Respiratory Response to Tobacco Dust Exposure[1-3]

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SUMMARY

Results of a study of the respiratory responses of 318 nonsmoking female workers to long-term tobacco dust exposure are reported. The mean total tobacco dust concentrations ranged from 0.9 to 27.5 mg per m^3; the respirable fraction, from 0.3 to 3.6 mg per m^3. The mean length of exposure to tobacco dust was 14.9 years; 24 per cent of the workers had been exposed to tobacco dust for 20 years or more. Comparatively low prevalences of chronic respiratory symptoms were found, and only the prevalences of chest tightness and wheezing were significantly higher among workers exposed to tobacco dust than those of the control group ($P < 0.01$). Calculating the expected 1-sec forced expiratory volume and forced vital capacity values by means of multiple linear regression equations, developed on the basis of data obtained in the 210 control subjects, revealed no significant differences between the measured and expected ventilatory capacity values among any of the groups of the workers observed. In contrast to negative findings with regard to chronic respiratory effects, significant acute decreases in ventilatory capacity during the work shift were recorded. No dose-response relationship was found between the level of exposure and the acute decreases in ventilatory capacity.

Introduction

Despite the fact that tobacco dust was claimed more than 100 years ago to cause tabacosis and that some tobacco components are, even now, supposed to affect adversely the respiratory tract (1), only a few published studies have described the effect of tobacco dust on the upper airways (2, 3). None of these, however, has dealt with changes in the bronchial tract or with functional respiratory changes. Published data are so scarce that the Committee on Threshold Limits of the American Conference of Governmental Industrial Hygienists has included tobacco dust among the 5 substances for which "TLVs are needed, but for which documentation is lacking" (4).

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Materials and Methods

Subjects. A group of 528 tobacco workers was studied in 3 cigarette factories. Data for 318 nonsmoking female workers were processed in detail and are reported herein. Their mean age was 42 years (range, 15 to 59 years), and their mean duration of exposure to tobacco dust was 14.9 years (range, 1 to 33 years).

A control group of 210 nonsmoking female factory workers, not exposed to dust or any airborne irritant, was selected to match the study group of 318 tobacco workers in age and height distribution.

Methods. Total and respirable tobacco dust particles were sampled by standard Hexhlet 2-stage samplers (5) (Casella Ltd., London) with a cubic velocity of 50 liter per min. A standard Hexhlet horizontal elutriator was used as the first stage, and a Whatman GF 82 glass fiber filter was used as the second stage. A total of 84 8-hour airborne dust samples were collected. The samples were taken at the average height from which the workers breathed.

Respiratory symptoms were recorded using the standard British Medical Research Council Questionnaire (6).

TABLE 1

PREVALENCES OF CHRONIC RESPIRATORY SYMPTOMS AMONG FACTORY WORKERS EXPOSED AND NOT EXPOSED TO TOBACCO DUST

Symptom	Tobacco Workers (N = 318) (%)	Control Group (N = 210) (%)	Significance of Difference
Chronic bronchitis	7.5	4.3	$P > 0.05$
Chest tightness	11.0	2.9	$P < 0.01$
Wheezing	10.1	0.9	$P < 0.01$
Nasal catarrh	11.0	10.0	$P > 0.10$

A Pulmonor spirometer (Jones Medical Instruments Co., Oak Brook, Ill.) was used for the measurement of ventilatory function. Forced vital capacity (FVC) and forced expiratory volume in 1 sec (FEV_1) were measured. All results were adjusted to BTPS. Five measurements were taken in each subject, and the mean of the 2 highest values was taken as the result. The measurements were performed before and immediately after the end of the work shift. Acute effects were assessed on the basis of the difference between the pre- and post-shift values. Chronic effects were estimated by comparing the pre-shift ventilatory capacity values of tobacco workers to their predicted values. The latter were calculated by means of the multiple linear regressions of ventilatory capacity on height and age developed in a control group of 210 nonsmoking women of a similar age distribution and exposed to no significant dust concentrations.

Results

The prevalences of chronic respiratory symptoms among 318 female tobacco workers and among 210 control subjects are presented in table 1. No significant difference between groups was found in the prevalence of either chronic bronchitis or nasal catarrh. The prevalences of both chest tightness and wheezing, however, were significantly higher ($P < 0.01$) among tobacco workers.

