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RESEARCH ARTICLE

Clinical evaluation of pulmonary functions among the non-smoking municipal street cleaners and healthy volunteers

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ABSTRACT

Background: In developed countries, street cleaning is done with the help of mechanical assets and precautionary measures. Hence, it has been found to have a lesser incidence of respiratory diseases. However, in developing countries like India, 90% of street cleaning is done manually. The prolonged inhalations of foreign particles stimulate inflammatory reactions which lead to obstructive pulmonary diseases. Hence, it could be considered as one of the major occupational hazards in India. **Aims and Objectives:** The objectives of the study were to measure the values of functional vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC, forced expiratory flow (FEF) 25–75%, and peak expiratory flow rate (PEFR) in municipal street cleaners and healthy volunteers and compare the clinical evaluation of respiratory functions of both the groups using the appropriate statistical tool. **Materials and Methods:** In this study, 100 subjects were taken and they are divided into two groups: 50 individuals of street cleaners and 50 healthy volunteers. Clinical examination of the respiratory system of municipal street cleaners and healthy volunteers of the same locality and measures the values of FVC, FEV1, FEV1/FVC, FEF 25–75%, and PEFR in both the groups. Statistical analyses were done using the unpaired *t*-test. **Results:** The results of the pulmonary function test (FVC, FEV1, FEV1/FVC, FEF 25–75%, and PEFR) showed that the values were significantly reduced in street cleaners when compared with the healthy volunteers. The values were statistically significant. **Conclusion:** Constant exposure to the dust and other hazardous inhaling substances causes permanent damage to the lung tissue. The street cleaners should have proper protection while they work, which will reduce the damage to the lungs.

KEY WORDS: Street Cleaners; Pulmonary Function Test; Non-smokers

INTRODUCTION

The prevalence of an occupational disease has been increased to many folds among the various workers in worldwide. Among all the occupational illness, the pulmonary disease ranks the top. According to the Centers for Disease Control and Prevention, chronic obstructive pulmonary disease (COPD) is in leading causes 3.09% of total DALYs worldwide. In Egypt, COPD is the fourth cause of death among the Egyptian population.[1] Labor Statistics Bureau in the US stated that respiratory diseases were one of the third most prevalent impairments among American workers in 2011.[2]

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The workers how are exposure to a complex mixture of pollutants; the inhaled particles get deposited in the lungs. These workers are more prone to get the pulmonary diseases.[3] Street cleaners play an essential role in continuously keeping the environment clean and healthy. Due to their job, the

street cleaner is constantly exposed to several hazardous substances like dust which contains a mixture of bioaerosols, microorganisms such as bacteria and fungi, endotoxins, motor vehicle exhaust, wearing the dust of car brakes and tires, diesel soot particles, and lead.[4] Due to the constant inhalation of the hazardous substances, the particles get lodged in the respiratory tract which causes irritations in the respiratory tract, leading to initially mucus hypersecretion, followed by lung inflammation, obstructive lung disease, and restrictive lung disease which finally causes various irreversible lung tissue destructions.[5]

In developed countries, street cleaning is done with the help of mechanical assets and precautionary measures. Hence, it has been found to have a lesser incidence of respiratory diseases. However, in developing countries, the problem arises from the rapid urbanization in addition to that proper occupational safety and health measures were not taken. The seriousness and complexity of this issue arise from the fact that in the developing country, the resources are limited, not well-developed technologies are available, having low socioeconomic standard and poor educational state.[6]

In India, street cleaners are believed to be the job of the underprivileged class. Majority of the street cleaners are below the poverty line, not well educated, living in poor housing environment, and not having proper medical care.[7] In a developing country like India, the majority of the workers work without proper protection, without proper health care and working without the awareness of the health hazards.[3]

Many studies were done in cotton workers, coal miners, grain and flour workers, quarry workers, and workers who are exposed to tobacco dust, barley dust, and talc dust. In this study, we have taken the street cleaners to check their lung functions because there were only very few studies in street cleaners.[8]

