

# Ventilatory function of factory workers exposed to tea dust

P. L. Jayawardana\* and M. Udupihille†

\*Department of Community Medicine and †Department of Physiology, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka

A cross-sectional study was conducted in order to determine the prevalence of respiratory symptoms and the effect on ventilatory capacity in workers exposed to tea dust for at least five years during the sifting process of tea manufacture compared to a control group of field workers who were not exposed to tea dust previously. Fifty-three subjects each in the study and control groups were matched for age, sex, ethnic group and height. Prevalence of chronic respiratory symptoms was obtained by questionnaire. Spirometric measurements included forced vital capacity (FVC), forced expiratory volume in the first second (FEV<sub>1,0</sub>) and forced mid-expiratory flow rate (FEF<sub>25–75%</sub>). The study group had a chest radiograph. The odds ratio for any chronic respiratory symptom was 11.6 (95% confidence interval [CI] = 3.7–39.4) in the study group. Mean values for the spirometric tests were lower in the study group; the differences in FEV<sub>1,0</sub> and FEF<sub>25–75%</sub> were significant. Tuberculosis was not found in the study group, while one subject (2.4%) had radiological evidence of bronchiectasis. It may therefore be concluded that chronic tea dust exposure causes increased prevalence of respiratory symptoms and a significant degree of small airways obstruction.

**Key words:** Occupational hazards; tea factory workers, ventilatory function.

Occup. Med. Vol. 47, 105–109, 1997

Received 2 April 1996; accepted in revised form 11 October 1996.

## INTRODUCTION

Tea is an indispensable beverage used the world over and is brewed from the tea plant *Camellia sinensis*. Manufacture of black tea involves several labour-intensive processes. In Sri Lanka it is done on a large scale, as tea is one of the major export crops.

The young tea shoot when harvested undergoes several treatments before the final product is derived. Initially the shoots are withered by blowing warm air over the leaves followed by rolling, a process which breaks up the dehydrated leaf enabling the polyphenol catechins to be oxidized. Then the leaves are allowed to ferment, during which the oxidized compounds are polymerized into theaflavin and thearubigin which gives the tea its colour and quality. The fermented tea is dried and sifted to be sorted according to the different sizes. Once sorted, the tea is blended and packed before export. The processes from withering to sifting are done in the factories and blending is done in the blending firms situated mainly in the capital city, Colombo. Sifting and blending are the dustiest processes in the tea industry<sup>1</sup> and the workers involved are

exposed to the hazard of inhaling the dust.

Inhalation of tea dust is known to give rise to both acute and chronic respiratory symptoms. Acute symptoms consist of burning sensation in the throat, nasal discharge and bleeding, irritation of the eyes and headache.<sup>2,3</sup> Chronic symptoms include byssinosis,<sup>1</sup> chronic cough, phlegm and dyspnoea.<sup>3,4</sup> Allergic reactions such as nasal catarrh and occupational asthma<sup>5–7</sup> too have been reported. Asthma has been described in a tea maker in Sri Lanka.<sup>5</sup>

Although the effects of exposure to tea dust among blenders in Sri Lanka<sup>4,8</sup> have been investigated, no studies have been carried out on long term effects in tea factory workers. The objectives of the present study therefore were: (1) to determine the prevalence of respiratory symptoms and ventilatory function in workers engaged in the sifting process in the factories when compared to a control group; and (2) to determine radiological changes in the workers exposed to tea dust during the sifting process.

## MATERIALS AND METHODS

Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine, University of

Correspondence and reprint requests to: P. L. Jayawardana, Department of Community Medicine, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka.

Peradeniya and informed written consent was obtained from all the participants of the study. Radiography was not performed on the control group because of ethical considerations.

The study period was between September 1988 and April 1990. The study area was situated in the Kandy district which included the city of Kandy and some of the surrounding tea estates. Eleven estates close to the Faculty of Medicine were selected for the study.

### Study population

The study group (SG) consisted of all the male and female permanent workers who have worked in the sifting room for a continuous period of five or more years. The control group (CG) was selected from the field workers in the estates. They belonged to the same socio-economic status as the study group and were not exposed to tea dust at any time. They were matched for age, sex, ethnic group and height on a frequency basis. Age was taken as the number of completed years for both SG and CG and each subject in the control group was matched exactly to the age of each subject in the SG.

There was a total of 55 workers who were eligible to participate in the study. However, two (3.6%) females in the study group were unable to perform spirometry satisfactorily. Therefore the total number in each group was 53 which included 13 males and 40 females.

