pm$ 1.28	3.53 $\pm$ 0.79	1.37 $\pm$ 0.57	0.83 $\pm$ 0.35
Control	16	36.2 $\pm$ 2.5	162.2 $\pm$ 4.6	111.8 $\pm$ 3.5	82.0 $\pm$ 3.7	7.39 $\pm$ 0.76	3.82 $\pm$ 1.03	1.36 $\pm$ 0.39	0.84 $\pm$ 0.24
D	29	50.4 $\pm$ 3.0	162.8 $\pm$ 6.0	106.9 $\pm$ 11.6	76.3 $\pm$ 10.1	6.28 $\pm$ 1.71	2.42 $\pm$ 0.95	0.96 $\pm$ 0.46	0.59 $\pm$ 0.28
Control	17	48.5 $\pm$ 3.2	163.0 $\pm$ 5.5	109.3 $\pm$ 15.1	74.5 $\pm$ 9.5	6.93 $\pm$ 1.93	2.73 $\pm$ 1.27	0.91 $\pm$ 0.49	0.56 $\pm$ 0.31

<sup>a</sup> Values are Mean  $\pm$ S.D.

### Discussion

The present epidemiological study on the prevalence of respiratory disease was carried out according to the most widely and comprehensively validated MRC questionnaire. The questionnaire is characterized by its making group comparison of the prevalence of individual symptoms singly or in combination, instead of searching for names of specific diseases such as bronchitis. The results obtained from this study clearly indicate the effect of working environment on the respiratory system of workers (Tables 1 and 2) and confirm the earlier findings reported on Japanese aluminum refinery workers (4). A greater number of the pot-line workers had cough and phlegm than office workers at the refinery. This is particularly true in Group D with an average age of 50.4 years. Compared with the controls, a higher percentage of subjects in this group complained of cough and phlegm.

The means of  $\dot{V}_{25}/HT$  given by the F-exposed group (Table 2) were lower than that reported elsewhere (5). It is important that this criterion reflects the severity of the small airway obstruction resulting from F-exposure, an observation supported by the high prevalence of chronic bronchitis syndrome found in the F-exposed group (Table 1). Saric *et al.* (6) reported bronchoconstrictive symptoms among workers employed at an aluminum plant in Yugoslavia. Similarly, Wergeland *et al.* (7) observed persons working in the potrooms in a primary aluminum production plant in Norway to suffer from "potroom asthma." After cessation of exposure, these workers still had respiratory dysfunction such as morning cough, dyspnea on exertion, and wheezing. Further evidence of the linkage between fluoride air pollution and respiratory symptoms and lung function was shown in a study which surveyed North American Indian children living on a reservation adjacent to an aluminum smelter (8).

Results of the interviews in this study showed that about two-thirds of the subjects were cigarette smokers. Analysis of our data did not show that smoking itself contributed to the prevalence of respiratory symptoms or impairment of ventilatory function.

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