MATERIALS AND METHODS

This is a prospective comparative study with a sample size of 100 individuals. The subjects taken for this study were divided into two groups. Group A: Municipal street cleaners (50) of the rural population and Group B: Age- and sex-matched healthy individuals (50) living in the same locality. Ethical committee approval was obtained and ethical guidelines were strictly adhered to. Inclusion criteria: The subjects who were working for more than 1 year will be included in the study. Exclusion criteria: Smokers and any other persons with known respiratory illness were excluded from the study. Well-informed written consents were obtained from all the study participants. A complete history was taken using the pro forma. Clinical examination was done by the physicians in the respective individuals. The pulmonary function test was carried out in both groups using the lung spirometer (SPIROLAB III) and Wright's peak expiratory flow meter. The values of functional vital capacity (FVC), forced expiratory volume in one second (FEV1) and FEV1/FVC ratio, peak expiratory flow rate (PEFR), and forced expiratory flow (FEF) at 25–75% were obtained and the statistical analysis was done using the method of unpaired "*t*" test, $P > 0.05$ is considered to be not statistically significant, $P < 0.01$* is statistically significant, and $P < 0.001$** is highly statistically significant.

RESULTS

The observations of the present study are depicted in Tables 1-6 and Figures 1 and 2.

DISCUSSION

In this study, we measured all the parameters of pulmonary function test (FVC, FEV1, FEV1/FVC, FEF 25–75%, and PEFR) present the best method for early identification of the abnormalities and severity of airway obstruction, restrictive, and other respiratory disorders. The anthropometric parameters were not statistically significant in this study. In our study, FVC, FEV1, FEV1/FVC ratio, PEFR, and FEF 25–75% are statistically significant.

The anthropometric parameters such as age, height, weight, and body mass index were not statistically significant in the effect of lung functions among the street cleaners and the control groups. The mean standard deviation of the anthropometric parameters is given in Table 1. A study was done in the Karnataka region also stated the same.[9] In our study, the FVC and FEV1 values were significantly reduced in street cleaners when compared with the control subjects, which is given in Tables 2 and 3. A similar study was done by Bellamy *et al*. stated that FVC and FEV1 were found to be decreased significantly, which indicates that FVC and FEV1 can be reduced in both obstructive and restrictive lung disease.[10] A study was done by Amato *et al*. stated that reduction in FVC indicates restrictive lung disease or pleural fibrosis and air trapping secondary to airway obstruction.[11] The PEFR values had been reduced in a study done by Johncy *et al*., indicating the obstructive type of lung disease.[9] In our study, the PEFR values are reduced in street cleaners; the values are given in Table 5. The partial explanation for the reduction in FEV1 and PEFR is the loss of the elastic recoiling effect of the lungs which is reduced, which leads to a reduction in the force needed to move the air out of the lungs. The effect of loss of elastic recoiling of the lungs is mainly due to microscopic enlargement of air space which is more preferable when compared to grossly visible emphysema.[11] The FEV1/FVC ratio was more significantly reduced in our study, given in Table 4. A similar study was done by Fahey stated that FEV1/FVC ratio was significantly reduced, which measures that all the cases had mild airway obstruction.[12] In Table 6, the FEF (25–75%) values are highly statistically

Table 1: Comparison of anthropometric parameters between controls and street cleaners

Parameters	Controls (healthy volunteers) Mean±standard deviation	Subjects (street cleaners) Mean±standard deviation
Age (years)	29.78±6.07	29.98±4.99
Height (cm)	168.34±7.38	163.88±9.01
Weight (kg)	64.82±11.67	61.5±12.28
Body mass index (wt. in kg/ht. in m^2)	22.89±4.09	22.75±3.3

Table 2: Comparison of functional vital capacity between controls and street cleaners

