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Respiratory function in tea workers

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ABSTRACT Respiratory function was studied in five groups of tea workers employed in processing different types of tea. The prevalence of almost all chronic respiratory symptoms was significantly higher in workers processing dog-rose, sage, and gruzyan tea than in control workers. During the Monday workshift there was a significant mean acute decrease in maximum expiratory flow rates at 50% vital capacity (range: 4·1–8·8%) and at 25% VC (range: 7·8–21·8%) except in those exposed to camomile. Acute reductions in forced expiratory volume in one second were considerably smaller and mostly not significant. Mean acute reductions on Wednesday were similar to those on Monday with no significant differences between preshift Monday and Wednesday data. Acute decreases in flow rates at low lung volumes suggest that the bronchoconstrictor effect of the dust acts mostly on smaller airways. Preshift administration of disodium cromoglycate significantly diminished acute reduction in flow rates except in workers processing Indian tea. A comparison of Monday preshift values of ventilatory capacity in tea workers with those in controls indicates that exposure to tea dust may, in some workers, lead to chronic respiratory impairment.

There are few published reports on the effect of tea on respiratory function in workers occupationally exposed to tea dust. Respiratory disease related to occupational exposure to tea dust was first described as "tea factory cough" by Castellani and Chalmers,[1] and Uragoda described a case of tea maker's asthma caused by the inhalation of tea fluff.[2] Attack of allergic diseases was described by Ebihara in two workers employed in a tea garden,[3] and Mackay described a high prevalence of respiratory diseases in tea garden workers.[4 5] In our preliminary study[6] a significantly higher prevalence of respiratory diseases was found in tea workers compared with controls. Similar results were obtained by Uragoda who found a higher prevalence of chronic bronchitis and asthma in tea workers than that expected in the general population.[7] Pulmonary function in tea workers was studied by Al-Zuhair and Cinkotai[8] and by Castellan *et al*[9] who reported shift reductions for FEV_1 in tea workers related to tea dust exposure.

In the present epidemiological investigation we have studied respiratory function in workers employed in processing different types of tea.

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Subjects and methods

PROCESS

Dog-rose, sage, and camomile used for making tea are grown in Yugoslavia. Indian tea is imported from India and gruzyan tea from the Soviet Union. The process includes manual unloading of bags of tea leaves, blending, grinding, milling, sifting, and manual packing. All these processes for each tea take place in a single hall and are quite dusty. There is no adequate ventilation system and in the working atmosphere there is, therefore, a high concentration of airborne tea fluff.

SUBJECTS

The study group included 100 female non-smoking workers exposed to different types of tea—dog-rose, gruzyan, sage, camomile, and Indian. In addition, 84 women employed in the production of soft drinks who were of similar age, height, and smoking habits were studied as controls. Table 1 shows the mean age and duration of employment of workers.

DEFINITIONS

The British Medical Research Council Committee Questionnaire[10] was used to assess the prevalence of chronic respiratory symptoms.

Chronic cough or phlegm or both: cough or phlegm or both on most days for at least three months a year.

Chronic bronchitis: cough and phlegm for a minimum of three months in the year and for not less than two successive years.

Dyspnoea grade 3: shortness of breath when walking with other people at an ordinary pace on the level; *grade 4:* shortness of breath when walking at own pace on the level.

Occupational asthma: chest tightness, cough, wheezing, and shortness of breath during exposure to dust at work.

The workers were also asked additional questions about any acute symptoms that developed while at work, such as coughing, dyspnoea, dryness or bleeding of the nose, burning of the throat, lacrimation, or headache.

VENTILATORY FUNCTION

Maximum expiratory flow-volume (MEFV) curves were recorded with a portable flow-volume spirometer (Pneumoscreen, Jaeger, West Germany) on the first working day of the week (Monday) before (6 am) and after (2 pm) the workshift. The forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and maximum flow rates at 50% and 25% of the control vital capacity ($MEF_{50\%}$, $MEF_{25\%}$) were read from these curves. The comparison of flow rates on MEFV curves before and after dust exposure, by superimposing the curves at the point of maximal inspiration, is justified if the changes in total lung capacity are not significant. Previous studies in coffee workers[11] and other studies[12–14] indicated the justification of such measurements. At least three MEFV curves were recorded, the mean of the two highest values being used as the result of the test. In 57 workers with acute reduction in flow rates on Monday, measurements of lung function were repeated on the following Wednesday before (6 am) and again after (2 pm) work.

