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PULMONARY FUNCTIONS IN PETROL PUMP WORKERS : A PRELIMINARY STUDY

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Abstract : Occupational exposures to petrol/diesel vapors have been shown to affect functioning of different systems of the body. The present study was planned to assess the pulmonary functions in petrol pump workers (filling attendants) who are continuously exposed to petrol/diesel vapors during duty hours. Thirty healthy non-smoker males working in petrol pump for more than one year formed the study group, while thirty healthy non-smoker males from hospital staff served as control group. The pulmonary functions were assessed using computerized spirometer. The FVC and FEV_1 were decreased in the study group while their ratio did not differ much. Both the inspiratory and expiratory flow rates were also decreased in the study group. These findings point towards adverse effects of petrol/diesel fumes mainly on lower airways with restrictive pattern of disease.

Key words : pulmonary functions petrol/diesel vapors occupational exposures

INTRODUCTION

Numerous epidemiological studies have documented decrements in pulmonary function and various other health problems associated with long-term air pollution exposure (1–4). Health problems posed by the pollutants at the work environment of an individual are closely linked to the nature and level of exposure to these hazardous chemicals. It has been known for quite sometime that air pollution from diesel exhaust is a major respiratory hazard for workers exposed to it in enclosed space (5).

Diesel exhaust, in addition to generating pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world. Symptoms like chronic cough, wheezing and breathlessness have been reported on exposure to these pollutants (2, 4). At high ambient concentrations, well-defined and marked systemic pulmonary inflammatory response is also observed (6). Various occupational exposures to petrol/ diesel products have been shown to affect

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different systems of body (7–10). Several animal studies have also demonstrated a consistent association between the air pollutants and the altered lung function (11–13). Petrol pump workers (filling attendants) are continuously exposed to the organic and inorganic substances present in the petrol. The average daily exposure to these chemicals in India generally exceeds about 10 h/day. Some of them are working for more than ten years now. Hence, the present study aims to evaluate the respiratory functions in subjects continuously exposed to petrol/diesel vapor for more than one year.

MATERIAL AND METHODS

The study was carried out in the environmental physiology laboratory of department. The study group (group I) consisted of thirty healthy non-smoker males in the age group of 20–40 years working in petrol pump for more than one year. They were selected from the petrol pumps located in the vicinity of the institution which are located in the lower pollution zones (3) and were brought to the laboratory for the test. While thirty age matched healthy male non-smokers, working as Laboratory attendants in our hospital served as controls (group II). None of the subjects had a history of asthma, respiratory or other illness or were taking any medication. The ethical committee clearance was taken and an informed written consent was taken after explaining the procedure to the subjects.

The pulmonary function tests were carried out using computerized spirometer (Spiro 232 of P. K. Morgan, London) using the standard laboratory methods. The spirometer was calibrated regularly and the values were corrected to DTPS. The questionnaire was filled up and relevant data (name, age, sex, height, weight, occupation, and smoker/nonsmoker) was entered in the computer. The test module was activated and the subject was given proper instructions about the procedure to be performed. All the pulmonary function tests were done on the subjects comfortably seated in an upright position. The subject was connected to the mouthpiece and was asked to breath in and out to familiarize himself with the equipment. During the test the subject was adequately encouraged to perform their optimum level and also a nose clip was applied during the entire maneuver. Tests were repeated three times and the best matching results were considered for analysis. The predicted values for above parameters were calculated from standard equation derived for Indian subjects (14, 15).

The flow volume curve was recorded and the parameters measured by the apparatus were the peak expiratory flow rate (PEFR), forced expiratory flow in 25–75% of vital capacity (FEF25–75), peak inspiratory flow rate (PIFR) and forced inspiratory flow at 50% of vital capacity (FIF50), forced vital capacity (FVC) and forced expiratory volume at one second (FEV1), forced inspiratory vital capacity (FIVC), inspiratory capacity (1C) and expiratory reserve volume (ERV).

Statistical analysis

The data of pulmonary function tests were presented as the Mean ± Standard Deviation for each of the parameter. The two groups were compared by using unpaired ‘t’ test and p value of less than 0.05 was considered significant.

RESULTS

The anthropometric parameters of study group were age 26.40 ± 8.15 years, weight 60.93 ± 10.13 kg, height 168.07 ± 8.72 cms while that of controls were age 24.13 ± 4.74 years, weight 62.67 ± 8.52 kg, height 172.67 ± 6.26 cms. The two groups did not differ significantly on these parameters. The observed values of various lung functions were compared between the two groups.

Table I shows the values of flow rates in the two groups. The peak expiratory flow rate (PEFR), forced expiratory flow in 25–75% of vital capacity (FEF25–75), peak inspiratory flow rate (PIFR) and forced inspiratory flow at 50% of vital capacity (FIF50) were found to be significantly decreased (P<0.05) in petrol pump workers as compared to controls.

TABLE I : Flow rates in the two groups.

