

Research Article

A study of pulmonary function test among tea garden factory workers in relation to exposure of tea dust

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ABSTRACT

Background: Tea is an indispensable beverage used worldwide and brewed from the tea plant *Camellia Sinensis*. Manufacture of black tea involves several labour intensive processes and the workers involved are exposed to hazards of inhaling fine tea dust. It has been found that fine tea dust contained fungi such as *Monilia*, *Aspergillus* as well as a peculiar streptococcus *Chromobacterium*. Inhalation of tea dust is known to give rise of both acute and chronic respiratory symptoms, as well as allergic reactions.

Methods: The present study is a comparative study among workers working in different sections of the tea factory. A total of 200 male subjects were taken, out of which 100 taken as study group and another 100 taken as control group. All subjects are in the age group of 20–40 yrs. and don't have any chronic respiratory illness. Pulmonary function tests (PFT) were carried out by using digital Spirometer (Medspiror) and results were recorded in a standard pro forma.

Results: The investigator is interested to test whether there were significant differences between parameters of PFT among the study and control group. For this purpose student t test has been applied and significant differences were found in all the parameters of PFT as $P < 0.01$.

Conclusions: Exposure to tea dust affects the lung volumes and flow rates, thereby causing increased prevalence of respiratory, allergic symptoms and significant degree of airway obstruction.

Keywords: Tea, Dust

INTRODUCTION

Tea is indigenous to India and is an area where country can take a lot of pride. In all aspects of tea production, consumption and export, India has emerged to be the world leader mainly because it accounts for 31% global production and engaging more than 1.1 million workers.¹

The state of Assam is the India's largest tea growing region contributes around 51% India's tea output and 15.6% world's tea production. It is the largest industry of the state providing employment to the thousands of people in the state. It is estimated that 12.5% of the total population depends on this industry.² Tea is brewed from the plant *Camellia Sinensis*.^{3, 4} Manufacture of black tea

involves several labour intensive processes namely withering, rolling, fermenting which are done in Wet section and drying, shifting and blending which are done in Dry section of the tea factory (Figure 1–5).

Shifting and blending which are done in dry section of the tea factory are the dustiest processes and the workers involved are exposed to the hazards of inhaling fine tea dust known as tea fluff.⁵ It has been found that tea fluff contained fungi such as *Monilia*, *Aspergillus* and *Penicillium* as well as peculiar streptococcus *Chromobacterium*.⁶

Inhalation of tea fluff as well as some size of tea dust is known to give rise of both acute and chronic respiratory

symptoms consist of burning sensation in the throat, nasal discharge and bleeding, irritation of eyes and headache.^{7,8} Chronic symptoms include byssinosis, chronic cough, phlegm and dyspnea.^{8,9} Allergic reactions such as nasal catarrh and occupational asthma characterized by high eosinophil count and IgE too have been reported.¹⁰⁻¹² Asthma has been described in a tea maker in Srilanka.¹⁰

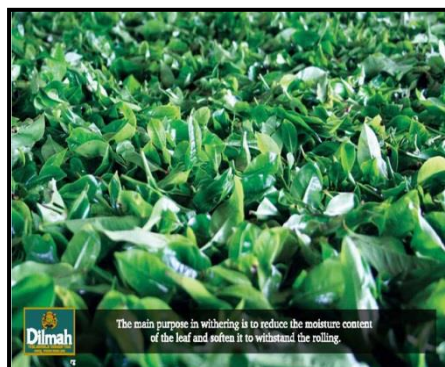


Figure 1: Withering.



Figure 2: Rolling.



Figure 3: Roll breaking.

Pulmonary function test

Pulmonary function tests are group of tests that measure how well the lungs take in and release air and how well they transfer oxygen into the body's circulation.^{13,14} It is the complete evaluation of the respiratory system including patients history, physical examinations, chest X ray examinations, arterial blood gas analysis and tests of

pulmonary functions. Pulmonary function testing has diagnostic and therapeutic roles and helps clinicians to have vital information about patients of lung disease.¹⁵

Pulmonary function tests are used for following reasons

- a) Screening for the presence of restrictive and obstructive lung disease
- b) Evaluating the patients prior to surgery
- c) Evaluating the patient's condition weaning from the ventilator
- d) Documenting the progression of pulmonary disease
- e) Documenting the effectiveness of therapeutic intervention

Thus pulmonary function tests are the powerful tools to measure different components of pulmonary functions and thereby help in diagnosing and quantifying respiratory diseases.