Group	*n*	Actual value (L)		% predicted	
		Range	Mean±standard deviation	Range	Mean±standard deviation
Controls	50	2.25–4.23	3.33±0.52	70–112	86.28±12.34
Street cleaners	50	1.42–3.52	2.68±0.57	66–94	81.5±9.09
Significance	*t*		5.95		2.2
	P		<0.001**		<0.03

Table 3: Comparison of forced expiratory volume in one second between controls and street cleaners

Group	*n*	Actual value (L)		% predicted	
		Range	Mean±standard deviation	Range	Mean±standard deviation
Controls	50	2.09–3.72	3.03±0.44	72–114	92.98±9.96
Street cleaners	50	1.42–2.87	2.31±0.38	64–89	80.04±7.17
Significance	*t*		8.62		7.45
	P		<0.001**		<0.001**

Table 4: Comparison of forced expiratory volume in one second/functional vital capacity ratio between controls and street cleaners

Group	*n*	Actual value (L)		% predicted	
		Range	Mean±standard deviation	Range	Mean±standard deviation
Controls	50	80.7–100	91.45±5.4	100–116	108.68±4.36
Street cleaners	50	88.2–104.6	96±4.66	99–119	109.32±5.25
Significance	*t*		4.5		3.66
	P		<0.001**		<0.05

Table 5: Comparison of peak expiratory flow rate between controls and street cleaners

Group	*n*	Actual value (L)		% predicted	
		Range	Mean±standard deviation	Range	Mean±standard deviation
Controls	50	4.07–10.9	6.53±1.26	74–114	8.87±6.83
Street cleaners	50	3.59–7.85	6.02±1.4	54–109	79.78±13.66
Significance	*t*		2.91		3.71
	P		<0.05		<0.001**

Table 6: Comparison of forced expiratory flow 25–75% between controls and street cleaners

Group	*n*	Actual value (L)		% predicted	
		Range	Mean±standard deviation	Range	Mean±standard deviation
Controls	50	2.7–4.76	3.91 ± 0.49	76–99	90.24±7.26
Street cleaners	50	2.04–3.22	2.74 ± 0.34	67–88	79.62±6.63
Significance	*t*		13.62		7.62
	P		<0.001**		<0.001**

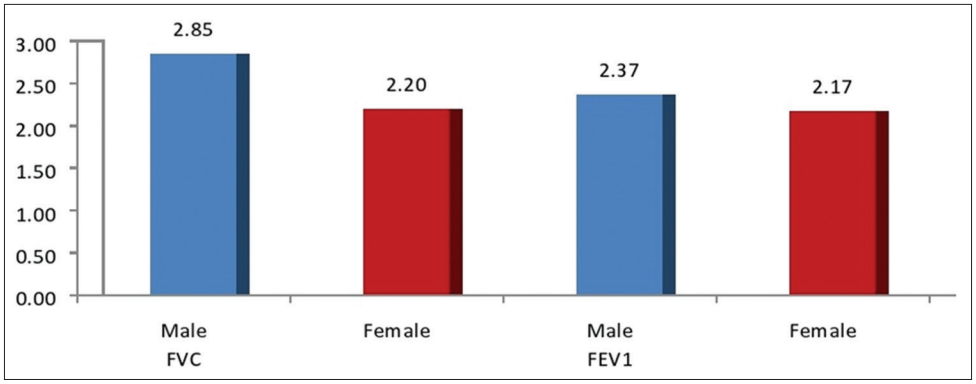

Figure 1: Comparison of gender for functional vital capacity and forced expiratory volume in one second in street cleaners

