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Original Research Article

Pulmonary functions in sewage workers

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ABSTRACT

Background: Occupational lung diseases in sewage workers have not received sufficient attention, despite chronic exposure to noxious material. We aimed to describe the pulmonary function testing pattern of sewage workers with special emphasis on estimated lung age.
Methods: We included sewage workers who came for health check-up. We excluded patients who had respiratory infection/any other respiratory ailments. Socio-demographic profile, history and examination were noted. Routine haematological investigations, chest radiograph, PFT were done. Basal and predicted measurements FVC, FEV1, PEFR, FE F25-75%, MVV and estimated lung age were noted.
Results: Average age was 43.48±7.96 years on presentation and no one was symptomatic, everyone had normal X-ray chest findings. Of these 82 participants,36 had normal pattern on PFT. Out of 46 abnormal patterns, 28 had obstructive,5 restrictive and 13 had mixed patterns. In Obstructive pattern, mean FEV1/FVC ratio was 78.15 + 4.42 %, FEV1% was 89.26+10.27 %. In restrictive pattern, mean FVC % was 71%±5.72. In mixed pattern mean FVC % was 71.83+10.7%, FEV1 % was 70.98+6.43%.FEF (25-75%) was 62±10.85% in the obstructive pattern and 93±11.49% in the restrictive pattern. Estimated lung age was found to be 45±10.71 years, 55±11.36 years and 67±7.54 years in normal, obstructive and restrictive pattern which was high.
Conclusions: There is a considerable burden of occupation lung diseases in the form of reduced lung functions among sewage workers, which often goes undiagnosed. Periodic assessment and appropriate measures in reducing the exposure should be considered.

Keywords: PFT, Sewage workers, Occupational lung diseases

INTRODUCTION

Sewage workers, because of their occupation, are exposed to different types of chemical pollutants and biological contaminants such as bacteria and fungi. It also includes dusts, bio-aerosols, fumes and a complex mixture of toxic and non-toxic gases. Sewage gases may include hydrogen sulphide, ammonia, methane, esters, carbon monoxide, sulphur dioxide and nitrogen oxides etc. This directly and as a consequence of oxidative stress, leads to detrimental effects on various organs especially lung function on chronic exposure. There can be accidental exposure which leads to acute respiratory distress. However, there is high prevalence of chronic respiratory symptoms particularly chest tightness and reduced lung functions after long term exposure.[1]

Currently in India there are no programs which screen routinely sewage workers for pulmonary conditions using spirometry. This results in debilitating health outcomes for sewage workers as many of these diseases take numerous years to develop. There is an increased risk for asthma and chronic bronchitis among sewage workers has been documented.[2] In this study we aimed to describe

the pulmonary function patterns in sewage workers, with special emphasis on estimated lung age who presented to our hospital for routine health check-up, presented from one suburb of the metropolitan city of India.

METHODS

We designed a cross-sectional study of sewage workers who were apparently healthy, presented to the outpatient clinic of department of general medicine of B.Y.L. Nair hospital, Mumbai. Study was conducted from June to Oct 2015. Male participants who were working as sewage worker in 2 wards of MCGM for more than 5 years came for routine health check with or without respiratory complaints. We excluded patients who were smokers and had respiratory infection in past two weeks, having any other respiratory ailments, acute symptoms and those who refused consent for the study. The inclusion in to this study did not affect the treatment they received.

In our study, out of 82 participants, 36 had normal pattern on PFT, 46 had abnormal patterns. Out of 46, 28 had obstructive pattern, 5 restrictive and 13 had mixed pattern on PFT irrespective of the length of service.

Data collection and data analysis

Approval from project in-charge and the institutional ethics committee was obtained. After informed written consent, socio-demographic profile of the study subjects, anthropometric data like height, weight and body surface area were noted. Clinical history and findings of examination were observed. All patients underwent routine haematological investigations and imaging studies like chest radiograph. PFT was done by using a computerized spirometer MIR (Medical International Research) Spiro Lab II in sitting position. The technique of spirometry was demonstrated to the subjects before they were asked to perform the test. The test was done three times and best among 3 readings was taken as final reading. Recommendations of American Thoracic society (ATS)/ERS task force series were followed. The data was noted in Microsoft excel sheet and analysed in SPSS (version 24). The baseline demographic data was described as means and standard deviation. Basal and predicted measurements of PFT like Forced Vital Capacity (FVC), Forced Expiratory Volume 1st second (FEV1), Peak Expiratory Flow rate (PEFR), Forced Expiratory Flow (25-75%), Maximal Voluntary Ventilation (MVV) and Estimated Lung Age (ELA) were noted for all patients. Based on the PFT patterns the patients were classified as normal, obstructive, restrictive and mixed pattern. Unpaired t-test was used to test for the difference of means in different parameters in the group of subjects. Statistical significance was defined as p value less than 0.05.

