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Respiratory function in coffee workers*

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ABSTRACT Respiratory function was studied in three groups of workers employed in processing coffee. The prevalence of almost all chronic respiratory symptoms was significantly higher in coffee processors than in control workers. In each group during the Monday work shift there was a significant mean acute decrease in the maximum expiratory flow rate at 50% vital capacity (VC), ranging from 4·0% to 8·7%, and at 25% VC, ranging from 6·0% to 18·5%. Acute reductions in $FEV_{1.0}$ were considerably lower, ranging from 1·3% to 2·8%. On Thursdays the acute ventilatory function changes were somewhat lower than on Mondays. Acute decreases in flow rates at low lung volumes suggest that the bronchoconstrictor effect of the dust acts mostly on smaller airways. Administration of Intal (disodium cromoglycate) before the shift considerably diminished acute reductions in flow rates. A comparison of Monday pre-shift values of ventilatory capacity in coffee workers with those in controls indicates that exposure to dust in green or roasted coffee processing may lead to persistent loss of pulmonary function.

It has been reported that occupational exposure to coffee dust may cause allergic symptoms (Figley and Rawling, 1950; Bruun, 1957; Kaye and Freedman, 1961; Layton *et al.*, 1965; Turula *et al.*, 1966; Van Toorn, 1970; Somazzi and Wütrich, 1975). However, there have been no epidemiological studies of lung function in a population occupationally exposed to coffee. We have studied two groups of workers employed in the processing of (a) roasted and (b) green coffee, with particular reference to acute and chronic changes of lung function.

Subjects and methods

THE PROCESS

Green coffee
This involves manual unloading of bags of green coffee, manual emptying of bags into a pneumatic transport system, and packing of green coffee.

Roasted coffee
Workers are involved in the roasting of coffee, grinding of roasted coffee, and in manual and mechanical packing.

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SUBJECTS

The study groups included 72 processors of roasted coffee (51 women and 21 men) and 31 processors of green coffee (women only) representing 94% of all the workers employed. Female workers were non-smokers. Male workers were all smokers (average 20 cigarettes daily). In addition, 103 workers employed in the production of soft drinks, matching coffee workers in age, height, and smoking habits, were studied as controls (82 women and 21 men). The mean age and duration of employment of subjects in processing of coffee are shown in Table 1.

DEFINITIONS

The British Medical Research Council Committee Questionnaire (Medical Research Council, 1960) was used to assess the prevalence of chronic respiratory symptoms. Chronic cough and/or phlegm were defined as cough and/or phlegm production on most days for at least three months per year. Chronic bronchitis described cough and phlegm for a minimum of three months in the year and for not less than two successive years. Dyspnoea was graded as follows: 3 = shortness of breath when walking with other people at an ordinary pace on the level; 4 = shortness of breath when walking at own pace on the level.

The workers were also asked additional questions about acute symptoms which developed while at work, such as coughing, dyspnoea, dryness or

Table 1 *Prevalence of chronic respiratory symptoms in coffee workers and in control workers*

Sex	*Process*	*N*	*Mean age (yr)*	*Mean exposure (yr)*	*Chronic cough (%)*	*Chronic phlegm (%)*	*Chronic bronchitis (%)*	*Asthma (%)*	*Dyspnoea grade 3 or 4 (%)*	*Nasal catarrh (%)*	*Sinusitis (%)*
F	Roasted coffee	51	31	6	21·6	19·6	13·7	3·9	33·3	33·3	25·5
					P <0·05	<0·05	NS	NS	<0·01	<0·01	<0·01
	Control	51	31		3·9	3·9	3·9	0	0	5·9	3·9
F	Green coffee	31	30	7	41·9	32·3	22·6	3·2	22·6	41·9	22·5
					P <0·01	<0·01	<0·05	NS	<0·05	<0·01	<0·05
	Control	31	30		6·5	3·2	3·2	0	0	0	3·2
M	Roasted coffee	21	37	9	57·1	61·9	52·4	0	33·3	38·1	23·8
					NS	NS	NS	NS	<0·05	<0·05	NS
	Control	21	36		42·7	42·7	42·7	0	4·8	9·5	9·5

NS = difference not statistically significant ($P > 0·05$).

bleeding of the nose, burning of the throat, lacrimation, or headache.