To study the effect of Intal (disodium cromoglycate) in the prevention of the acute reduction of ventilatory capacity, a clinical trial was carried out in a group of 51 tea workers who had experienced acute reductions in maximum expiratory flow rates on the first Monday. On the second Monday the workers inhaled a placebo, and MEFV curves were recorded before and after work. On the third Monday, the same workers inhaled Intal, and the MEFV curves were again recorded before and after work. Placebo or Intal were administered by spinhaler 15 minutes before work, whereupon the preshift pulmonary function was measured.

ENVIRONMENTAL MEASUREMENTS

The airborne dust was sampled during the eight hour workshift in all the workplaces of the workers examined. Casella personal samplers were used to estimate total dust exposures while home made stationary two stage samplers, consisting of a filter preceded by a horizontal elutriator, were used to obtain the respirable fraction. The duration of sampling was four to eight hours with personal samplers, or one or two working shifts with the two stage samplers.

STATISTICAL ANALYSIS

The results of the pulmonary function measurements were analysed by using the *t* test for difference of paired (acute effects) and unpaired (chronic effects) variables. The chi-square test was used for testing differences in the prevalence of respiratory symptoms; $p < 0.05$ was considered statistically significant.

Results

RESPIRATORY SYMPTOMS

Table 1 shows the prevalence of chronic respiratory symptoms in the different groups of tea workers and in the control workers. The highest prevalence of almost all chronic respiratory symptoms was found in workers processing dog-rose, followed by sage and gruzyan tea. A considerably lower prevalence of all chronic respiratory symptoms was found in

Table 1 *Prevalence of chronic respiratory symptoms in tea workers and controls*

Tea	*No*	*Mean age (years)*	*Mean exposure (years)*	*Chronic cough (%)*	*Chronic phlegm (%)*	*Chronic bronchitis (%)*	*Asthma (%)*	*Dyspnoea grade 3 or 4 (%)*	*Nasal catarrh (%)*	*Sinusitis (%)*
Dog-rose	10	38	12	50·0**	40·0**	40·0**	10·0	30·0*	40·0**	30·0*
Gruzyan	28	37	13	28·6*	14·3	10·7	3·6	32·1**	42·9**	10·7
Sage	20	37	12	40·0**	15·0	10·0	0	35·0**	50·0**	15·0
Indian	16	23	2	0	0	0	0	6·3	6·3	6·3
Camomile	26	36	13	26·9*	7·7	3·9	3·9	26·9*	42·3**	11·5
Control	84	35	9	9·5	8·3	4·7	0	8·3	7·1	4·7

Difference between tea workers and controls statistically significant.
* $p < 0.05$; ** $p < 0.01$.

Table 2 *Prevalence of acute symptoms during the workshift in tea workers*

Tea	No	Cough (%)	Dyspnoea (%)	Nose		Throat burning (%)	Lacrimation (%)	Headache (%)
				Dryness (%)	Bleeding (%)			
Dog-rose	10	40·0	40·0	80·0	30·0	60·0	40·0	40·0
Gruzyan	28	50·0	50·0	0	21·4	53·6	46·4	39·3
Sage	20	65·0	45·0	0	10·0	25·0	0	25·0
Camomile	26	50·0	50·0	0	23·1	53·9	46·2	38·5
Indian	16	25·0	31·5	0	25·0	18·8	18·8	6·3

workers exposed to camomile and Indian tea. Among the tea workers we found three with symptoms characteristic of occupational asthma. One had been exposed mostly to dog-rose tea for 16 years, one to gruzyan tea for 18 years, and the third to camomile tea for 18 years. They all mentioned that the asthmatic symptoms had started a few years after they had been working with tea. In almost all tea workers the prevalence of chronic cough, dyspnoea, and nasal catarrh was significantly higher than in the controls.

Complaints of acute symptoms during the workshift were similar in all tea workers (table 2). Only workers exposed to Indian tea had a lower frequency, but the duration of exposure of these workers was considerably shorter than for the other tea workers.

VENTILATORY FUNCTION

The results of the ventilatory function testing in the tea workers and in the controls are shown in tables 3 and 4. Statistically significant mean acute reductions in $MEF_{50\%}$ and $MEF_{25\%}$ over the workshift on Monday were recorded in all groups of tea workers except in those exposed to camomile. Acute reductions in FVC and FEV_1 were smaller and mostly not significant. Such data indicate a bronchoconstricting effect of tea dust located predominantly in smaller airways.