Ethical approval

Permission granted from ethics committee for academic research projects from our institution.

RESULTS

Average age 43.48±7.96 years on presentation and everyone had normal X-ray chest findings. The average age, height, weight and body surface area was comparable in all the participants (Table 1). Of these 82 participants, 36 had normal pattern on PFT, 46 had abnormal patterns which is clinically significant.

Out of 46, 28 had obstructive pattern, 5 restrictive and 13 had mixed pattern on PFT. In Obstructive pattern, mean FEV1/FVC ratio was 78.15+4.42 %, FEV1% was 89.26+10.27 %. In restrictive pattern, mean FVC % was 71%±5.72 of the predicted and FEV1 was 81% of the predicted (Table 2). In mixed pattern mean FVC % was 71.83+10.7%, FEV1 % was 70.98+6.43%. Forced expiratory flow (25-75%) was 62±10.85% in the obstructive pattern and 93±11.49% in the restrictive pattern. FEV1 percentage of predicted was found to be 103±10.44%, 89±10.27% and 81±5.10%, 71+ 6.43 % in the normal, obstructive, restrictive and mixed pattern respectively. FVC % of predicted was found to be 98+11.95%, 95+13%, 71+5.72 % ,72+10% in the normal, obstructive, restrictive and mixed pattern respectively. Estimated/spirometric lung age was found to be 45±10.71 years, 55±11.36 years and 67±7.54 years in normal, obstructive and restrictive pattern patients which was significantly high. Forced expiratory flow (25-75%) was 62±10.85% in the obstructive pattern and 93±11.49% in the restrictive pattern patients. On making comparison with various PFT parameters within the patient groups we found statistically significant difference in the FEV1 and FEF, ELA and FEF (25-75%) in all patient groups. Predicted and basal FEV1 values were statistically different in the obstructive, restrictive and mixed pattern patient (Table 3).

Table 1: Baseline demographic characteristics of the sewage workers included in the study.

Variables	All subjects	Normal on PFT	Obstructive on PFT	Restrictive on PFT	Mixed on PFT
Total sample	82	36	28	5	13
Average age (years)	43.48±7.96*	42.64±8.52	42.52±7.70	46.20±3.56	47.31±7.53
Average height (cms)	165.85±4.76	165.54±3.51	165.69±4.99	163.40±2.30	166.15±4.85
Average weight (kgs)	65.09±10.29	65.60±11.59	66.35±9.40	62.20±7.69	65.46±8.63
Average body surface area (m^2)	1.77±0.12	1.71±0.13	1.73±0.12	1.67±0.09	1.72±0.13

Table 2: Results of pulmonary function testing in our study subjects.

PFT measurements	Normal	Obstructive	Restrictive	Mixed
Forced vital capacity (litres)				
Predicted	3.68±0.30*	3.72±0.34	3.48±0.17	3.59±0.33
Basal	3.61±0.53	3.55±0.67	2.49±0.26	2.58±0.48
Percentage	98±11.94	95±12.99	71±5.72	72±10.69
Forced expiratory volume in 1st second (FEV1) (litres)				
Predicted	3.05±0.29	3.10±0.30	2.88±0.15	2.99±0.35
Basal	3.14±0.44	2.77±0.46	2.32±0.20	2.12±0.32
Percentage	103±10.44	89±10.27	81±5.10	71±6.63
FEV1/FVC				
Predicted	83±1.51	83±1.31	83±0.62	83±5.12
Basal	87±3.91	78±4.41	93±4.42	83±10.59
Percentage of peak of expiratory flow rate (litres/minute)				
Predicted	411±31.87	407±26.23	400±0.00	400±0.00
Basal	464±78.68	422±92.42	390±91.92	362±80.30
Forced expiratory flow (25-75%) basal (litres/second)				
Predicted	4.08±0.39	4.13±0.35	3.88±0.17	3.85±0.35
Basal	4.09±0.88	2.56±0.50	3.60±0.48	2.55±0.63
Percentage	100±19.85	62±10.85	93±11.49	66±14.79
Maximal voluntary ventilation (litres/minute)				
Predicted	124±8.88	126±9.45	119±4.76	118±14.26
Basal	124±36	114±23.01	123±16.38	98±17.72
Estimated lung age (years)				
	45±10.71	55±11.36	67±7.54	79±8.38

*All values are mean ±standard deviation.

Table 3: Within group comparison on various PFT measurements.