VENTILATORY FUNCTION

The forced vital capacity (FVC) and the one-second forced expiratory volume ($FEV_{1.0}$) were obtained from the forced expiratory spirogram (Godart Pulmonet) on the first working day of the week (Monday) before (6 am) and after the work shift (2 pm). Maximum expiratory flow–volume (MEFV) curves were recorded with a portable flow–volume spirometer (Peters *et al.*, 1969). The maximum flow rates at 50% and 25% of the control vital capacity (MEF 50% and 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; this proved to be the case in preliminary testing in coffee workers as well as in a number of our previous studies (Žuškin and Bouhuys, 1974; Žuškin *et al.*, 1975; Žuškin and Bouhuys, 1976). Three forced expiratory spirograms and three MEFV curves were recorded each time, and the mean of the two highest values was used as the result of the test.

In 25 female and 14 male workers exposed to roasted coffee, the measurements of lung function were repeated on the following Thursday before (6 am) and after (2 pm) work.

In order to study the effect of Intal (disodium cromoglycate) in preventing acute reduction of ventilatory capacity, a clinical trial was carried out in a group of 39 coffee 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 pre-shift pulmonary function was measured.

ENVIRONMENTAL MEASUREMENTS

The air-borne dust was sampled during the eight-hour shift 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 applied to obtain respirable fractions. The duration of sampling was 4–8 h with personal samplers, or one or two working shifts with two-stage samplers.

Results

ENVIRONMENTAL MEASUREMENTS

In all, 27 dust samples were taken during handling of green coffee and 36 during processing of roasted coffee. The mean total dust concentration in green coffee processing (mean: 11·2 mg/m^3; range: 1·4–62·3 mg/m^3) was considerably higher than in the roasted coffee manufacture (mean: 4·3 mg/m^3; range: 1·1–8·8 mg/m^3). The respirable fraction for green coffee dust averaged 3%, and for roasted coffee dust 2%.

RESPIRATORY SYMPTOMS

In female workers the prevalence of almost all chronic respiratory symptoms was significantly higher, in processors of roasted and of green coffee, than in controls (Table 1). Two processors of roasted and one of green coffee had symptoms characteristic of asthma, while none of the control workers had these symptoms. Among the men, only the prevalence of dyspnoea grade 3 or 4 and of nasal catarrh was significantly higher in coffee workers than in

Table 2 *Prevalence of acute symptoms during work*

Sex	*Process*	*N*	*Cough* (%)	*Dyspnoea* (%)	*Nose* dryness (%)	*Nose* bleeding (%)	*Throat burning* (%)	*Lacrimation* (%)	*Headache* (%)
F	Roasted coffee	51	35·3	45·1	62·8	21·6	41·2	33·3	47·1
			NS	NS	<0·01	<0·05	NS	NS	NS
	Green coffee	31	38·7	41·9	9·7	41·9	32·3	25·8	32·3
M	Roasted coffee	21	57·1	52·4	61·9	33·3	61·9	52·4	47·6

NS = difference not statistically significant ($P > 0·05$).

Table 3 *Ventilatory capacity in coffee workers and in control workers*

Sex	*Process*	*N*	*FVC* Before shift (litres)	*FVC* Difference before − after (%)	*FVC* (P)	*FEV*$_{1·0}$ Before shift (litres)	*FEV*$_{1·0}$ Difference before − after (%)	*FEV*$_{1·0}$ (P)	*MEF 50%* Before shift (litres/s)	*MEF 50%* Difference before − after (%)	*MEF 50%* (P)	*MEF 25%* Before shift (litres/s)	*MEF 25%* Difference before − after (%)	*MEF 25%* (P)
F	Roasted coffee	51	3·81 ±0·55	−1·6	<0·05	3·23 ±0·53	−2·8	<0·01	4·94 ±0·94	−4·0	<0·01	2·49 ±0·90	−12·0	<0·01
	Control	51	3·87 ±0·44			3·29 ±0·44			5·07 ±0·56			2·86 ±0·45		
F	Green coffee	31	3·80 ±0·57	−2·1	<0·01	3·20 ±0·49	−1·3	<0·05	4·85 ±1·05	−8·7	<0·01	2·33 ±0·76	−18·5	<0·01
	Control	31	3·84 ±0·39			3·25 ±0·51			5·16 ±0·86			2·78 ±0·33		
M	Roasted coffee	21	4·93 ±0·67	−1·6	<0·05	3·99 ±0·58	−2·0	<0·05	5·60 ±1·48	−5·7	<0·01	2·49 ±0·94	−6·0	<0·01
	Control	21	5·18 ±0·60			4·05 ±0·56			6·14 ±0·77			3·12 ±0·64		

Data before shift are presented as mean ± standard deviation.
The difference between pre-shift data in exposed and control workers was statistically significant for MEF 25% (roasted coffee: $P < 0·05$; green coffee: $P < 0·01$).

controls ($P < 0·05$). Those employed for more than five years in processing either roasted or green coffee had a somewhat higher prevalence of all chronic respiratory symptoms than those with shorter exposure, but the difference was statistically significant only for dyspnoea in female processors of green coffee (5·6% with less than five years' exposure, 46·2% with more than five years' exposure; $P < 0·01$).