Figure 4: Fermenting.



Figure 5: Blending.

Occupational exposure plays a role in the onset of several respiratory diseases and the lung function deficits. Occupational lung diseases are the major work related illness. The lung function impairment is the most common occupational respiratory problem in the industrial plants especially in the welding, cement and wood industries.¹⁶⁻¹⁹

Respiratory symptoms among tea workers were first recognized 60 years ago, but since then reports on the subject have been scanty. Castellani and Chalmers working in Srilanka described two allied conditions

which they named tea factory cough and tea taster's disease.²⁰ In 1996 P L Jayawardana and M Udupihille carried out a cross sectional study of ventilatory capacity among tea garden factory workers in Srilanka who are exposed to tea dust for atleast five years. Results indicated that there was significant decrease in FEV1 and FEV25-75% in the study group comparing the control group who were not exposed to tea dust.²¹

Similar type of study was carried out in North Bengal by K C Sarkar and his colleagues, where they found that value of VC, FVC, FEV1, FEV1%, PEFR were significantly lower in factory workers than those in tea garden plantation workers.²²

Exposure to tea dust have been known to be associated with variety of adverse health effect which include irritation of eyes, allergic reactions, cough, bronchitis etc.^{7,8} Tea factory cough and tea taster's disease are two other occupational diseases associated with the tea industry. Ebihara described two patients who were considered to have allergic symptoms; headache, cough, expectoration, stridor, dyspnea and rhinitis which he thought were caused by cilia from tea leaves.²³

Respiratory symptoms among tea workers were first recognized 60 years ago, but since then reports on the subject have been scanty. So with this view on mind, the present study is designed to see whether workers in the tea factories exposed to tea dusts have an altered ventilatory function or not, with the following aims and objectives:

- a) To study the pulmonary function tests in tea garden factory workers working in two different sections of the tea factory i.e. Dry section and Wet section.
- b) To study the effect of exposure to tea dust in workers by comparing the measured values.

METHODS

The present study is a cross sectional study (comparative) which was conducted during the period from June 2012 to June 2013 on 200 male factory workers, working in different tea gardens in Assam. Only male workers were selected as the number of females, working within the tea factory was very low. Full authorized permission had been taken from factory management to conduct the work. Prior to conducting this study the subjects were carefully assessed and only the subjects who were cooperative were considered. History of every subject was taken and each was clinically examined as per the standard pro-forma.

A standard pro-forma was used to record particulars of the subject which included age, height, weight, smoking habits and history of any respiratory illness.

The study was conducted between 2.00pm – 4.00pm of the day to avoid the bias due to circadian rhythm.

Selection criteria:

Inclusion criteria:

Study group: 100 healthy male factory workers working in dry section of tea factory, exposed to tea dust for more than 1yr.

Duty hour: 8 hrs. /day

Age group: 20-40years

Control group:

Control group comprise of 100 male factory workers working in Wet section of the tea factory, which are not exposed to tea dust having experienced in working there for more than 1year.

Duty hour: 8hrs /day

Age group: 20-40years

Exclusion criteria;

Tea garden factory workers having history of smoking, respiratory symptoms or history of any known lung diseases like asthma, bronchitis, TB, emphysema etc., any known history of allergy, worm infestation, cardiac dysfunctions were excluded from the study.

Parameters recorded:

Age
Height
Weight
FVC
FEV1
FEV25-75%
PEFR

Equipment's used:

Weighing machine
Anthropometer
Medspiro
Mini Wright Peak Flow Meter

Recording of weight:

Weight was measured using a weighing machine. The machine was placed on a flat surface and before each measurement; pointer was corrected to zero mark. The subjects were wearing minimal necessary light clothing and were on bare feet while taking the reading. It was noted that the subjects looked straight ahead horizontally without looking down while their weight was recorded in kilograms.

Recording of height:

Height was recorded using the Anthropometer that consisted of a foldable, graduated (0-200) cm, vertical rod and a horizontal adjustable graduated bar (1-25 cm). The subject was made to stand against a wall on which a measuring scale was placed. The subject stood erect with bare feet on a flat floor against the wall with feet parallel with heels, buttocks, shoulders and occiput touching the vertical rod. The head was held erect with eyes aligned horizontally and ears vertically without any tilt. The horizontal bar which is at right angles to vertical rod was placed firmly on the head touching the top most point of the vertex. The height was then measured from the graduations of the vertical rod. It as measured in centimeters.

