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Study of effect of petrol vapours and fumes on pulmonary functions of petrol pump workers

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Abstract
Occupational exposures to petrol/diesel vapours 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 vapours during duty hours. 60 petrol pump workers who were categorized into two groups depending on duration of exposure, while thirty healthy non-smoker males from hospital staff served as control group. The pulmonary functions test (PFT) were assessed using computerized spirometer. Following parameter, FVC, TV, FEC, FEV/FC, FEF 25-75%, FEF 75-85%, PEF and MVV were checked. Results showed statistically significant decrease in the values of TV, FVC, FEV, FEF 25-75%, FEF 75- 85%, FEV/FC, PEF and MVV in petrol pump workers who have worked for more than 4 years when compared to control group. The result shows statistically decreased in value of TV, FVC, FEV1, FEF 25-75% and MVV in petrol pump workers who have worked for below 4 years when compared to control group 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. The study concludes that the deleterious effects of air pollution and petrol/diesel vapor inhalation on the lung function of petrol pump workers results in a restrictive type of lung function abnormality. The pattern of respiratory impairment changes to a mixed type as the duration of exposure increases.

Keywords: Petrol and diesel fume, pulmonary function test (PFT), occupational exposure, spirometry, restrictive impairment

Introduction
Rapid industrial growth, globalization, and poor environmental conditions at work places have created a lot of health-related issues. There is a high prevalence of occupational diseases, such as, silicosis, asbestosis, and pneumoconiosis among workers working in different industrial environments in India (Saiyed and Tiwari, 2004) [1]. Globalization and increased populations lead increase number of automobiles plying on roads are increasing each day. Which in turn increase the demand of patrol pumps and also the workers whole day work on this petrol pump. Workers work on this petrol pump, expose to petrol vapours and gases from exhaust of automobiles (Anupama *et al*., 2012) [2]. Deleterious effect of petrol vapours and gases from automobile exhaust have been observed on respiratory system (Solanki *et al*., 2015; Uzma *et al*., 2008) [3, 14]. The rising number of vehicles has sharply increased the level of air pollution in various cities of India. A Health Survey done by the Centre for Science and Environment (CSE), New Delhi, has shown that 141 (80%) cities in India exceed the PM 10 (pollutants that emit particulate matter of less than 10 micrometers in size) standard, 90 cities have a critical level of PM 10 and 26 cities have the most critical level, exceeding thrice the standards (cseindia.org).
Several animal studies have also demonstrated a consistent association between the air pollutants and the altered lung function (Gross, 1981; Moorman *et al*., 1985) [6, 7]. 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. A long term exposure to the air pollutant leads to effects of respiratory functions. Air pollutants and chemicals like benzenes, lead, CO2, NO2,CO etc; play a role in the pathogenesis of respiratory diseases. 2 Petrol also called gasoline is a complex combination of hydrocarbons.

In addition, most of the benzene (88%) is emitted while supplying fuel to the vehicle (Krivoshto *et al*., 2008) [8]. The toxic effects of the benzene content of petrol on the various hematological indices and liver have been studied in gasoline-filling workers, (Chawla and Lavania *et al*., 2008; Nightingale *et al*., 2000) [9, 10, 17] with documented neurotoxicity (Li *et al*., 1999) [11, 16]. About 95% of components in petrol vapours are aliphatic and cyclic compounds and less than 2% are aromatics. Prolonged exposure to air pollution and petroleum vapours causes broncho-constriconstriction (Aprajita *et al*., 2011) [12]. Mucosal irritation and alveolar swelling leads to obstructive and restrictive disorders of lungs. Hence, the present study aims to evaluate the respiratory functions in subjects continuously exposed to petrol vapour for more than one year.

Materials and Methods

The study was carried out in Dept. of Physiology. The study group consisted of 60 healthy males working in petrol pump for more than one year. They were selected from the petrol pumps located in the vicinity of the institution and were brought to the laboratory for the test. Their age, smoking habits, duration of exposure, physical status and health conditions were recorded by using a questionnaire. After recording their brief history, their examination was done as per the proforma which was attached. Exclusion Criteria: Smokers, Emphysema, pulmonary tuberculosis, Bronchial asthma, Chronic Bronchitis, Diabetes mellitus, Malignancy and those who were drug and tobacco addicts were excluded. The study group was categorized according to the duration of the services at the petrol pumps which was two groups. The PFT were performed at their work place by using a digital spirometer 2010. The testing procedure is quite simple, invasive and harmless to the subject. The FEV, FEV/FC, FEF 25-75%, FEF 75-85%, FEF and MVV, values are calculated. The data was analyzed by using the computer software, MS EXCEL, statistical package of social science. The mean and SP were calculated and reported for the quantitative variables.

The statistical difference, in the mean values was tested by using one way analysis of variance. P value (0.05) are considered as statistically significant.

Group Duration of Servies No. of Cases

1. Persons working at petrol pump Below 4 years (Group II)
2. Persons working at petrol pump Above 4 years (Group I)
3. Control group (Group III)

Results and Observations

Table 1: Showing the Means and SD of the workers working above 4 years and below 4 years and controls.