Because no data on the acute respiratory response to tobacco dust exposure are available in the literature, we present herein the changes that occurred in FEV_1 and FVC during the work shift in 177 tobacco workers (workers in one of the 3 plants refused to undergo spirometry twice per day). Assuming that tobacco, as a vegetable dust, might cause "Monday effects," we tested the difference between the changes in ventilatory lung capacity on Monday and on Thursday in a group of 36 tobacco workers. The differences between the mean Monday and Thursday decreases in FEV_1 and FVC were not significant ($P > 0.10$). Consequently, we measured ventilatory function of the study workers on any of the working days.

The cohort studied was divided into 3 groups working in 3 different technologic processes: tobacco sorting and blending, cigarette making, and cigarette packing. The acute changes in FEV_1 in these 3 groups of tobacco workers are shown in table 2. The exposure level of each group is given both as the mean total and as the

TABLE 2

ACUTE CHANGES IN 1-SEC FORCED EXPIRATORY VOLUME (FEV_1) DURING WORK SHIFT IN 3 GROUPS OF TOBACCO WORKERS

	Exposure Group					
	1 Tobacco Blending		2 Cigarette Making		3 Cigarette Packing	
	Mean	Range	Mean	Range	Mean	Range
Concentration, mg/m^3						
Total dust	18.9	6.2–27.5	1.9	1.1–2.8	1.3	0.9–1.9
Respirable tobacco dust	2.4	0.8–3.6	0.8	0.5–1.1	0.5	0.3–0.7
No. of subjects	39		52		86	
ΔFEV_1,* ml						
Mean	−202		−209		−101	
SD	54		44		45	
t value	3.75 ($P < 0.01$)		4.75 ($P < 0.01$)		2.26 ($P < 0.05$)	

*ΔFEV_1 = post-shift FEV_1 − pre-shift FEV_1.

TABLE 3

ACUTE CHANGES IN FORCED VITAL CAPACITY (FVC) DURING WORK SHIFT IN 3 GROUPS OF TOBACCO WORKERS

	Exposure Group		
	1	2	3
Concentration, mg/m^3			
Total dust	18.9 (6.2–27.5)	1.9 (1.1–2.8)	1.3 (0.9–1.9)
Respirable tobacco dust	2.4 (0.8–3.6)	0.8 (0.5–1.1)	0.5 (0.3–0.7)
No. of subjects	39	52	86
ΔFVC,* ml			
Mean	−200	−194	−161
SD	65	56	50
t value	3.08 ($P < 0.01$)	3.47 ($P < 0.01$)	3.25 ($P < 0.01$)

*Δ FVC = post-shift FVC − pre-shift FVC.

mean respirable airborne dust concentration, each with the corresponding range. In all 3 groups, FEV_1 values during the work shift were significantly decreased ($P < 0.05$).

The acute decreases in FVC during the work shift were also highly significant ($P < 0.01$) in all 3 groups (table 3).

The mean acute changes in FEV_1 in "reactors" and "strong reactors" among tobacco workers are shown in table 4. Strong reactors were subjects with a decrease in FEV_1 during the work shift that exceeded the mean decrease in FEV_1 of the control group by 2 SD, i.e., subjects with a decrease of more than 226 ml. Reactors were subjects in whom the reduction exceeded the mean reduction of the control group by 1 SD, i.e., a reduction of more than 106 ml. Strong reactors were included in the group of reactors.

Possible chronic changes in ventilatory function were assessed on the basis of the difference between measured and predicted values of FEV_1 and FVC. The predicted values were calculated by means of the multiple linear regressions of FEV_1 or FVC on age and height of 210 control subjects. Mean differences between measured and predicted values of FEV_1 in 6 groups of tobacco workers differing in total exposure (mean dust concentration × length of exposure) and the results of the testing of significance of these differences are shown in table 5. The expected values were calculated by the regression equation, $FEV_1 = 20.1 \times$ age, in years, $+ 25.6 \times$ height, in cm, $- 753$.

No significant difference between measured and predicted FEV_1 values was found in any of the classes observed. The same results were obtained with FVC.