In 57 tea workers ventilatory function on Wednesday was compared with that on Monday (table 5). The preshift values of $MEF_{50\%}$ and $MEF_{25\%}$ on both days did not differ significantly. Acute reductions in $MEF_{50\%}$ and $MEF_{25\%}$ on Wednesday were similar and not significantly different from acute reductions on Monday.

Preshift inhalation of Intal (figure) significantly diminished acute reduction in flow rates ($p < 0.01$) in tea workers compared with those after pretreatment with placebo, except in the workers processing

Table 3 *Ventilatory capacity in tea workers and controls on Monday*

Tea	FVC			FEV_1		
	Before (l)	Difference before-after (%)	p	Before (l)	Difference before-after (%)	p
Dog-rose (n=10)	3·42 ±0·81	−0·8	NS	3·02 ±0·70	−1·3	NS
Control (n=13)	3·86 ±0·64			3·02 ±0·52		
Gruzyan (n=28)	3·36 ±0·53	−2·7	<0·01	2·74 ±0·51	−0·3	NS
Control (n=30)	3·62 ±0·32			2·92 ±0·36		
Sage (n=20)	3·46 ±0·52	−3·2	<0·05	2·82 ±0·45	−1·8	NS
Control (n=25)	3·78 ±0·43			3·02 ±0·43		
Camomile (n=26)	3·49 ±0·40	−3·7	<0·05	2·87 ±0·39	−0·3	NS
Control (n=31)	3·75 ±0·50			2·99 ±0·51		
Indian (n=16)	3·64 ±0·29	−2·5	<0·05	3·38 ±0·31	−2·7	<0·01
Control (n=17)	3·70 ±0·54			3·31 ±0·34		

Data before shift are presented as $\bar{X} \pm SE$.
Difference between preshift data in exposed and control workers statistically not significant ($p > 0.05$).
NS = Not significant.

Table 4 *Ventilatory capacity in tea workers and controls on Monday*

Tea	$MEF_{50\%}$			$MEF_{25\%}$		
	Before (l/s)	*Difference before-after (%)*	*p*	*Before (l/s)*	*Difference before-after (%)*	*p*
Dog-rose (n=10)	3·96 ±1·31	−8·8	<0·05	1·64 ±0·52	−14·6	<0·05
Control (n=13)	5·06 ±0·71			2·47 ±0·95		
Gruzyan (n=28)	3·85 ±1·15	−8·1	<0·01	1·65 ±0·81	−21·8	<0·01
Control (n=30)	4·72 ±1·03			2·49 ±0·31		
Sage (n=20)	4·39 ±1·10	−4·1	<0·05	1·72 ±0·55	−14·5	<0·01
Control (n=25)	4·96 ±0·71			2·39 ±0·92		
Camomile (n=26)	4·10 ±1·15	−1·11	NS	1·63 ±0·68	−1·8	NS
Control (n=31)	4·88 ±0·18			2·54 ±1·07		
Indian (n=16)	5·86 ±0·65	−4·3	<0·01	3·21 ±0·59	−7·8	<0·01
Control (n=17)	5·67 ±0·63			3·21 ±0·46		

Data before shift are presented as $\bar{X}$ ± SE.
Difference between preshift data in exposed and control workers statistically not significant ($p > 0·05$).
NS = Not significant.

Indian tea. Three workers with symptoms of occupational asthma on the placebo day showed acute reductions in $MEF_{50\%}$ (24%, 21%, and 20%) and in $MEF_{25\%}$ (31%, 29%, and 29%). After pretreatment with Intal, reductions in flow rates were considerably diminished ($MEF_{50\%}$: 10%, 6%, and 9%; $MEF_{25\%}$: 11%, 13%, and 15%).

