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Original Research Article

Comparison of pulmonary function test between exposed and non-exposed non-smoker adult males to indoor air pollutants: An observational and cross-sectional study in different offices of North India

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ABSTRACT

Background: This study was planned to evaluate and compare the effect of indoor air pollutants on the pulmonary function testing of office workers (Safai Sewaks). We hypothesize that acute exposure to dust and other indoor pollutants daily during their job would lead to deterioration of their lung function more than anyone who is exposed to these indoor pollutants intermittently.
Materials and Methods: An observational and cross-sectional study comparing the pulmonary function parameters FEV_1, FVC and PEFR between 100 Safai Sewaks and 100 controls matched for age, weight, height and body surface area. Study participants included were adult males between 18-45 years age and non-smoker.
Results: The actual values of FEV_1, FVC and PEFR were compared in both the groups. FEV1 was significantly lower in Safai Sewaks (2.2350 $\pm$ 0.61072 L; p<0.01) as compared to the controls (2.5606 $\pm$ 0.64785 L). FVC was also significantly lower in Safai Sewaks (2.382 $\pm$ 0.7007 L; p<0.01) as compared to the controls (2.790 $\pm$ 0.76955 L). PEFR, which is a good indicator of the expiratory effort was also lower in Safai Sewaks (6.033 $\pm$ 1.9170 L/min; p<0.01) as compared to the controls (7.558 $\pm$ 4.7082 L/min).
Conclusion: Respiratory function as assessed by FEV_1, FVC and PEFR is reduced in Safai Sewaks as compared to the controls due to indoor air pollution and exposure to dust associated with their daily job.

1. Introduction

Most people are aware that outdoor air pollution can damage their health but may not know that indoor air pollution can also have significant effects. Indoor air pollution is the degradation of indoor air quality by harmful chemicals and other materials which can be up to 10 times worse than outdoor air pollution, as contained areas enable potential pollutants to build up more than open spaces.[1]

These levels of indoor air pollutants are of particular concern because it is estimated that most people now-a-days spend considerable amount of their time indoors.

Occupational exposures to dust are associated with increased prevalence of respiratory symptoms and impairment of lung functions.[2] The dust particles are composed of very small solid or liquid substances that are light enough to float in the air and also lay on the household/Office surfaces. When we see a shaft of sunlight, we can see dust particles suspended in the air, out of these the large particulates will settle out onto the surfaces in the room and disturbing these particles while cleaning and sweeping causes them to be airborne. Though these may not penetrate deep into the lungs through breath but can cause allergic reactions and other health problems like reduced lung functions and obstructed airways Smaller particulates are not visible to the naked eye and some of these stay suspended indefinitely but can penetrate deep into the lungs where they stay for a long time and cause acute or chronic illnesses.[3]

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Office workers (Safai Sewaks) which do routine cleaning in the offices like dusting, sweeping is exposed to these indoor air pollutants more than anyone else as they get exposed to these pollutants before they settle down on various surfaces during their daily job.

We planned the current study to evaluate the effect of indoor air pollutants on the pulmonary function testing of office workers (Safai Sewaks). We hypothesize that acute exposure to dust and other indoor pollutants daily during their job would lead to deterioration of their lung function more than anyone who is exposed to these indoor pollutants intermittently.

2. Materials and Methods

The present study had been conducted in the various offices of Patiala, Punjab. We planned to include 100 Male Safai Sewaks who were non-smoking, in the age group of 18-45 years working in the various offices of Patiala and whose job was to clean and sweep office on a daily basis and 100 controls working in the same offices but doing work other than cleaning and sweeping.

Exclusion criteria were any history of exertional dyspnea, cardiorespiratory disorder, existing sinusitis, malnutrition, obesity (BMI>30Kg/m^2), anemia or smoking.

Pulmonary Function Testing was performed using a spirometer (MEDSPIROR, Recorder and Medicare Systems India). The spirometer gives two values, one is actual and the other is expected. The Medspiror software calculates the expected values for adults, using the following set of prediction equations:

FVC (L) (0.05 $\times$ H) – (0.014 $\times$ A) – (4.49) (1)

FEV1 (L) (0.04 $\times$ H) – (0.021 $\times$ A) – (3.13) (2)

PEFR (L/s) (0.071 $\times$ H) – (0.035 $\times$ A) – (1.82) (3)

Where,

H = height in cm.

A = age in years.

FVC = forced vital capacity, that is, the maximum amount of air that can be exhaled following a maximal inspiratory effort.