Variables	Working Above 4 years (Group I)	Working below 4 years (Group II)	Control's BMI (Group III)
Height	1.650±0.07	1.640±0.12	1.690±0.08
Weight	70.03±11.65	70.0±11.09	66.08±6.54
BMI	24.95±5.43	27.38±6.11	29.57±22.21

Table1 shows that mean values of the height of Group I and Group II i.e. 1.64±0.12 and1.65±0.07 respectively. Mean values of the controls (Group III) was observed to be 1.69±0.08 and the differences was not significant. The mean values of the weight of the subject of Group I and Group II was observed to be 70.03±11.65 and 70.00±11.09 respectively and Mean values of the control group 66.08±6.54 and differences was statistically not significant. The differences observed in BMI of Group II, Group I and controls was also not significant i.e. 27.38±6.11, 24.95±5.43 and 29.57±22.21.

Table 2: Showing the p value of the above 4 years, below 4 years and controls.

	Height	Weight	BMI
Above 4 years compared (Group I) with below 4 years (Group II)	0.70	0.90	0.75
Above 4 years compare (Group I) with Controls (Group III)	0.19	0.07	0.02
Below 4 years compare (Group II) with Controls (Group III)	0.20	0.06	0.03

Observed p-values are given in the table No: 2, There is not significant increase in height was observed between three groups (0.70,0.19,0.20). Values of weight is also not significantly increased when Group I compared with Group II (0.90), and Group II compared with controls(0.06). Whereas significant increase in weight was observed when compared between Group I and Group II i.e 0.07. The BMI is not increased when comparison made between Group I and Group II (0.75) but Whereas increase in BMI observed when group I compared with controls and Group II compared with controls i.e.0.02,0.03 respectively.

Table 3: Showing the Means and SD of the above 4 years, below 4 years and Controls.

	Above 4 years (Group I)		Below 4 years (Group II) MEAN±SD		Controls (Group III) MEAN±SD	
	Mean	SD	Mean	SD	Mean	SD
TV	0.28	0.12	0.36	0.19	0.51	0.14
FVC	2.20	0.89	2.42	0.96	3.47	0.65
FEV1	1.92	0.79	2.32	0.93	3.19	0.56
FEF25-75%	3.54	1.40	3.39	1.10	3.99	1.17
FEF75-85%	1.70	0.85	2.21	0.80	2.28	0.88
PEF	4.99	1.77	5.8	2.2	6.89	1.56
MVV	32.45	7.69	38.80	12.17	44.62	9.23

Mean values of the Tidal volume for group I, Group II and Group III was observed to be 0.28±0.12, 0.36±0.19 and 0.51±0.14 respectively. However differences of mean between these three groups were statistically not significant. Differences of mean values of FVC observed for Group I; 2.20±0.89, Group II; 2.42±0.96, and Group II; 3.47±0.65 was also statistically not significant. Differences observed for mean values of the FEV between these three groups (Group I; 1.92±0.79; Group II; 2.32±0.93 and Group II; 3.19±0.56) was statistically not-significant. Mean values of FEF 25-75% of the subjects of group I, Group II and Group III was 3.54±1.40, 3.39±1.10 and 3.99±1.17 respectively and the differences were statistically decreases. Differences of mean values of the FEF 75-85% for Group I; 1.70±0.85, group II; 2.21±0.80 and group III; 28±0.88 and that were also significantly decreases. Mean values of the PEF for Group I, Group II and Group II was observed to be 4.99±1.77, 5.8±2.2 and 6.89±1.56 respectively and the differences observed between mean of these three groups

were statistically decreases. Mean values of MVV for Group I; 32.45±7.69, group-II; 38.80±12.17 and groupie; 44.62±9.23 were found to be significantly decreases.

Table 4: Showing the Means and SD of the above 4 years, below 4 Years and Controls of FEV/FC.

	Above 4 years ((Group I)		Below 4 years (Group II) MEAN±SD		Controls (Group III) MEAN±SD	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
FEV/FC	99.62	7.56	97.54	11.09	92.78	10.6

Table 4, shows that the mean and SD values of the FEV/FC of the subjects of Group I, Group II and Group III was observed to be 97.54±11.09, 99.62±7.62 and 92.78±10.6 respectively

Table 5: Showing the P-value of the group-B below 4 years and control groups

	Above 4 years compared with below 4 years p-value	Above 4 years compared with controls p-value	Below 4 years compared with controles p-value
TV	0.04	0.1	0.1
FVC	0.07	0.1	0.2
FEV1	0.04	0.1	0.1
FEV/FEC	0.20	0.03	0.11
FEF25-75%	0.59	0	0.02
FEF75-85%	0.02	0.01	0.6
PEF	0.17	0	0.03
MVV	0.01	0	0.01