The comparison of Monday mean preshift flow rates in the exposed and control workers has shown considerably lower values of $MEF_{50\%}$ and $MEF_{25\%}$ in tea workers than in controls, except for those employed in processing Indian tea (table 4). The

Table 5 *Ventilatory capacity in 57 tea workers on Monday and following Wednesday*

Tea	*Day*	$MEF_{50\%}$				$MEF_{25\%}$			
		Before (l/s)	*Difference before (l/s)*	*after (%)*	*p*	*Before (l/s)*	*Difference before (l/s)*	*after (%)*	*p*
Dog-rose (n=7)	M	4·36 ±1·38	−0·50	−11·5	<0·01	1·81 ±0·54	−0·37	−20·4	<0·01
	W	4·17 ±1·40	−0·23	−5·5	<0·05	1·70 ±0·47	−0·20	−11·8	<0·05
Gruzyan (n=19)	M	4·04 ±1·12	−0·52	−12·9	<0·01	1·69 ±0·77	−0·50	−29·6	<0·01
	W	4·06 ±1·06	−0·47	−11·6	<0·01	1·65 ±0·71	−0·40	−24·2	<0·01
Sage (n=14)	M	4·52 ±1·32	−0·30	−6·6	<0·01	1·76 ±0·61	−0·38	−21·6	<0·01
	W	4·59 ±1·44	−0·48	−10·5	<0·01	1·69 ±0·62	−0·40	−23·7	<0·01
Camomile (n=7)	M	4·24 ±1·44	−0·37	−8·7	<0·05	1·44 ±0·58	−0·28	−19·4	<0·05
	W	4·16 ±1·41	−0·32	−7·7	<0·05	1·39 ±0·55	−0·18	−12·9	<0·05
Indian (n=10)	M	6·04 ±0·52	−0·34	−5·6	<0·01	3·31 ±0·57	−0·34	−10·3	<0·01
	W	5·62 ±0·89	−0·71	−12·6	<0·01	3·22 ±0·63	−0·69	−21·4	<0·01

M = Monday.
W = Wednesday.
Data before shift are presented as $\bar{x}$ ± SE. Differences between preshift Monday and Wednesday data are not statistically significant ($p > 0·05$).
NS = Not significant.

mean $MEF_{50\%}$ in the tea workers as a percentage of the control values varied from 78% to 103%, while the mean $MEF_{25\%}$ in the tea workers varied from 64% to 100% of the controls (table 3). The mean FEV_1 values in tea workers as a percentage of the controls were all above 80% (range: 89% to 98%).

A comparison of the ventilatory capacity results for each tea worker with expected normal values[15] shows that a large number of workers had decreased flow rates on MEFV curves less than 70% of normal: in exposure to dog-rose ($MEF_{50\%}$: 30%, $MEF_{25\%}$: 20%), to gruzyan tea ($MEF_{50\%}$: 36%, $MEF_{25\%}$: 51%), to sage ($MEF_{50\%}$: 15%, $MEF_{25\%}$: 45%), and to camomile ($MEF_{50\%}$: 19%, $MEF_{25\%}$: 50%).

A considerably smaller number of tea workers had decreased FEV_1 by comparison with normal values: in exposure to dog-rose (10%), gruzyan (11%), sage (5%), and camomile tea (8%). Among workers processing Indian tea none had FEV_1 or flow rates on MEFV curves less than 70% of the expected normal values.

ENVIRONMENTAL MEASUREMENTS

The mean total dust concentrations and respirable dust fractions in the working areas of processing different tea are presented in table 6 and indicate that the workers employed in processing gruzyan, dog-rose, and sage tea are exposed to the highest airborne dust concentrations.

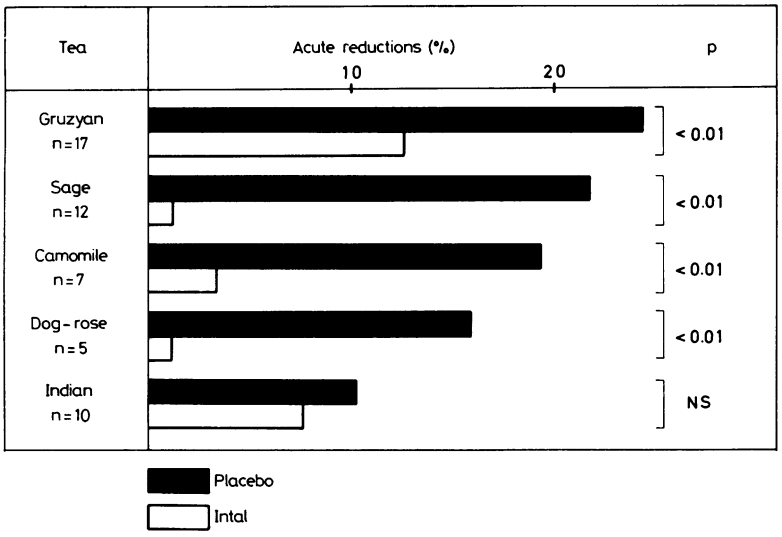
Table 6 *Dust concentrations in processing different types of tea*