**Medspiror:**

FVC, FEV1, FEV25-75% was recorded using the Medspiror which is an electronic device for measurement of lung function parameters, the subjects were asked to close their nostrils and then to inhale as deeply as they can. The subjects then was asked to fix his lips on the mouthpiece of the Medspiror and was asked to blow out as forcibly and fast as he could into mouthpiece. He was instructed to make an airtight seal with his lips around the mouthpiece. Moreover a practical demonstration was done. This was however repeated 3-4 times before any attempt to record was done. So when the Medspiror was switched on and all parameters regarding the subjects name, age, sex, weight, height entered, the person was asked to perform as practiced and once he did so, the recording came out on the small screen of the machine and a graph and print of the record taken out by pressing the Print key of the machine (Fig. 6).



Figure 6: Performing PFT in factory.

Mini wright peak flow meter: Mini Wright Peak Flow Meter was used to measure PEF which is useful in the clinical assessment and management of conditions associated with increased airway resistance. The apparatus is small, simple, portable, easy to handle and the most commonly used instrument in the world over. It has following parts:

Mouthpiece
Body
Slot and Indicator
Scale (marking were in lit/min)

At first the maneuver was explained and demonstrated to the subjects. Each subject was given a few trial runs of at least two until he did procedure correctly. The subject thus, as he was demonstrated, inspired as deeply as possible and blew out into the Wright Peak Flow Meter as hard and rapidly as he could, keeping his nostril closed. Three readings were taken and the highest reading was accepted in each case. They were all examined in standing posture (Figure F).

During the procedure care was taken:

To see that the indicator on the peak flow meter was at the end of the scale (at zero position, nearest to the mouthpiece)

That no air escaped by the side of the mouth and nose during the procedure. For that reason the subject was asked to hold their breath for a moment after taking deep inspiration and immediately place the mouthpiece into the mouth and make an air tight seal by lips around the mouthpiece.

Every time the subject was changed, the mouthpiece was cleaned regularly in warm water to remove the accumulated foreign matter like mucus, dust etc.

Statistical analysis:

The significance of the difference of the mean was calculated by student t- test (unpaired t-test). The formula for student t- test is given by

$$t = \frac{M1 - M2}{\sqrt{\frac{SD1^2}{n1} + \frac{SD2^2}{n2}}}$$

Where,

M1= mean of the study group

M2= mean of the control group

SD1 = standard deviation of the study group

SD2 = standard deviation of the control group

n1 = number of subjects of the study group

n2 = number of subjects of the control group

FORMULA for mean and standard deviation are

$$\text{Mean (M)} = \frac{1}{n} \sum x$$

$$SD = \sqrt{\frac{1}{n} \sum (x - M)^2}$$

Where \sum =summation, x= individual values, n= no of objects.

After getting the values of t, that value is to be compared with the table value with (n1+n2-2); degrees of freedom at 0.01 and 0.05 were taken levels of significance. The table values of t for 100+100-2= 198, therefore degree of freedom are 1.97 and 2.60 at 0.05 and 0.01 respectively.

RESULTS

The present study comprised of 200 male tea factory workers. 100 of them working in dry section (exposed to tea dust), taken as Study group and rest 100 working in wet section (don't have exposure to tea dust) taken as Control group.

Table 1: Number of subjects in study group and control group.

Group	No.	%
Study	100	50%
Control	100	50%
Total	200	100%

Table 2: Mean distribution of demographic variables among the study group (n=100).

Variables	Mean	SD
Age (in years)	29.88	5.71
Height (in cm)	159.34	5.05
Weight(in kg)	58.51	2.96

Table 3: Mean distribution of demographic variables among the control group (n=100).

Variables	Mean	SD
Age (in years)	29.84	5.79
Height (in cm)	159.91	4.38
Weight(in kg)	58.61	2.81

Interpretation: On statistical analysis applying unpaired t test, the differences in anthropometric data (age, height

and weight) shown in Table 1, 2, and 3 has no significance difference between study and control group. This shows that the subjects in the study and the control group were properly matched in terms of age, height and weight.

Table 4: Mean distribution of different parameters of PFT among the Study group (n=100).