### Study instruments

A questionnaire on respiratory symptoms developed by the Medical Research Council, United Kingdom<sup>9</sup> was used with modifications to suit local conditions to obtain demographic data, personal data and information on respiratory symptoms such as cough, phlegm, dyspnoea, occupational asthma, hay fever and past illnesses related to chest and smoking habits.

The following definitions of respiratory symptoms<sup>3</sup> were adopted:

- *Chronic cough/phlegm.* Cough and/or phlegm production on most days in at least 3 months per year.
- *Chronic bronchitis.* Presence of cough and/or phlegm for a minimum of 3 months a year for at least 2 consecutive years.
- *Dyspnoea.*  
Grade 3 — shortness of breath when walking with other people at an ordinary pace on level ground.  
Grade 4 — shortness of breath when walking at their own pace on level ground.
- *Occupational asthma.* Chest tightness, cough, wheezing and shortness of breath during exposure to dust at work.
- *Hay fever.* Sneezing and runny nose on exposure to dust at work.

The questionnaire which was originally in English was translated to Sinhala and Tamil languages and retranslated to English to ensure the retention of the meaning of the original text. It was amended after pretesting on a group who did not form part of the study subjects. The Sinhala translation was administered by one of the authors (PJ) and the Tamil translation by a volunteer, both of whom underwent training in administering the questionnaire.

A clinical examination was conducted by PJ. This included measurement of height and examination of the cardiovascular and respiratory systems. Height was measured to the nearest 0.1 cm and the control group was matched to 5 cm above or below the height of the corresponding subject in the SG.

Lung function tests were carried out using a Morgan rolling seal dry spirometer which conformed to specifications recommended by the American Thoracic Society.<sup>10</sup> The procedure was explained to the subjects followed by a demonstration. A minimum of three practice blows were allowed and at least three and not more than eight test readings were taken; measurements were taken in the seated position. Forced vital capacity (FVC), forced expiratory volume in the first second (FEV<sub>1.0</sub>) and forced mid-expiratory flow rate (FEF<sub>25-75%</sub>) were calculated from the tracings and the highest reading was considered to be the correct value. The readings were converted to BTPS.

Chest radiography was performed on the study group. A posterior anterior view was taken on full inspiration on a standard size film. The X-rays were inspected by two radiologists independently for the presence of emphysema, bronchiectasis and pulmonary tuberculosis. A final diagnosis was made on agreement by both the radiologists.

### Analysis of data

Two sample Student's *t*-test was used to compare age and height in the two groups. Chi square and Fisher's exact tests were used to compare categorical data. Multiple linear regression was used to determine the contribution of each relevant variable on ventilatory capacity. Cut off points for significance was a probability of less than 5%.

Regression equations for the prediction of FVC, FEV<sub>1.0</sub> and FEF<sub>25-75%</sub> applicable to the Sinhalese<sup>11</sup> were used to determine predicted values for both study and control groups (these models are considered the closest applicable to the Tamil estate workers who are mainly of Indian origin). Observed values of lung function were expressed as percentages of the predicted values for each subject. Values less than 80% of predicted were considered significant.

### RESULTS

The mean age was 42.3 years for each group. The heights of the males were 160.9 and 161.3 cm and of

the females, 148.4 and 147.9 cm for SG and CG respectively. Smokers were found only among the males; 12 (22.6%) in SG and 10 (18.9%) in CG. The above differences were not significant.

The mean duration of service among the factory workers was 11.8 years (range 5–37 years). Distribution of workers according to duration of service is shown in Table 1. Those with a service of more than 15 years were significantly fewer among the factory workers.

The prevalence of respiratory symptoms in the two groups is given in Table 2. The study group, on the whole, had a significantly higher prevalence of chronic respiratory symptoms than the control group. The differences in the prevalence of cough, phlegm, chronic bronchitis and dyspnoea (grades 3 and 4 together) were significant. The differences in the prevalence of asthma and hay fever, although slightly higher in the study group, were not significant. Sixty eight per cent of those positive for symptoms had a duration of service of equal and less than 15 years. Sixty per cent

of those with a duration of service of more than 15 years reported symptoms.

The ventilatory function of those with symptoms did not differ significantly from those without symptoms in any of the three indices. However, the ventilatory function of the eight chronic bronchitics were significantly lower for FEF<sub>25%–75%</sub> ( $p = 0.011$ ). No abnormal clinical signs were found on examination of the cardiovascular and the respiratory systems.