Tea	*Total dust (mg/m³)*		*Respirable fraction (%)*
	Range	*Mean*	
Dog-rose	3·2–24·2	11·4	15
Gruzyan	5·3–24·9	16·8	12
Sage	2·5–10·0	6·3	16
Camomile	2·4–5·6	3·7	10
Indian	1·5–3·5	2·1	17

Discussion

The present study has shown that exposure to dust during the processing of different types of tea may cause acute or chronic respiratory symptoms to develop. The highest prevalence of almost all chronic respiratory symptoms was found in the workers processing dog-rose, sage, and gruzyan tea. Workers employed in processing dog-rose and gruzyan tea were exposed to higher concentrations of airborne dust than those exposed to sage. Our preliminary immunological studies[6] indicated that the largest number of tea workers had positive skin reaction to allergen prepared from sage. A similar prevalence of chronic respiratory symptoms and changes in respiratory function in the workers manufacturing sage, dog-rose, and gruzyan tea, and the highest skin sensitivity to sage allergen even with lower dust concentrations in processing sage than in the latter two groups, suggest that sage might be the most potent in causing respiratory impairment.

Many tea workers complained of acute symptoms during working hours. Many reported that acute chest symptoms were more intense at the beginning of the working week or on return to work after a period of absence. This is similar to the results



Mean relative acute reductions in maximum expiratory flow rates at 25% ($MEF_{25\%}$) in tea workers after preshift administration of placebo or Intal.

obtained in tea workers by Castellan *et al*,[9] in coffee workers,[11 16] or in textile workers.[17]

The inhalation of tea dust on Monday and Wednesday caused acute bronchoconstriction in a large number of tea workers. This was more evident by changes in flow rates on MEFV curves than in FEV_1 or FVC. Among our tea workers only one subject had acute FEV_1 decrease greater than 10% (11·4%). This is similar to the results of Castellan *et al* who found one person with acute shift decrement in FEV_1 of more than 10%.[9] Acute reductions during workshift in $MEF_{50\%}$ between 10% and 20% were found in 21% of our tea workers and between 21% and 30% in 3% of workers. Acute reductions in $MEF_{25\%}$ were greater: between 10% and 20% in 25% of workers and between 21% and 33% in 22% of workers. Since a decrease in flow rates reflects changes in the smaller airways, our results may indicate that the constrictor effect of tea dust is mostly located in these smaller airways. The present data are in agreement with the results of some of our previous studies,[11 18] which have shown that flow rates at lower lung volumes, such as $MEF_{50\%}$ or $MEF_{25\%}$, are more sensitive tests of the changes caused by pharmacological agents and some organic dusts in the smaller airways.

An experimental trial with Intal showed it prevented the acute reductions caused by inhalation of tea dust. Previous studies have shown that Intal can also protect against an acute airway response to textile dust or textile dust extract[18 19] and to coffee dust.[11] In the present study there was considerable, although not full, protection with Intal. As this compound prevents the release of chemical mediators from mast cells[20] our results seem to indicate that flow rate responses in tea workers are, at least partly, dependent on the release of histamine. The protective effect of Intal was obtained irrespective of the magnitude of the acute reductions in expiratory flow rates.

A comparison of Monday preshift flow rates on MEFV curves of tea workers with those of controls has suggested that exposure to dust in the processing of tea may lead to a progressive impairment of ventilatory capacity.

The effects of occupational exposure to active tea dust should be controlled by medical examination and by controlling the working environment. Because some cases of chronic respiratory diseases related to tea dust exposure may still be expected to occur at very low dust concentrations, we recommend that pre-employment examination and medical surveillance be required to prevent irreversible changes in lung function. Lung function tests should be performed before and after the workshift by recording FEV_1 or MEFV curves. Medical supervision serves as a means of detecting those workers sensitive to dust, since there is a large variation in individual susceptibility to chronic respiratory diseases. Such an examination would prevent a sensitive person from working in those processes that carry the risk of respiratory allergy, chronic obstructive lung disease, or any other respiratory diseases.

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