During the working shift complaints of nasal dryness were recorded significantly more frequently by women processing roasted coffee than by those processing green coffee; however, nasal bleeding occurred more commonly among those who processed green coffee (Table 2). Other acute symptoms frequently developed during coffee processing, but the differences between working groups were not significant (Table 2).

VENTILATORY FUNCTION

There were statistically significant acute reductions in ventilatory capacity during work on Mondays in workers processing either roasted or green coffee (Table 3). When expressed as percentages, the flow rates fell considerably more during a working shift than did the $FEV_{1·0}$ and FVC.

The three women with symptoms of asthma showed a marked decrease in MEF 50% (20·0%, 27·8% and 31·0%) and in MEF 25% (18·2%, 29·0% and 36·0%), during the first shift on a Monday.

Recently NIOSH has recommended that reductions of ventilatory capacity exceeding 10% of the pre-shift value should be classified as definite and marked effects of dust (National Institute for Occupational Safety and Health, 1974). The MEF

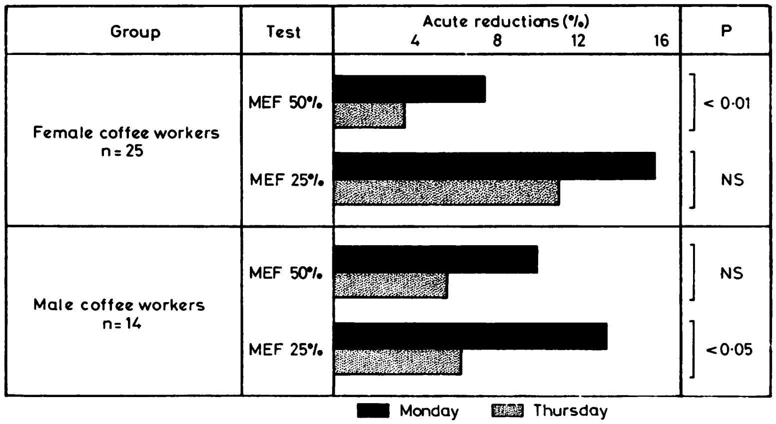

Figure *Mean relative acute reductions in maximum expiratory flow rates at 50% VC (MEF 50%) and at 25% VC (MEF 25%) in coffee roastery workers on Mondays and Thursdays.*

Table 4 *Mean acute changes in flow rates over work shift in coffee workers after pretreatment with placebo or Intal*

Sex	*Process*	*N*	*Drug*	*MEF 50%* Before shift (litres/s)	*MEF 50%* Difference before – after (litres/s)	*MEF 50%* Difference before – after (%)	*MEF 50%* (P)	*MEF 25%* Before shift (litres/s)	*MEF 25%* Difference before – after (litres/s)	*MEF 25%* Difference before – after (%)	*MEF 25%* (P)
F	Roasted coffee	24	Placebo	4·57 ±0·98	−0·32	−7·0	<0·01	2·22 ±0·90	−0·35	−15·8	<0·01
			Intal	4·51 ±0·93	+0·06	+1·3	NS	2·22 ±0·87	+0·07	+3·2	NS
	Green coffee	6	Placebo	4·67 ±0·79	−0·45	−9·6	<0·01	2·10 ±0·77	−0·37	−17·6	<0·01
			Intal	4·72 ±0·56	−0·19	−4·0	NS	2·25 ±0·76	−0·22	−9·8	<0·01
M	Roasted coffee	9	Placebo	5·62 ±1·43	−0·52	−9·3	<0·01	2·30 ±0·80	−0·37	−16·1	<0·01
			Intal	5·58 ±1·46	−0·26	−4·7	<0·05	2·40 ±0·81	−0·06	−2·5	NS

Data before shift are presented as mean ± standard deviation.

50% showed reductions of this order in 19·6% of women and 28·6% of men working with roasted coffee, and in 35·5% of processors of green coffee. The corresponding figures for reduction of MEF 25% were 50·9% for females, 42·9% for males, and 77·4% among the handlers of green coffee.