As compared to control group, p-value of the" TV" was significantly decreased in both subjects involve in Group I (0.1) and Group II (0.1) working at the petrol pump. But, p value of comparison of between group I and Group II (0.04) was not-significantly decreased. p-values of the FVC significantly decreased in both Group I (0.1)and Group II (0.2) experienced persons in the petrol pump when compared with controls. But when comparison mead between two study group p-values (0.07) was not significantly decreased. p-values of the FEV was significantly decreased in Group I (0.1) and Group II (0.1) experienced persons in the petrol pump when they compared with control group. Comparisons between two study groups show that p value (0.04) was not significantly decreased. The P-value of the FEV/ FEC value was significantly increased in Group I (0.03) when compared to controls. While increased in Group II (0.11) as compared to controls. Comparison between persons of two study groups include workers of study group, P-value (0.20) was not significantly decreased. p-value of FEF 25-75%, was significantly decrease in both Group I (0) and Group II (0.02) experienced in the petrol pump workers as compared to control. Comparison between two study groups includes experienced persons in the petrol pumps the observed p-value (0.59) was not-significantly decreased. The p value of the PEF 75-85% values were not-significantly decreased in Group I (0.01) and in Group II (0.6) significantly decreased as compared with controls. Whereas comparison between persons includes in two study groups i.e. Group I and Group II, working at petrol pump the p-value (0.02) was observed to be significantly decreased. p-value observed for PEF was significantly decreased in both above 4 years (0) and below 4 years(0.3) experienced persons in the petrol pump compared with controls. Whereas comparison between Group I and Group II experienced person in the petrol pump workers the p-value (0.17) was not-significantly decreased. The P-value for MVV category of was significantly decreased in both above 4 years froup (0) and below 4 years group (0.01) experienced person in the petrol pump workers compared with controls but when compared between above 4 years and below 4 years experienced persons in the petrol pump the P-value (0.01) was not-significantly decreased.

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 (Innes and Reid, 2006) [13]. Also there was a statistically significant decrease in FEF 75-85% and MVV values in below 4 years as compared to above 4 years. As petrol pump workers in the present study were exposed to petrol and diesel vapors for a longer period of time (10 hours/day, >1 year), they were likely to develop chronic respiratory impairment as indicated by the results of the present study.

In addition to this, it was found that all the lung volumes were decreased in petrol pump workers when compared to control group and the decrease was more in workers working for more than 4 years when compared to those who have worked for less than 5 years. Our findings suggest that exposure to petrol vapour fumes, diesel exhaust and airborne particulate matter leads to impairment in lung functions. This impairment increases with increased duration of exposure.

Petrol is a complex combination of hydrocarbons, which on emission generates particles with a diameter of 0.02 nm. These particles, due to their large surface area, can carry various toxic compounds that are likely to remain in atmospheric air for a longer period and can deposit them in the small airways on inhalation (Madhuri and Chandrashekar, 2012) [15]. Long-term exposure to such particles can cause chronic respiratory impairment, which includes lung parenchyma and small airways. The ambient air concentration of carbon monoxide (CO) has been found to be maximum in areas surrounding petrol stations during peak hours (6 a.m. - 2 p.m.), as compared to residential areas, in a study done by Nazia Uzma *et al*.(2008) [4].

Exposure to petrol fumes, vapours and other pollutants leads to different respiratory symptoms and derangement in lung function. These changes are mainly due to increase in airway resistance and inflammatory changes in lungs due to exposure to petrol exhaust and petrol vapour fumes. Li XY *et al* (1999) [11, 16] reported that neutrophil influx into lungs and increase in broncho alveolar lavage fluid concentrations of tumor necrosis factor á in rats following intratracheal instillation of ultrafine carbon particles.

Benzene found in petrol fumes can also be absorbed in the lungs by inhalation.7 Benzene content present in petrol is in the range of 1-5%. Benzene is an exaggerating cause for lung function derangements in petrol pump workers (Nightingale *et al*., 2000) [10, 17]. Similar results were reported by Neena Sharma *et al* (2012) [18] and Singhal M *et al* (2007) [19].

Hence chronic exposure to petrol vapours, fumes and related particulates can lead to chronic inflammation of respiratory tract and lung parenchyma. Therefore future study could be extended to evaluate status of alveolocapillary membrane, by determining lung diffusion capacities in these workers.

Conclusion

We found lung function abnormalities in petrol pump workers. The pattern of respiratory impairment is restrictive, which changes to a mixed variety as the duration of exposure to petrol vapour. In order to prevent lung damage in petrol pump workers awareness programmes should be conducted and also pre-employment check up and periodic medical checkups which include pulmonary function tests should be conducted to detect any lung function impairment at the earliest. Use of protective masks can also reduce exposure to pollutants. Control strategies to reduce benzene concentration in air emission, improvement in engine design, soot filters and fuel modification such as use of biodiesel can also go a long way in reducing exposure hazards. Study group who have lung function impairment during the study were advised to practise yoga exercises related lung functions like pranayama, sukhasana studies are required to investigate the effects on the diffusion capacity of the lungs and other pulmonary markers in petrol pump workers.

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