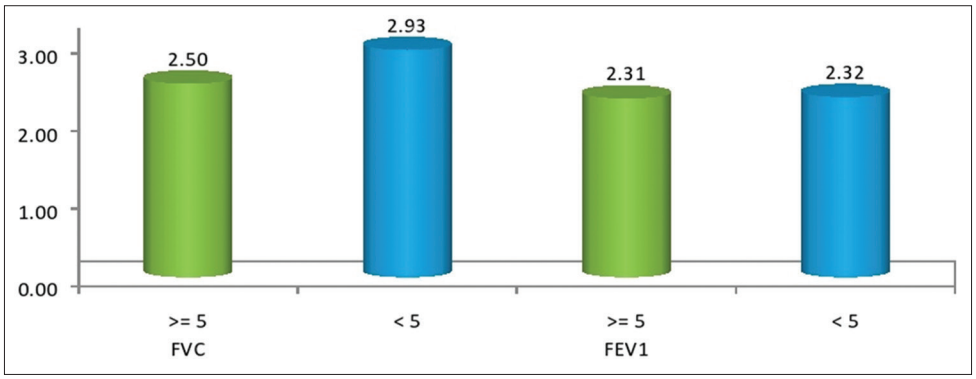

Figure 2: Comparison of functional vital capacity and forced expiratory volume in one second for duration in street cleaners

significant. Similar to our study, a study was done in Spain which also had reduced FEV1 and FEF (25–75%) values in person who had prolonged exposure to dust.[13] One of the studies done in Nigeria also had all the lung parameters that were reduced in female sweepers.[4] A study was done in outer regions of Bangkok metropolis also had FVC, FEV1, and FEF (25–75%) that were significantly reduced.[14] In Figure 1, it compares the value of FVC and FEV1 among the male and female street cleaners showed a significant reduction of values in females when compared to males. A study was done by Juhi *et al*. found that the FEV1/FVC ratio was less in the female when compared to male street sweepers.[15] In Figure 2, the duration of occupation in street cleaners was compared. It is found to be statistically significant in prolonged duration of occupation. A study done by Kuhn and Askin stated that people exposed for prolonged duration to dust, gases, and fumes, their pulmonary function test parameters were decreased significantly giving us a shred of evidence that these people are more prone to airway obstruction and respiratory diseases.[16] Similarly, a study was done by Rabe *et al*. explained that variation in the values of FVC, FEV1, and FEV1/FVC ratio may be related to particle size and site of deposition. The large particles obstruct the larger airway with increasing in the duration of exposure which leads to irreversible lung diseases. However, the smaller particles having a diameter <1 micron reach the alveolar spaces.[17] The smaller particles cross the alveolar wall and get attached to alveolar fluid where they are taken up by alveolar macrophages. The macrophages try to eliminate the foreign particles out of the lungs. The macrophages could not able to make it up due to the constant deposition of these particles in huge amount for a prolonged period.[18,19] These failed macrophages produce toxic substances while trying to eliminate the foreign particles causing inflammation of the surrounding lung areas. The prolonged reaction causes lung tissue destruction. If the constant irritant dust particles are not removed, the damage to lung tissue is persistent which leads to permanent lung damage.[20]

CONCLUSION

The interpretation of this study is prolonged exposure to dust and other hazardous inhaling substances in the street cleaners had resulted in lung impairment in them. The most important awareness to be created in the street cleaners is a must toward the occupational health hazards and mortality. As India is a developing country, the seriousness of the situation is the economical state, the availability of the materials for the precautions during working, awareness toward the occupational hazards, and mortality were not well developed. The street cleaners were working without proper precautions. Our study was the first to be done on street cleaners in our locality to find lung disorders due to the acute effect of inhaling dust and hazardous inhaling substances. The results of our study reveal that the street cleaners due to their nature of work, these workers are exposed for a prolonged period

of time to hazardous inhaling substances like dust which contains a mixture of bioaerosols, microorganisms such as bacteria and fungi, endotoxins, motor vehicle exhaust, wearing dust of car brakes and tires, diesel soot particles, and lead. Due to these reasons, the street cleaners are more prone to permanent lung disorders. By the results of this study, it will be useful in understanding the hazards of occupational exposure. Regular health check-up, health education, and counseling about the importance of wearing the dustproof face mask, using long-handled brooms instead of short-handled brooms, where ever possible, they should try to use machines for cleaning and have shift duties among the street cleaners are recommended. This can reduce the direct exposure to dust and other hazardous inhaling substances which, in turn, reduces the damage to the lungs.

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