Discussion

Our results suggest that exposure to tobacco dust is likely to cause acute decreases in ventilatory capacity during the work shift (tables 2 and 3). It is striking, however, that acute reductions of ventilatory capacity did not differ much among the 3 groups of workers, despite the fact that

TABLE 4

ACUTE CHANGES IN 1-SEC FORCED EXPIRATORY VOLUME (FEV_1) DURING WORK SHIFT IN REACTORS AND STRONG REACTORS

	Exposure Group		
	1	2	3
Concentration, mg/m^3			
Total dust	18.9 (6.2–27.5)	1.9 (1.1–2.8	1.3 (0.9–1.9)
Respirable tobacco dust	2.4 (0.8–3.6)	0.8 (0.5–1.1)	0.5 (0.3–0.7)
Reactors			
No.	24	27	36
Mean ΔFEV_1,*ml	−395	−431	−440
Strong reactors			
No.	17	20	26
Mean ΔFEV_1,*ml	−489	−519	−544

*ΔFEV_1 = post-shift FEV_1 − pre-shift FEV_1.

TABLE 5

CHRONIC CHANGES IN 1-SEC FORCED EXPIRATORY VOLUME IN NONSMOKING FEMALE TOBACCO WORKERS

	Total Exposure, (mean dust concentration X length of exposure/ mg/ m^3 X years)					
	−9.9	10–19.9	20–29.9	30–39.9	40–49.9	50
No. of subjects	114	72	21	32	16	63
d*	98	98	−116	110	−225	59
SE	65	65	77	88	137	92
t value†	1.50	1.48	1.51	1.24	1.64	0.63
	None of the differences significant ($P > 0.10$)					

*Mean difference between measured and predicted values, in ml.
†For "Student's" t test.

their mean levels of exposure to total dust differed by a factor of 14.5; to respirable dust, by a factor of 4.8. It is also interesting that at the mean concentration as low as 1.3 mg of total dust per m^3 and 0.5 mg of respirable tobacco particles per m^3 there were significant decreases in both FEV_1 and FVC during the work shift, whereas there was an insignificant increase of 14 ml among the 210 control subjects.

In 63 women, the acute decrease in FEV_1 exceeded the mean reduction of the control group by 2 SD, i.e., the decrease was more than 226 ml ("strong reactors"). These women represented 61 per cent of exposure group 1, 51.9 per cent of exposure group 2, and 41.8 per cent of exposure group 3. In other words, the proportion of those who reacted very strongly was related to the level of exposure. Their mean acute FEV_1 changes during the work shift were considerable (−489, −519, and −544 ml, respectively; table 4). These women were obviously more sensitive to the acute effect of tobacco dust than average. It is difficult, however, to explain why "reactors" as well as "strong reactors" with the highest exposure to both total and respirable particles had the lowest mean decreases in FEV_1.

With regard to the possible chronic effects of exposure to tobacco dust, the prevalences of chronic bronchitis (7.5 per cent) and nasal catarrh (11 per cent) were not higher among subjects exposed to tobacco dust than among the control group ($P > 0.05$), whereas the prevalences of chest tightness (11 per cent) and wheezing (10.1 per cent) were significantly higher ($P < 0.01$). The prevalence of chronic bronchitis did not differ much from that described by Saakadze (7), 5 per cent, in his study of 1,586 tobacco workers. He did not measure ventilatory function. We found no chronic effects of tobacco dust exposure on the ventilatory function assessed by the difference between the measured and predicted FEV_1 and FVC values. Classifying tobacco workers into 6 groups on the basis of the total exposure, expressed as the product of the respective mean dust concentration and the duration of exposure, no significant difference between the measured and predicted ventilatory function values was found for any of the groups observed, despite the facts that (*1*) the mean duration of exposure to tobacco dust in our workers was almost 15 years; (*2*) 24 per cent of the workers had been exposed to tobacco dust for 20 years or more; and (*3*) 21.9 per cent of them were exposed to tobacco dust concentrations exceeding 15 mg per m^3, 58 per cent of them for more than 20 years.

Our results suggest that tobacco dust may cause acute decreases in ventilatory function during the work shift, but that it does not induce chronic effects in workers exposed to tobacco dust concentrations even greater than 20 mg per m^3 for a long period of time.

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