Parameters	Mean	SD
FVC(litres)	3.007	0.6398
FEV ₁ (litres)	2.51	0.7173
FEV _{25-75%} (litre/sec)	3.7021	0.2860
PEFR(litre/mint)	431.89	44.484

Table 5: Mean distribution of different parameters of PFT among the control group (n=100).

Parameters	Mean	SD
FVC(litres)	3.178	0.351
FEV ₁ (litres)	2.7929	0.341
FEV _{25-75%} (litre/sec)	3.92	0.396
PEFR(litre/mint)	454.71	61.131

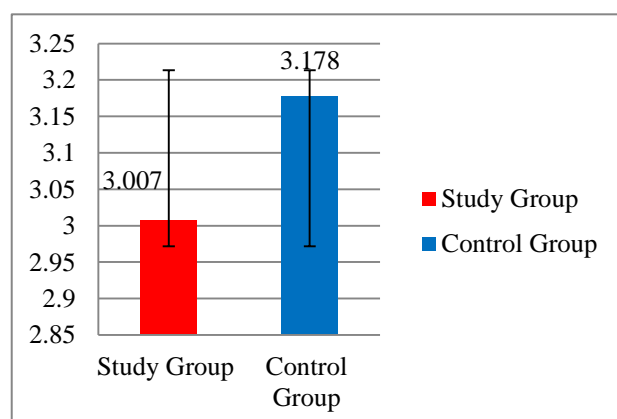


Figure 7: Graph showing the mean & SD values of FVC (liters) among the study & control groups.

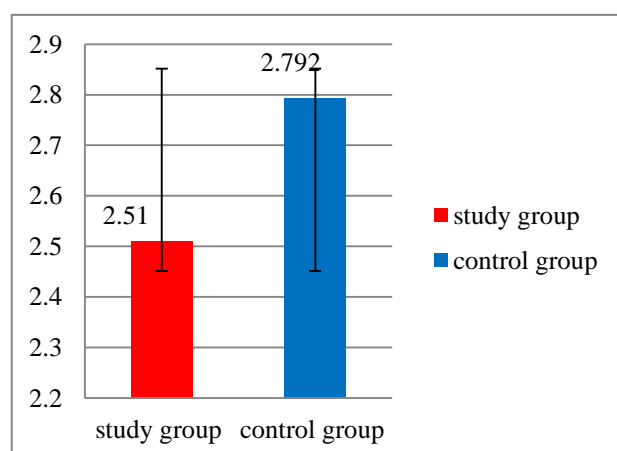


Figure 8: Graph showing the mean & SD values of FEV₁ (liters) among the study & control groups.

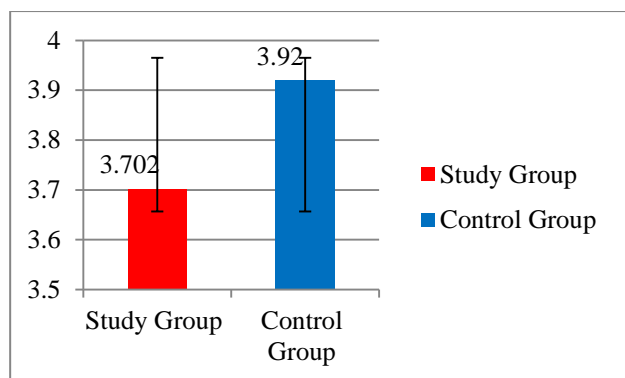


Figure 9: Graph showing the mean & SD values of FEV_{25-75%} (liter/sec) among the study & control groups.

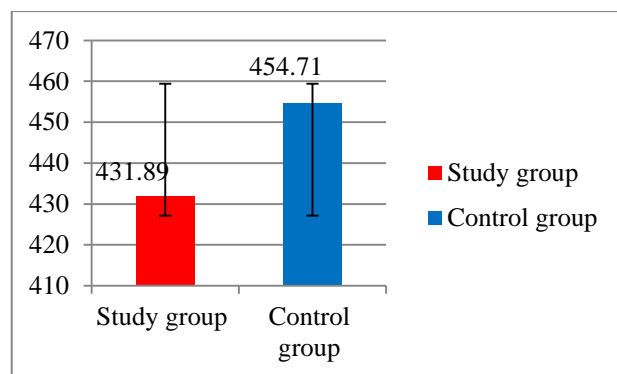


Figure 10: Graph showing the mean & SD values of PEFR (liter/mint) among the study & control groups.

Table 6: Mean distribution of different parameters of PFT among the Study and Control groups & their 't'-values.