Comparisons	Normal	Obstructive	Restrictive	Mixed
FEV1 vs FEF (25-75%) basal	5.85 (p<0.001)*	1.57 (p<0.001)	5.51 (p<0.001)	2.17 (p<0.05)
ELA vs FEF (25-75%) basal	22.84 (p<0.001)	24.35 (p<0.001)	18.89 (p<0.001)	32.83 (p<0.001)
FEV1 (predicted vs basal)	-	3.18 (p<0.05)	5.01 (p<0.001)	6.65 (p<0.001)
FEF (25-75%) predicted vs basal	-	13.11 (p<0.001)	1.24 (p>0.05)	6.49 (p<0.001)
FVC predicted vs basal	-	-	7.24 (p<0.001)	-

FEV1: Forced expiratory volume in 1st second (Litres); FEF: Forced expiratory flow (Litres/second); FEV1: Forced expiratory volume in 1st second (FEV1) (Litres); FVC: Forced vital capacity (Litres); ELA: Estimated lung age. *Values are t test value (2 tailed p value).

Predicted and basal values of FEF (25-75%) in obstructive and mixed pattern patients were found to be significantly different as well. Restrictive pattern patients had statistically significantly different FVC predicted and basal values on PFT.

DISCUSSION

Workers with occupational exposure to agents with known lung toxicity are very commonly seen in clinical practice. Numerous lung diseases can result from occupational exposure to dust, smoke, fumes and various biological agents.[3] The proposed pathophysiological mechanisms include oxidative stress and chronic respiratory irritation due to exposure to noxious bioaerosols.[4]

The most commonly seen acquired occupational lung diseases include occupational asthma, bronchitis, hypersensitivity pneumonitis, pneumoconiosis, and cancers.[4] Pulmonary Function Testing (PFT) is by spirometry which can be done as pre-employment as well as for periodic screening in high-risk occupations. Only a few studies have employed spirometry as an objective marker of abnormal lung function, majority of the studies focuses on respiratory symptomatology.

This shows significant affection of lung functions in sewage workers. These findings were similar to the results of previous studies.[5,7]

In obstructive pattern most of the patients had mild obstruction (FEV1% was 89.26+10.27 %), only one subject had moderate obstruction with FEV1 of 72%, mean FEV1/FVC ratio was 78.15+4.42 %. Zuskin et al reported obstructive pattern in smaller airways on pulmonary function test in 74 sewage workers, close channel workers and drainage workers in Croatia.[6]

In restrictive pattern, mean FVC % was 71%±5.72 of the predicted which is low and FEV1 was 81% of the predicted. Exposure to bio-aerosols was associated with significant reductions in most PFT parameters in exposed workers. These findings are consistent with the results of Richardson et al, who found FEV1/FVC was significantly lower in wastewater treatment workers in comparison with a comparison group.[5] In mixed pattern mean FVC % was 71.83+10.7%, FEV1 % was 70.98+6.43% which is significantly low.

Spirometric lung age was found to be 45±10.71 years, 55±11.36 years and 67±7.54 years in normal, obstructive and restrictive pattern which is high as compared to chronological age of the workers. The concept of "spirometric-lung-age (SLA)" (the age of an average person who has, for example, FEV1equal to a subject) was developed in 1985 as a potential psychological tool to show smokers the apparent ageing of their lungs. The basis of interpretation of the "lung age" relies upon a comparison of the chronological lung-age (CLA) data with the SLA predicted from norms[10]. It may be considered in this scenario of occupational lung diseases.

On making comparison with various PFT parameters within the patient groups we found statistically significant difference in the FEV1 and FEF, ELA and FEF (25-75%) in all patient groups. Bener et al reported significantly lower FVC, FEV1, FEV1/FVC, PEF 25:75 and PEFR ($p<0.05$) in his study on sewage workers in UAE. The Mumbai sewage worker study in 2010 also reported predominantly obstructive pattern on pulmonary function test in nearly half the subjects and restrictive pattern was also seen in about one-fifth of subjects.[11] In a study on sewage workers in Aligarh in 2014, Shadab et al also found significant reduction in all parameters on spirometry.

Sewage workers who participated in our study were found to have significant reduction in lung functions due to the occupational exposure to detrimental agents. Many of these patients had decreased work capacity as a result of their lung pathology.

The most likely route of exposure to noxious agents among sewage workers is by inhalation of aerosols while working mostly underground work- closed channel and drainage workers. Hydrogen sulphide, methane, ammonia and carbon monoxide are the gases which the sewage workers encounter very commonly.

Limitations of our study

The results of our study might not be generalizable to other geographical areas, owing to the small sample size and single-centric study design. Smoking status, respiratory symptoms should be considered. Measurement of ambient air concentrations of bio-aerosols in the work area should also be measured to establish cause and effect relationship.

CONCLUSION

Results of our study show that there is a considerable burden of occupation lung diseases among sewage workers, which often goes undiagnosed. Ensuring use of personal protective gears by the sewage workers, as the exposure to toxic fumes and oxidative molecules can be decreased. Periodic assessment of lung functions and appropriate measures in reducing the exposure should be considered.

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