The means of respiratory indices were lower in the study group than in the control group. These differences were significant with respect to FEV<sub>1.0</sub> and FEF<sub>25–75%</sub> (Table 3). The mean predicted values of the SG also differed significantly from those of the observed values in FEV<sub>1.0</sub> and FEF<sub>25%–75%</sub>. The predicted values in the CG did not differ from the observed values (Table 3). The duration of service and smoking did not contribute significantly to the decline in ventilatory capacity.

On grading the ventilatory capacity, expressed as a percentage of the predicted values, the number affected (< 80%) was greater in the study group than in the control group. This was significant in the case of FEF<sub>25–75%</sub> (Table 4).

Forty-nine subjects underwent chest radiography. In seven radiographs the two radiologists differed with respect to the diagnosis. Of the remainder, one (2.4%) showed bronchiectasis. No evidence of pulmonary tuberculosis was reported.

**Table 1.** Number of workers according to duration of service among factory workers

Service in years		$\chi^2$ value	Probability
5–15	> 15		
43 (81.1%)	10 (18.9%)	20.55	0.000

**Table 2.** Respiratory symptoms

Symptom/condition	Study group		Control group		Odds ratio	CI <sup>†</sup>	Significance of difference (p)
	n	%	n	%			
Any respiratory symptom <sup>‡</sup>	29	54.7%	5	9.4%	11.60	3.7–39.4	0.000
Cough	14	26.4%	3	5.7%	5.98	1.5–28.4	0.008*
Phlegm	15	28.3%	1	1.9%	20.53	2.6–434.4	0.000*
Chronic bronchitis	8	15.1%	1	1.9%	9.24	1.1–204.6	0.037*
Dyspnoea	14	26.4%	2	3.8%	9.15	1.8–62.1	0.003*
Asthma	1	1.9%	0	0.0%	Undefined	—	0.500**
Hay fever	3	5.7%	0	0.0%	Undefined	—	0.121**

† CI = Confidence interval

‡ Twenty-two had more than one symptom

\* Yates' corrected Chi square

\*\* Fisher's exact one-tailed test of probability

**Table 3.** Ventilatory capacity

Variable	Observed				Predicted				Significance of difference (p)*		
	Study group		Control group		Study group		Control group		SG/CG	SG/PSG	CG/PCG
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)			
FVC (litres)	1.84	(0.07)	1.94	(0.08)	2.09	(0.07)	2.10	(0.08)	0.240	0.063	0.520
FEV <sub>1.0</sub> (litres)	2.21	(0.06)	2.32	(0.06)	2.40	(0.06)	2.42	(0.06)	0.035	0.004	0.410
FEF <sub>25–75%</sub> (litres/sec)	2.02	(0.09)	2.42	(0.12)	2.50	(0.08)	2.51	(0.08)	0.006	0.000	0.620

\* SG = Study group; CG = Control group; PSG = Predicted values for the study group; PCG = Predicted values for the control group

**Table 4.** Grading of ventilatory capacity

	FVC (litres)				FEV <sub>1</sub> (litres)				FEF <sub>25-75%</sub> (litres/sec)			
	Study group		Control group		Study group		Control group		Study group		Control group	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Affected (< 80%)	9	(17.0%)	6	(11.3%)	15	(28.3%)	8	(15.1%)	33	(62.3%)	18	(34.0%)
Normal (≥ 80%)	44	(83.0%)	47	(88.7%)	38	(71.7%)	45	(84.9%)	20	(37.7%)	35	(66.0%)
Odds ratio	1.60				2.22				3.21			
Confidence interval	0.47–5.59				0.78–6.48				1.35–7.71			
Probability	0.557				0.137				0.006			

## DISCUSSION

This is a cross-sectional study where exposure and outcome are measured together at one point in time. Although such a study is conveniently carried out, it has the limitation of being unable to assess the temporal association.

The percentage of subjects with at least one respiratory symptom in the present series is higher than that of the blenders in the city of Colombo as reported by Urugoda<sup>4</sup> and Alwis<sup>8</sup> (36.8% and 39.1% respectively). The prevalence observed in the present series may be an overestimate. The subjects of SG were over-enthusiastic due to the fact that this was the first instance where a study of this nature had been conducted. This may have led them to exaggerate the symptoms. However the same circumstances applied to the control group. The interviewers were not blinded although they were trained to adopt the same format and the style of interview irrespective of the status of the group they interviewed. The technician who performed lung functions, however, was blind to the exposure status of the subjects.