Parameters	Study Group(n=100) Mean± SD	Control Group (n=100) Mean ± SD	Degrees of freedom (d.f.)	t-values	Significance
FVC(litres)	3.007 ± 0.6398	3.178 ± 0.351	198	2.435*	p<0.01
FEV ₁ (litres)	2.51 ± 0.7173	2.793 ± 0.341	198	3.562*	p<0.01
FEV _{25-75%} (Litre/Sec)	3.702 ± 0.2860	3.9212 ± 0.396	198	4.486*	p<0.01
PEFR(Litre/mint)	431.89 ± 44.485	454.71± 61.131	198	3.018*	p<0.01

*→ Significant (p<0.01)

Statistical significance

The investigator is interested to test whether there are significant differences between the different parameters of PFT among the study and control group. For this purpose, Student t-test has been adopted. The results are analysed in the following tables.

Interpretation: Table 6 has depicted the Mean and SD values of different parameters of PFT among the study and control groups. The mean values of all the parameters of Ventilatory Function i.e. FVC, FEV₁, FEV_{25-75%} and PEFR among the control group were found to be higher than that of the study group.

The 't'-test has been applied to test the statistical significance of the parameters between the two groups. Significant differences were found in all the parameters between the study and control groups as p<0.01.

DISCUSSION

From the above mentioned data found as a result of the study, it is observed that there is significant decreased in ventilatory function parameters FVC, FEV₁, FEV_{25-75%}, and PEFR values in dry section factory workers having chronic exposure to tea dust.

Eugenija Zuskin and Zdenka Skuric from the University of Yugoslavia (1984) carried out a similar study on respiratory function in five group of tea workers employed in processing different type of tea. As a result they found significant decline in ventilatory functions in workers exposed to tea dust.⁸

K C Sarkar, S Chakraborty, A K Mukherjee, A ROY, D S Mandal and K Samajdar of Department of Physiology of North Bengal Medical College conducted a study on 64 tea garden factory workers in West Bengal in March 2010. In the study they found the value of vital capacity, FVC, FEV₁, FEV_{25-75%}, PEFR were significantly lower in workers having chronic exposure to tea dust.²²

The actual mechanism as how tea dust causes airways disease is not clear, but evidence suggest that decline in ventilatory capacity that occurs after exposure to some dust is brought about by airway constriction due to the release of histamine in the bronchioles of the lung. A number of primary and secondary mediators of IgE mediated immunologic reactions have been identified. Histamine and Bradykinin have profound effect on the microvascular, causing vasodilation and increase vascular permeability. Increased histamine and bradykinin cause smooth muscle to contract and could cause mucosal edema and hypersecretion of bronchial muscle resulting increase airway resistance and decrease lung compliance.

CONCLUSION

Occupational exposure plays a role in the onset of several respiratory diseases and lung function deficits. Occupational lung diseases are the major work related illness. The lung function impairment is the most common occupational respiratory problem in the industrial plant. The present study was conducted among male tea garden factory workers to evaluate the effect of tea dust on human, to see whether tea dust is allergen or not and emphasize the importance of occupational hygiene practice to reduce the dust level in the factories.

In the study it was seen that the ventilatory functions of the dry section factory workers were lower than that of wet section factory workers.

In the course of this study, it came to light the fact that, studies on tea garden factory worker are very few. The present study was conducted among tea garden factory workers of different tea gardens of Assam. The results of the study cannot be taken as representative of characteristics of a region as the values are likely to vary from place to place and region to region. The findings of the present study, therefore, should be considered as preliminary and this calls for further detailed study and statistical analysis with a large sample size.

Hence we can conclude that tea dust particle can be hazardous for human. The factory workers having chronic exposure to tea dust for at least more than 1yr may appear to be at risk of developing allergic symptoms and ventilatory dysfunctions. Therefore it is recommended that the appropriate measures be adopted in factories in addition to educating the workers regarding the risk of tea dust exposure and the importance of correct usage of preventive measures like using mask, exhaust fan etc. in the factories. Studies shows that most of the people working in the factories are illiterate and unaware about the preventive measures to be taken in the factories. Assam being famous for tea production, such studies would help in assessing the health status of the workers and take remedial or preventive measures as needed, thereby helping to ensure a healthy environment for the workers for whom the factories are buzzing with life. As the number of studies on the tea dust is very few, it is hoped that present study will help in further studies on tea dust exposure.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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