FEV_1. forced expiratory volume in one second, that is, the volume of air exhaled in the first second during a forced vital capacity effort.

PEFR = peak expiratory flow rate, that is, the maximum amount of air exhaled with forced effort during FVC.

The pulmonary function test was carried out in the afternoon hours. The actual values of FVC, FEV_1, and PEFR are based on the maximal inspiration and expiration of the subjects. The tests were conducted in standing position. Regular sterilization of the mouthpieces was done before each use. The subjects were asked to do maximum inspiration followed by maximal expiration. Three such tests were performed and the best of the three performances was considered.[4]

Before performing the pulmonary function tests, the following measurements were taken: -

1. Pulmonary functions tests were carried out in standing posture
2. Height was measured in centimeters in standing upright position without shoes
3. Weight was measured in kilograms
4. After measuring height and weight, the body surface area was read from 'Nomogram' Dubois and Dubois.

Formula for Body Surface Area (B.S.A)

B.S.A (in sq. meters) = 0.007007184 X [wt. (in Kgs.)]$^{0.425}$ X [ht. (in cms)]$^{0.725}$

A written informed consent to participate in the study was taken from all the participants. They could withdraw from the study at any time if they wish to not to participate in the study. The procedures followed were in accordance with the ethical standards of the institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

2.1. Statistical considerations

The data was processed for mean and standard deviation. It comprises FVC, FEV_1, and PEFR. Age, height and weight were the independent variables, whereas spirometric parameters were the dependent variables. These were treated as categorical variables. The statistical analysis was carried out with SPSS PC software version 14.0. The data was analysed using independent t-test.

3. Results

The present study was carried out at different offices of Distt. Patiala, Punjab India. It was an observational, cross-sectional and comparative study. 110 office workers (Safai Sewak) were selected to undergo the Pulmonary Function Testing but 10 were excluded because they could not co-operate during the procedure. This study finally included 100 Male Safai-Sewaks who were non-smoking, in the age group of 18-45 Years working in the various offices of Patiala, whose job was to clean and sweep the offices on a daily basis. 130 subjects working in the same offices but doing work other than cleaning and sweeping were taken as controls. 30 controls were excluded because they could not co-operate during the procedure. Finally, 100 controls were included in the study. All Controls were also males.

The average age, height, weight and body surface area of Safai Sewaks and controls was shown in Table 1. Both the groups were comparable in all these parameters.

Table 2 shows the results of the Pulmonary Function Tests (PFT's) inSafai Sewaks and Controls. The actual values of FEV_1, FVC and PEFR were compared in both the groups. FEV_1 was significantly lower in Safai Sewaks

Table 1: Anthropometric Data ofSafai Sewaks (n=100) and Controls (N=100)

Parameters	Safai-Sewaks Mean ± SD	Control Mean± SD	t value	p value
Age (yrs)	38.63 ± 7.477	37.08 ± 7.511	1.46	>0.05
Height (cm)	167.02 ± 6.915	168.47 ± 6.004	-1.59	>0.05
Weight (Kg)	67.82 ± 11.058	69.15 ± 12.340	-0.80	>0.05
BSA (m^2)	1.7584 ± 0.15064	1.7831 ± 0.15682	-1.13	>0.05

Table 2: Comparison ofspirometric parameters among Safai Sewaks (n=100) and Controls (n=100)

Parameters	Safai-Sewaks Mean ± SD	Control Mean± SD	t value	p value
FVC (L)	2.382 ± 0.7007	2.790 ± 0.76955	-3.92	<0.01
FEV_1(L)	2.2350 ± 0.61072	2.5606 ± 0.64785	-3.66	<0.01
PEFR (L/min)	6.033 ± 1.9170	7.558 ± 4.7082	-2.99	<0.01

(2.2350 ± 0.61072 L; p<0.01) as compared to the controls (2.5606 ± 0.64785 L). FVC was also significantly lower in Safai Sewaks (2.382 ± 0.7007 L; p<0.01) as compared to the controls (2.790 ± 0.76955 L). PEFR, which is a good indicator of the expiratory effort was also lower in Safai Sewaks (6.033 ± 1.9170 L/min; p<0.01) as compared to the controls (7.558 ± 4.7082 L/min).

Table 3 shows that the values of FVC, FEV_1 and PEFR were significantly lower in Safai Sewaks exposed to the indoor dust for more than 20 years as compared to the workers exposed for less than 10 years or 10 to 20 years. (p<0.01)

4. Discussion

Results of this study showed that respiratory function as assessed by FEV1, FVC and PEFR was reduced in Safai Sewaks as compared to the controls. This indicates that indoor air pollution and exposure to dust associated with their daily job, may lead to deterioration of their lung function. Duration of exposure plays an important role in impairing the lung functions in Safai Sewaks. We found that exposure of more than 20 years leads to significant impairments of lung function of Safai Sewaks as compared to exposure less than 20 years.

