

# Chronic Exposure to Dust and Lung Function Impairment: A Study on Female Sweepers in India

S Smilee Johncy<sup>1</sup>, G Dhanyakumar<sup>1</sup>, Kanyakumari<sup>1</sup>, T Vivian Samuel<sup>2</sup>

<sup>1</sup> Department of Physiology, JJM Medical College, Davangere, Karnataka, India

<sup>2</sup> Department of Biochemistry, JJM Medical College, Davangere, Karnataka, India

**Correspondence to:**

S Smilee Johncy  
(smileevivian@yahoo.co.in)

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## ABSTRACT

**Background:** Sweeping of streets, a poor man's occupation is a simple and humble job. Street sweeping with short handled brooms without precautionary measures affect the respiratory system.

**Aims & Objective:** The main objective of this study was to assess the pulmonary functions and also the relationship between the duration of exposure to dust and lung function parameters in female sweepers.

**Materials and Methods:** Thirty female sweepers and thirty healthy females were included in this study. The subjects were matched for age, height and weight. The pulmonary function test was performed by using computerized RMS medspiror and results were compared by students unpaired 't' test. The overall mean pulmonary function data were also correlated with the duration of exposure using linear regression.

**Results:** The study showed a statistically significant reduction in FVC, FEV<sub>1</sub>, PEFr, FEF<sub>25-75%</sub> and FEF<sub>200-1200</sub> and this impairment was increased with duration of exposure to dust in sweepers.

**Conclusion:** Our study showed a positive relationship between the extent of exposure to street dust and decreasing lung function. It is suggested that protective measures, such as long brooms and appropriate respiratory protective equipment, should be provided to workers engaged in sweeping; the workers should undergo periodic spirometry tests.

**Key Words:** Pulmonary Function Test; FVC; FEV<sub>1</sub>; PEFr; Sweepers

## INTRODUCTION

Street sweeping is one of the popular occupations of the less privileged. To maintain the cleanliness of the roads and streets in the cities, sweepers, mostly women, are engaged in this job in India.<sup>[1]</sup> Sweepers are exposed to dust while cleaning the streets and roads. The dust raised by street sweeping consists of a complex mixture of soil, sand particles, dust, motor vehicle tear and wear particles, bioaerosols, plant particles etc.<sup>[2]</sup> Exposure to these dusts irritate the respiratory tract leading to varying degrees of respiratory symptoms and airway obstruction.<sup>[3]</sup> Tiny particulates that migrate far into the respiratory system are generally beyond the body's natural cleaning mechanisms such as mucociliary clearance and are likely to be retained.<sup>[4]</sup> Inhalation of foreign materials can cause the lungs to react in wide variety of ways, irritating the airways, exacerbating the conditions such as asthma and setting up an inflammatory reaction and fibrosis.<sup>[5]</sup> Several studies have reported an increase in occupational lung diseases in women especially occupational asthma and airway diseases.<sup>[6]</sup> This may be due to increasing participation by women in occupations which were previously predominantly male. There is also evidence that airway deposition of aerosol in women's larger airways is more when compared to men and that women may be more susceptible to developing chronic bronchitis, though this potential to increased susceptibility has not been assessed in relation to work exposures.<sup>[6]</sup> Developed countries follow certain standards and norms for the management of dust control which have substantially reduced these occupational health impacts.<sup>[7]</sup> Although developed countries take measures to prevent the occupational health hazards it is not the case in the developing countries like India. In India sweepers use only short handled brooms for sweeping. They do not observe any precautionary measures like wearing of facemasks or watering the streets before sweeping to minimize the raising of dust. Any person's airflow resistance and changes in the airways have been shown to be reversible and it has therefore been suggested that if the

abnormalities are detected early and if further exposure to the responsible agent is avoided irreversible diseases may be avoided. Although the harmful effects of inhalation of airborne dust have been known, no earlier study was done on the lung function in female sweepers in India. Hence this study was undertaken to assess the pulmonary functions and also the relationship between the duration of exposure to dust and lung function parameters in female sweepers.

## MATERIALS AND METHODS

30 female sweepers by profession and age matched 30 healthy females were selected for the study. A brief history was taken and clinical examination of the respiratory system and other systems were done to exclude medical problems and to prevent confounding of results. Informed consent was obtained after explaining the procedure. Subjects with history of acute or chronic respiratory infections, tuberculosis, cardiovascular diseases, diabetes, hypertension, abdominal or chest surgery were excluded from the study.