	Petrol pump workers	*Controls*
n	*30*	*30*
PEFR (L/min)	5.41±1.79*	7.25±1.55
FEF_{25-75} (L/min)	3.48±1.62*	4.83±1.27
PIFR (L/min)	2.17±0.58*	3.52±1.10
FIF_{50} (L/min)	1.86±0.61*	3.24±1.10

*P<0.05 as compared to controls.

The values of lung volumes and capacities are shown in Table II. Both forced vital capacity (FVC) and forced expiratory volume at first second (FEV1) were decreased significantly while their ratio did not differ much between the two groups. Expiratory reserve volume (ERV) is also lowered in the study group. Forced inspiratory vital capacity (FIVC) and inspiratory capacity (1C) were not significantly different in the two groups.

TABLE II : Lung volumes and capacities in the two groups.

	Petrol pump workers	*Controls*
FVC (Litres)	3±0.75*	3.96±0.34
FEV1 (Litres)	2.65±0.67*	3.57±0.41
FEV1/FVC (%)	89.25±13.34	90.31±9.02
FIVC (Litres)	2.17±0.69	2.68±0.46
IC (Litres)	2.39±0.56	2.74±0.43
ERV (Litres)	0.61±0.51*	1.24±0.42

*P<0.05 as compared to controls.

The ambient air quality data as reported by central pollution control Board (21) in the vicinity of petrol pump showed the levels of suspended particulate matter (SPM) levels 301 ± 71 µg/m^3 (upper limit 200), respirable suspended particulate matter (RSPM) levels 135 ± 46 µg/m^3 (upper limit 100), both being above the permissible upper limits. While SO_2 9 ± 2 (upper limit 80) and NO_2 36 ± 5 (upper limit 80) within the normal standards.

DISCUSSION

In the present study most of the parameters were decreased significantly in petrol pump workers as compared to controls. Although FEVl and FVC both decreased in petrol pump workers their ratio did not differ between the two groups. This finding indicates the restrictive nature of pulmonary involvement in the study group (16). Similar findings were observed in cats following long-term exposure to diesel exhaust (12). However previous work involving animal exposures to diesel exhaust and pulmonary function tests has shown varying results (17–20). While short term exposure to diesel exhaust in healthy human volunteers have demonstrated marked systemic and pulmonary inflammatory response but lung function measurements did not show a significant change (6). These volunteers were exposed to diluted diesel exhaust under controlled conditions for 1 hour with intermittent exercise. Such low exposure could be one of the reasons for normal lung function parameters in their study. Since our subjects are exposed to these exhausts for longer period of time (more than a year, for at least 10 hrs/day), they have more chances of chronic inflammatory involvement of lungs as indicated by the results of our study. Moreover, the ambient air quality monitored in the vicinity of petrol pumps by central pollution control Board (21) also showed increase in the levels of SPM (301 ± 71 µg/m^3 and RSPM (135 ± 46 µg/m^3). These values were 35% to 50% greater as compared to maximal permissible levels (21). Another important pollutant which may have contributed to our findings is lead. Inhalation of lead from leaded petrol emissions is an important source of lead exposure. Few studies have related lead to structural damage or impaired functions of the lungs (22, 23).

In the present study expiratory and inspiratory flow rates i.e. PEFR, PIFR, FEF25–75 and FIF50 are also decreased in the study group. PEFR was also decreased in the experimental study of cats which otherwise showed a classic pattern of restrictive lung disease (12). Since petrol pumps are located on busy roads, hence, these workers in addition to diesel exhaust are exposed to other air pollutants. The flow rates at low volumes i.e. FEF25–75 and FIF50 indicates flow rates in small airways i.e. those with internal diameters of less than 2 mm. These are reduced at low lung volumes both in restrictive and obstructive diseases (24). Thus findings suggest greater involvement of small airways. Particles generated from diesel exhaust are extremely small and are present in the nuclei or accumulation modes, with diameters of 0.02 nm and 0.2 nm respectively (25). These small sized particles, by virtue of their greater surface area to mass ratio, can carry a much larger fraction of toxic compounds, such as hydrocarbons and metals on their surface (25). Importantly, they can remain airborne for long periods of time and deposit in greater numbers and deeper into the lungs than larger sized particle (26). Hence chronic exposure to them can lead to chronic inflammation of respiratory tract and lung parenchyma. Therefore future study could be extended to evaluate status of alveolo-capillary membrane, by determining lung diffusion capacities in these workers.

REFERENCES

1. Gamble J, Jones W, Minshall S. Epidemiological-Environmental study of Diesel Bus Garage workers : Acute effects of NO_2 and respirable particulate on the respiratory system. *Environ Research* 1987; 42: 201–214.
2. Nakai S, Maeda K, Crest JST. Respiratory health associated with exposure to automobile exhaust. III. Results of a cross sectional study in 1987, and repeated pulmonary function tests from 1987 to 1990. *Arch Environ Health* 1999; 54: 26–32.
3. Chabra SK, Chabra P, Rajpal S, Gupta RK. Ambient air pollution and chronic respiratory morbidity in Delhi. *Arch Environ Health* 2001; 56: 58–63.