Dust exposure as part of daily job has been shown to deteriorate lung function in street workers.[2] Obstructive and restrictive lung disease were more common in hospital cleaners in Ethiopia as compared to controls.[5] In Indian female sweepers also, dust exposure has been shown to deteriorate lung function.[3] Though most of these studies focused on outside air pollution and effect on lung function, our study showed the effect of indoor dust exposure on deterioration of lung function in office Safai Sewaks.

Studies have shown that chronic exposure of more than 20 years to indoor biomass pollution leads to impairment of lung functions.[6] Short term exposure to indoor air pollution has also been shown to impair lung function in children.[7] Exposure to cotton dust for more than 1yr has been shown to deteriorate lung function in Indian mill workers.[8] Our study also shows similar results for Safai Sewaks exposed to indoor dust for more than 20 years.

All the Safai Sewaks included in our study did not use any protective gear like masks covering their nose and mouth during cleaning and dusting.

Safai-Sewaks and the management staff should be educated on the potential health effects of indoor dust and air pollutants and should be advised about safety measures to decrease the effect of indoor dust exposure while cleaning and sweeping.

We would like to give some recommendations regarding the implementation of occupational hygiene and use of personal protection equipment.

1. Face masks while at workshould be regularly used by Safai Sewaks. Studies have shown that proper fitting masks in workers exposed to dust prevents deterioration of lung function.[9,10]
2. Use of mop instead of broom dusting will decrease the dispersion of pollutant particles into the air.
3. If possible, use modern gadgets like vacuum cleaners to decrease the burden of dust particles in the indoor air while cleaning and sweeping.
4. Installation of electrostatic air cleaners in the offices can constantly remove the dust particles from the room, thus reducing the total load of the pollutants from the working environment.
5. Ion generators cause the particulate matter to have an electronic charge and cause them to be attracted to walls, floors etc. in the room, thus decreasing the suspended particulate matter load indoors.
6. Use mechanical air filters which can capture particulate matter by utilizing a filter media
7. Safai Sewaks should have periodic clinical and spirometric evaluation. Regular 3-6 monthly check-up should be done to check the initiation or progression of respiratory disease due to the adverse effects of occupational exposure of dust. Persons prone to

Table 3: Duration of indoor dust exposure inSafai Sewaks and effect on spirometric values

Parameters	Duration of Exposure			p Value
	<10yrs	10-20yrs	>20yrs	
FVC (L)	2.75±0.57	2.66±0.65	1.85±0.56	<0.001*
FEV_1 (L)	2.56±0.57	2.41±0.57	1.75±0.51	<0.001**
PEFR (L/min)	6.74±1.29	6.47±1.90	4.96±1.91	<0.001***

*FVC <10 & 10-20yrs versus >20yrs; **FEV_1 <10 & 10-20yrs versus >20yrs; ***PEFR <10 & 10-20yrs versus >20yrs

respiratory diseases due to their sensitivity to dust particles should be deputed to some other section where the exposure rates are less.

Our study had some limitations as well. We included only male workers since most of the Safai Sewaks employed in the offices were males. But we expect that lung function will deteriorate in female Safai Sewaks doing indoor cleaning and sweeping as well as has been shown in outside female cleaners.[3] We cannot establish the causality since it was a cross sectional study only. But since we excluded anyone with cardiorespiratory disease in our study, it can be assumed that deterioration of lung function was due to occupational exposure to indoor dust during sweeping and cleaning.

Recently it has been shown that high concentrations of indoor PM_{10} in the bedroom environment lead to increased severity of Obstructive Sleep Apnea (OSA).[11] This may be due to the PM_{10} particles causing inflammation in the upper airway. Outside air pollution has also been shown to increase the severity of OSA.[12,13] It will be interesting to see in future studies whether daytime indoor dust pollution in offices has any influence on OSA severity.

5. Conclusion

Respiratory function as assessed by FEV_1, FVC and PEFR was reduced in Safai Sewaks as compared to the controls due to indoor air pollution and exposure to dust associated with their daily job. We hope our recommendations would help to decrease the exposure to Safai Sewaks of indoor dust exposure during cleaning and sweeping there by improving their lung function in the long run.

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7. Conflict of Interest

The authors declare they have no conflict of interest.

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