Chronic bronchitis was reported to be higher in Urugoda's<sup>4</sup> study (24.8%) while Alwis<sup>8</sup> reported a lower prevalence (7.7%).

Smoking was not found to be significantly related to the decline in ventilatory capacity. Since there were only 12 smokers in the SG, the contributory effect may not have been large enough to show a significant decline. The prevalence of smoking did not differ in the two groups, and therefore the presence of a higher prevalence of chronic respiratory illness and a greater degree of ventilatory impairment in the study sample seems to point to tea dust as the causative agent.

Measurement of FEF<sub>25-75%</sub> denotes small airways function while FEV<sub>1.0</sub> indicates overall airways function including that of the larger airways. It appears from the results that there is a significant degree of small airways obstruction in the workers exposed to tea dust. This confirms the results observed by several other workers on exposure to tea dust.<sup>1-3</sup>

The actual mechanism as to how tea dust causes obstructive airways disease is not clear. The study of Zuskin *et al.*<sup>2</sup> did not demonstrate conclusive evidence to indicate an immunologic response behind the respiratory changes observed. A non-specific reaction to tea dust may also be a possible cause.

A main drawback in the study is its inability to highlight a dose-response relationship. From Table 1 it is evident that there is a significant difference in the number of workers with regard to the duration of service. This may be attributed to a tendency to leave the job with the onset and the persistence of the symptoms. The available data however is inadequate to arrive at firm conclusions as to whether there is in fact a higher turnover of employees owing to the prevalence of respiratory symptoms. It is remarkable that none of the workers in the present study had evidence of pulmonary tuberculosis even though Urugoda<sup>4</sup> reported that 5.6% of tea blenders had evidence of active or inactive tuberculosis.

With the knowledge from the literature it may be assumed that the results given here are consistent with the hypothesis that exposure to tea dust could lead to the development of respiratory symptoms and impairment of ventilatory capacity. Studies carried out in Sri Lanka so far indicate a definite effect of long term tea dust exposure on the respiratory system. Therefore it is important that preventive measures are adopted in order to protect the workers.

Most factories in Sri Lanka are not equipped with local exhaust ventilation although some general means of dust extraction may be available. Most workers are reluctant to use industrial masks which may provide added protection. Remedial measures such as the above may reduce the effects of exposure among the workers.

## CONCLUSIONS

The factory workers exposed to tea dust for a period of at least five years appear to be at risk of developing respiratory symptoms and ventilatory dysfunction. Therefore it is recommended that appropriate preventive measures be adopted in addition to educating the workers regarding the risks of tea dust exposure and the importance of correct usage of preventive measures.

## ACKNOWLEDGEMENTS

The guidance provided by the late Professor S. Balasuriya, the support by Dr D. Bandara of the Janatha Estate Development Board and the secretarial

assistance of Ms Padmini Angunawala, Priyani Jayawickrema and M. Sugathapala are gratefully acknowledged.

## REFERENCES

1. Castellan RM, Boehlecke BA, Petersen MR, Thedell TD, Merchant JA. Pulmonary function and symptoms in herbal tea workers. *Chest* 1981; 79: 81–85.
2. Zuskin E, Kanceljak B, Skuric Z, Ivankovic D. Immunological and respiratory changes in tea workers. *Int Arch Occup Environ Health* 1985; 56: 57–65.
3. Zuskin E, Skuric Z. Respiratory function in tea workers. *Br J Ind Med* 1984; 41: 88–93.
4. Uragoda CG. Respiratory disease in tea workers in Sri Lanka. *Thorax* 1980; 35: 114–117.
5. Uragoda CG. Tea maker's asthma. *Br J Ind Med* 1970; 27: 181–182.
6. Lewis J, Morgan WKC. Tea asthma: Response to specific and non-specific challenges. *Br J Ind Med* 1989; 46: 350–351.
7. Blanc PD, Trainor WD, Lim DT. Herbal tea asthma. *Br J Ind Med* 1986; 43: 137–138.
8. de Alwis WR. *Ventilatory Capacity of Workers Exposed to Tea Dust*. Thesis MD Community Medicine. Postgraduate Institute of Medicine, University of Colombo, Sri Lanka.
9. Medical Research Council definition and classification of chronic bronchitis. *Lancet* 1965; 1: 775.
10. American Thoracic Society. Standardization of spirometry — 1987 update. *Amer Rev Respir Dis* 1987; 136: 1285–1298.
11. Udupihille M. Respiratory function tests: Reference norms for the Sinhalese. *Ceylon Med J* 1995; 40: 53–58.