Pulmonary function test was carried out on computerized RMS medspiror. To minimize the confounding results due to diurnal variation tests were carried out at in the forenoon session and tests were done in accordance to the official statement of the American Thoracic Society of Standardization of Spirometry. Proper instruction was given to the subjects about the procedure and they were motivated too. The tests were performed in the sitting position. On feeding the necessary anthropometric data, the software from the recorder and Medicare system which is loaded to the computer, computes the predicted value and also gives the actual value and the percentage predicted value for the individual. The tests were repeated three times after adequate rest. The parameters were Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV<sub>1</sub>), Forced Expiratory ratio (FEV<sub>1</sub>/FVC%), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow (FEF<sub>25-75%</sub>), Forced Expiratory Flow (FEF<sub>200-1200</sub>).<sup>[8]</sup>

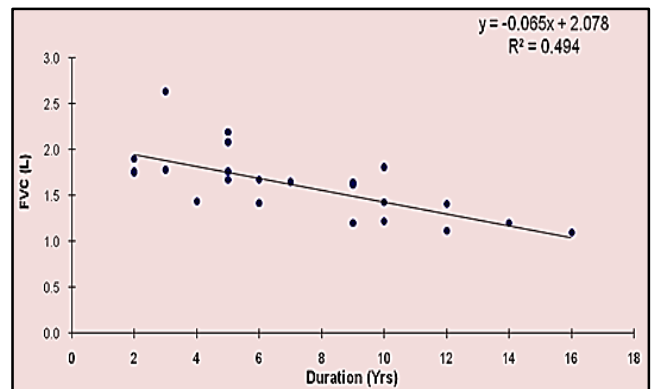
**Statistical Analysis**

Data was subjected for analysis using students unpaired 't'-test (two-tailed) for comparison between the groups. p value of 0.05 or less was taken as significant. Correlation between the various lung function parameters and the duration of exposure was evaluated using simple linear regression applying equation  $y = bx + c$ , derived with the correlation coefficient(r), where "y" means spirometric value, b is the slope, "x" indicates years of exposure and "c" is the intercept, that is the value of y when x is 0. The R<sup>2</sup> value determined the level of the correlation significance.

**RESULTS**

Table 1 depicts the comparison of the anthropometric parameters between the sweepers and their matched control subjects and expressed as mean ±SD. There was no significant difference in terms of age, height and weight between the groups. The mean values of the lung function parameters of sweepers and their matched controls are also shown in Table 2. The values of FVC, FEV<sub>1</sub>, PEFR and FEF<sub>200-1200</sub> were significantly decreased (p < 0.01) in sweepers as compared with their matched controls. P value of

FEF<sub>25-75%</sub> was highly significant (p < 0.001). FEV<sub>1</sub>/FVC% was increased slightly, but it is not statistically significant. The mean duration of exposure to dust in sweepers was 7.5 ± 4.1 years. (Range 2-16 years). Correlation between mean pulmonary function data of the sweepers against the duration of exposure to dust was done using Regression analyses (Table 2). Negative correlation for the r values were found for FVC (p < 0.001), FEV<sub>1</sub> (p < 0.01), PEFR (p < 0.001) and FEF<sub>25-75%</sub> (p < 0.001), FEF<sub>200-1200</sub> (p < 0.001), as shown in Figures 1, 2, 3, 4, 5 which was statistically significant indicating that the increased duration of exposure to dust decreases the lung function.



**Figure-1: Regression Analysis of FVC against the Duration of Exposure to Dust in Sweepers**

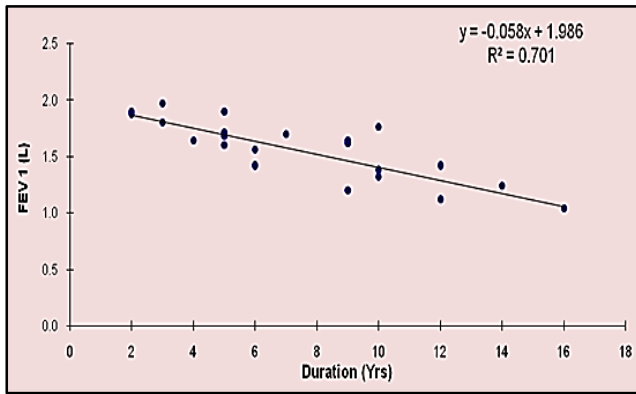
**Table-1: Comparison of Lung Function Parameters between Sweepers and Controls**