4. Ware JH, Spengler JD, Neas LM, Samet JM, Wagner GR, Coultas D et al. Respiratory and irritant health effects of ambient volatile organic compounds. The Kanawa county health study. *Am J Epidemiol* 1993; 137: 1287–1301.

5. Kilburn KH. Effects of diesel exhaust on neurobehavioral and pulmonary functions. *Arch Environ Health* 2000; 55: 11–17.

6. Salvi S, Blomberg A, Rudell B, Kelly F, Sandstorm T, Holgate ST, Frew A. Acute inflammatory responses in the airways and peripheral blood after short-term exposure to diesel exhaust in healthy human volunteers. *Am J Respir Crit Care Med* 1999; 159: 702–709

7. Niazi GA, Fleming AF, Siziya S. Blood dyscrasia in unofficial vendors of petrol and heavy oil and motor mechanics in Nigeria. *Trop Doct* 1989; 19: 55–58.

8. Bergdahl IA, Toren K, Eriksson K, Hedhind U, Nilsson T, Flodin R, Jarvholm B. Increased mortality in COPD among construction workers exposed to inorganic dust. *Eur Respir J* 2004; 23: 402–406.

9. Lipsett M, Campleman S. Occupational exposure to diesel exhaust and lung cancer: a meta analysis. *Am J Public Health* 1999; 89: 1009–1017.

10. BiceDE, Mauderly JL, Jones RK, McClellan RO. Effects of inhaled diesel exhaust on immune responses after lung immunization. *Fundam Appl Toxicol* 1985; 5(6 Pt 1): 1075–1086.

11. Gross KB. Pulmonary function testing of animals chronically exposed to diluted diesel exhaust. *J Appl Toxicol* 1981, 10: 116–123.

12. Moorman WJ, Clark JC, Pepelko WE, Mattox J. Pulmonary function responses in cats following long-term exposure to diesel exhaust. *J Appl Toxicol* 1985; 5: 301–305.

13. Ikeda M, Suzuki M, Watarai K, Sagai M, Tomita T. Impairment of endothelium-dependent relaxation by diesel exhaust particles in rat thoracic aorta. *Jpn J Pharmacol* 1995; 680: 183–189.

14. Udwadia FE, Sunavala JD, Shetye VM and Jain PK. The maximal expiratory flow volume curve in normal subjects in India. *Chest* 1986; 89: 852–856.

15. Vijayan VK, Kuppurao KV, Venkatesan P, Sankaran K and Prabhakar R. Pulmonary function in healthy young adult Indians in Madras. *Thorax* 1990; 45: 611–615.

16. Innes JA and Reid PT. Respiratory disease. In Boon NA, Coiledge NR, Walker BR and Hunter JAA. Davidson’s principles and practice of Medicine. 20th edition Churchill Livingston Elsevier Publishers. 2006: 647–738.

17. Wiester MJ, Iltis R, Moore W. Altered function and histology in guinea pigs after inhalation of diesel exhaust. *Environ Res* 1980; 22: 285–297.

18. O’Neil JJ, Hu P, Miller FJ, Carson JL, Collier AM, Garland DE. Functional and morphological consequences of diesel exhaust inhalation in mice. In Health Effects of Diesel Engine Emissions: Proceedings of an International Symposium, Cincinnati, Ohio. US Environmental Protection Agency, *Cincinnati*. 1980; 766–771.

19. Vinegar A, Carson A, Pepelko WE. Pulmonary function changes in Chinese hamsters exposed six months to diesel exhaust. *Env Internal* 1981; 5: 369–371.

20. Mauderly et al. Life-span of rodents inhaling diesel exhaust: results through 30 months. *Inhal Toxicol Res Inst Ann Rep* 1983; 305–316.

21. Ambient air quality data of NAMP station, Shahadara, Delhi. http://cpcb.nic.in/bulletin/del/2005/june2005.html.

22. Fortoul TI, Osorio LS, Tovar AT, Salazar D, Castella ME and Olaiz-Fernandez G. Metals in lung tissue from autopsy cases in Mexico city residents : Comparison of cases from the 1950’s and the 1980’s. *Environmental Health Perspectives* 1996; 104: 630–632.

23. Lippman MB Lead and human health: Background and recent findings. *Environ Res* 1990; 51: 1–24.,

24. Cotes JE, Chinn DJ and Miller MR. How individual diseases affect lung functions. In Lung function : Physiology measurement and application in medicine. 6th edition. *Blackwell Scientific Publications* 2006; 560–592.

25. Levsen K. The analysis of diesel particulate. *Fresenius Z Anal Chem* 1988; 331: 467–478.

26. Harrison RM, Brimblecombe P, Dervent RG Health effects of non biological particles. In Airborne Paniculate Matter in the United Kingdom: Third Report of the Quality of Urban Air Review Group. Department of Environment, London. 1996; 115–118.