In 25 women and 14 men exposed to roasted coffee, ventilatory function on Thursdays was compared with that on Mondays. The pre-shift values of $FEV_{1\cdot 0}$, MEF 50% and MEF 25% were lower on Thursdays than on Mondays but the difference reached statistical significance only in the case of MEF 50% in the women (Monday 4·62 litres/second; Thursday 4·44 litres/second; $P < 0·05$). There were significant reductions in MEF 50% and MEF 25% on both days, but they were smaller on Thursdays (Figure).

When Intal was administered there was considerably less reduction of flow rates during the shift, than when placebo was given (Table 4). Of 33 coffee roastery workers, 16 were completely protected by Intal, whereas treatment with placebo resulted in a mean reduction of MEF 50% of 8·9%, and of MEF 25% of 13·5%. Only one of the six who were processing green coffee was completely protected by Intal.

In the three workers with asthma, after pretreatment with placebo, acute reductions in MEF 50% were 16%, 17%, and 31% respectively. Following the pre-shift treatment with Intal, their acute reductions were diminished to 3%, 12%, and 13% respectively.

A comparison of Monday pre-shift ventilatory function values in exposed and matched control workers (Table 3) demonstrated a significantly lower MEF 25% in coffee workers than in controls (roasted coffee $P < 0.05$, green coffee $P < 0.01$).

The measured pre-shift values of MEF 50% on a Monday were less than three-quarters of the corresponding values in the controls in five of 21 male coffee roastery workers and the values of MEF 25% were equally low in six. Ten of the 51 female coffee roastery workers had a pre-shift MEF 50% less than three-quarters of the values shown by their controls, and 11 had a low MEF 25%. Among 31 processors of green coffee, low values of MEF 50% were recorded in five, and of MEF 25% in six.

Discussion

This study has shown that exposure to dust during the processing of both roasted and green coffee may be associated with chronic respiratory symptoms. The prevalence of chronic cough, chronic phlegm, and chronic bronchitis was higher in the women exposed to green coffee, although the concentration of airborne dust in processing of green coffee was considerably lower than in processing of roasted coffee. This suggests that the former type of dust has a more potent effect on the respiratory system.

Among 82 non-smoking female workers in the study, three (3·7%) had symptoms characteristic of asthma, a prevalence lower than that reported by Kaye and Freedman in 1961 (7·3%). Two of our asthmatic subjects were employed in processing roasted coffee for 17 and seven years respectively, and the third in processing green coffee for 11 years. Their Monday pre-shift values of flow rates were considerably below the control values (MEF 50%: 61·7%, 60·0% and 39·1% respectively; MEF 25%: 44·0%, 40·0% and 36·0% respectively).

A large number of workers complained of acute respiratory symptoms during working hours. Many of them reported that the acute symptoms had been more pronounced at the beginning of their work in the industry, and that the intensity of their symptoms had decreased with continuing exposure. Some of them mentioned that acute symptoms were more intense at the beginning of the working week or on returning to work after a period of absence. Similar acute responses to coffee dust during working hours were found by Turula *et al.* (1966).

Coffee processing caused bronchoconstriction in a large proportion of coffee workers. This was more easily demonstrated by changes in MEFV than in $FEV_{1\cdot0}$ or FVC. As a decrease in MEF 50% and MEF 25% is believed to reflect changes in small airways, our results suggest that the constrictor effect of dust in coffee processing is confined mainly to the small airways. The present data are in agreement with the results of some of our previous studies (Valić and Žuškin, 1973; Žuškin *et al.*, 1975) which have shown that flow rates at small lung volumes such as MEF 50% or MEF 40% are sensitive tests of changes in small airways caused by pharmacological agents and some organic dusts.

Our trial has demonstrated that Intal prevents bronchoconstriction occurring during the processing of coffee. Previous studies by Žuškin and Bouhuys (1976) and Žuškin *et al.* (1976) had shown that Intal can protect against the airway constrictor response to textile dust or dust extracts. In the present study 43·6% of affected coffee workers obtained full protection with Intal. As this compound prevents the release of chemical mediators from mast cells (Cox, 1971) our results indicate that flow-rate response in coffee workers may be dependent on the release of histamine. The protective effect of Intal was obtained irrespective of the magnitude of previous acute reductions in expiratory flow rates.

A comparison of Monday pre-shift data on flow rates in coffee workers with those in controls has suggested that exposure to dust in the processing of coffee may lead to progressive impairment of ventilatory capacity.

Dust released in coffee manufacture is a complex mixture of particles, only some of which (especially in green coffee processing) are of coffee. It is therefore unjustifiable, on the basis of this study, to attribute the effects found in coffee workers to exposure to coffee dust alone. An investigation, by inhalation experiments, into the constrictor potency of various components of the dust released during the processing of coffee is currently under way.

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