Parameters	Sweepers (n =30)	Controls (n =30)	Percentage Difference (%)	Significance	
	Mean ± SD	Mean ± SD		t-value	p-value
Age (yrs)	39.7 ± 8.2	40.0 ± 12.9	-0.75	0.12	0.91 NS
Height (m)	1.49 ± 0.06	1.50 ± 0.1	-0.66	0.0009	0.99 NS
Weight (Kg)	52.62 ± 10.54	54.1 ± 6.1	-2.73	0.49	0.62 NS
BMI	23.43 ± 4.16	22.58 ± 2.74	3.74	0.91	0.37 NS
FVC (L)	1.60 ± 0.37	1.88 ± 0.30	-14.89	3.22	0.002 S
FEV <sub>1</sub> (L)	1.56 ± 0.28	1.76 ± 0.31	-15.34	2.81	0.007 S
FEV <sub>1</sub> / FVC(%)	98.60 ± 12.99	98.28 ± 4.25	0.35	0.46	0.65 NS
PEFR (L/S)	4.30 ± 0.68	5.23 ± 0.91	-17.78	3.09	0.003 S
FEF <sub>25-75%</sub> (L/S)	2.66 ± 0.67	3.32 ± 0.63	-20.18	9.42	< 0.001HS
FEF <sub>200-1200</sub> (L/S)	2.96 ± 0.80	3.80 ± 0.88	-22.10	2.66	0.011 S

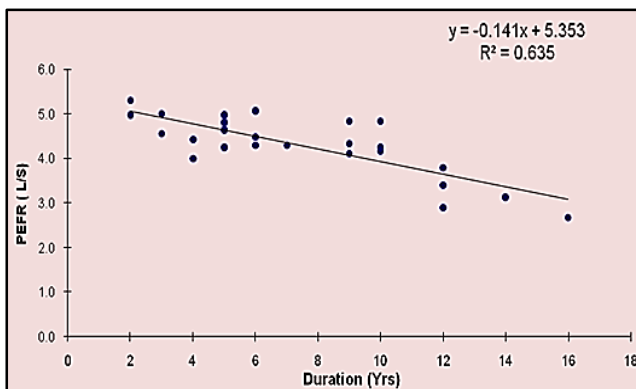
p > 0.05: Not significant (NS); p < 0.05: Significant (S); p < 0.001 Highly Significant (HS)

**Table -2: Correlation and Regression Analysis between Lung Function Parameters and Duration of Exposure**

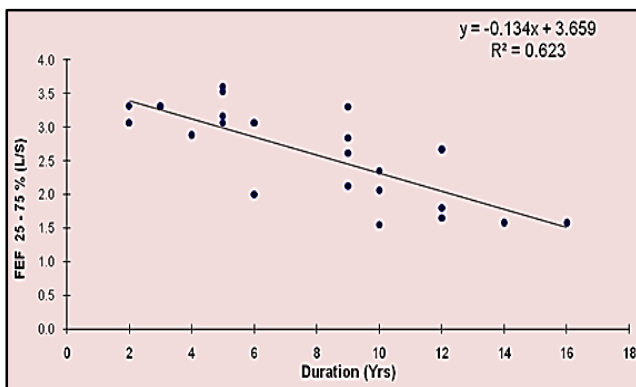
Relationship	Correlation co-efficient (r)	Regression co-efficient (b)	p value	Regression equation (prediction of Lung function for duration)	R <sup>2</sup>
Duration & FVC	-0.70	-0.07	<0.001HS	FVC = -0.07 (Dur) +2.08	0.49
Duration & FEV <sub>1</sub>	-0.83	-0.06	<0.001HS	FEV <sub>1</sub> = -0.06 (Dur) + 1.99	0.70
Duration&FEV <sub>1</sub> /FVC%	0.05	0.17	0.70 NS	FEV <sub>1</sub> / FVC% = +0.17 (Dur) +97.33	0.01
Duration &PEFR	-0.80	-0.14	<0.001HS	PEFR = -0.14 (Dur) + 5.35	0.64
Duration &FEF <sub>25-75%</sub>	-0.79	-0.13	<0.001HS	FEF <sub>25-75%</sub> = -0.13 (Dur) + 3.66	0.62
Duration &FEF <sub>200-1200</sub>	-0.83	- 0.17	<0.001HS	FEF <sub>200-1200</sub> = - 0.17+ 4.20	0.68



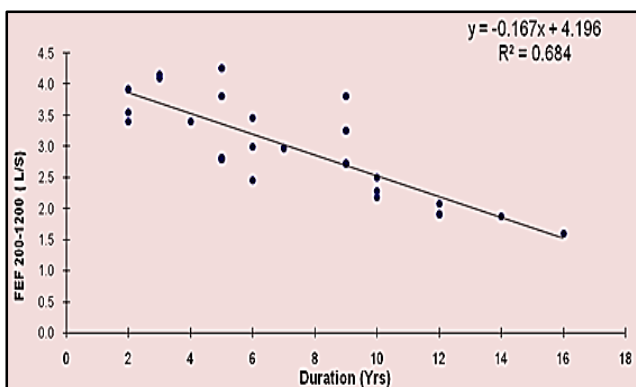
**Figure-2: Regression Analysis of FEV<sub>1</sub> against the Duration of Exposure to Dust in Sweepers**



**Figure-3: Regression Analysis of PEFR against the Duration of Exposure to Dust in Sweepers**



**Figure-4: Regression Analysis of FEF<sub>25-75%</sub> against the Duration of Exposure to Dust in Sweepers**



**Figure-5: Regression Analysis of FEF<sub>200-1200</sub> against the Duration of Exposure to Dust in Sweepers**

## DISCUSSION

In our environment, street sweeping with brooms without precautionary measures will affect the respiratory system.<sup>[1]</sup> There is increase in occupational lung disease in women sweepers as participation of women as sweepers is more in India.<sup>[7]</sup> The present work specifically focuses on how the occupational environment affects women's respiratory health. We have analyzed the relationship between the pulmonary function impairment and the duration of exposure to dust in female sweepers.

It has been established from various reports that anthropometric parameters, such as age, sex, height, weight and ethnicity are factors that account for variations in FVC, FEV<sub>1</sub> and PEFR.<sup>[9]</sup> These factors were taken into consideration in the present study. The test group and the controls had mean values of anthropometric parameters that were not significantly different. The results of the present study showed a significant reduction in the mean values of FVC, FEV<sub>1</sub>, PEFR, FEF<sub>25-75%</sub> and FEF<sub>200-1200</sub> in sweepers as compared with their matched controls, as well as directly proportional impairment of their lung function parameters to the duration of exposure. But the FEV<sub>1</sub>/FVC% was not significant statistically. In addition, the percentage change for FVC (-14.89), FEV<sub>1</sub> (-15.34), FEV<sub>1</sub>/FVC% (0.35), PEFR (-17.78), FEF<sub>25-75%</sub> (-20.18), FEF<sub>200-1200</sub> (-22.10) were also noted.

A cross sectional study on the respiratory morbidity among street sweepers revealed that the risk of having chronic respiratory morbidity among street sweepers was 4.24 times higher than that in the comparison group and the risk increased significantly with increasing length of service. The chronic respiratory morbidity included chronic bronchitis, asthma and bronchiectasis.<sup>[3]</sup> The effect of dust on lung function in loaders and drivers was compared with sweepers in a study at Chennai and it was found that pulmonary functions were significantly low in sweepers compared with loaders and drivers. Female workers had significant lower PFT values when compared with men.<sup>[10]</sup> A study on lung function among street sweepers in Nigeria

reported that the lung function parameters were lower than in their control group and a gradual deterioration of the lung function of the subjects was observed with chronic exposure. This highlights the significance of the length of exposure to dust and lung function impairment.<sup>[11]</sup> A study of traffic related ambient concentrations of air pollution as a risk factor in the work environment of a group of street cleaners in Copenhagen emphasized that traffic related air pollution is an occupational health hazard to individuals who perform physical labor close to traffic.<sup>[12]</sup> A study on lung function of street sweepers in Bangkok Metropolis, showed that the mean values of FVC, FEV<sub>1</sub> and FEV<sub>1</sub>/FVC% of the street sweepers were significantly lower than the predicted values. It was also found that the number of years of employment affects the abnormalities in FVC, FEV<sub>1</sub> and FEF<sub>25-75%</sub>.<sup>[13]</sup>

The findings of our study revealed that dust that arises during street sweeping adversely decreases the pulmonary function parameters like FVC, FEV<sub>1</sub>, PEF<sub>R</sub>, FEF<sub>25-75%</sub>, FEF<sub>200-1200</sub> in the sweepers and increases FEV<sub>1</sub>/FVC% causing both obstructive and restrictive pattern of lung function impairment which is related with the years of exposure to dust. Sweepers showed a significant decrease in the FEF<sub>25-75%</sub> which indicates a small airway obstruction. The above findings strongly show positive relationship between the extent of exposure to street dust and decreasing lung function. Our study was limited to the female subjects in view of the fact that the majority of street cleaning workers are women in India.

## CONCLUSION

The occupation related lung diseases in sweepers are most likely due to the deposition of harmful airborne dust particles that are inhaled during sweeping. If the abnormalities are detected early and if further exposure to dust is avoided irreversible diseases may be avoided. The following precautions are recommended to reduce the dust exposure during sweeping. Instead of using short handled brooms, work force may be advised to use long handled brooms which will reduce the amount and direct exposure to dust. The use of respiratory protection like face mask is

the most widely used preventive measure which reduces airborne dust entry into lung during sweeping. Workers may be limited to three or four days of sweeping per week. Watering the street prior to sweeping will considerably reduce the dust.

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