Lung function abnormalities among petrol-pump workers of Lucknow, North India

Petrol (gasoline) is a complex combination of hydrocarbons. About 95% of the components in petrol vapour are aliphatic and alicyclic compounds and less than 2% aromatics[1]. The benzene content of petrol has typically been in the range 1–5%, but may have risen following the removal of lead additives[2]. Typical 8 h benzene exposure concentrations in distribution and retail operations average less than 1 ppm, although exposures can reach 2–3 ppm for shorter (say: 30–120 min) periods[3]. India does not have an air quality standard for benzene. In the UK, the permissible annual average limit is 16.5 μg/cum. A Delhi pollution control committee study[4] revealed high levels of benzene at the Delhi Traffic intersection (Jail Road Shivaji Marg crossing –7817 μg/cum) and Delhi residential areas (Guru Teg Bahadur enclave –10161 μg/cum). The concentration of benzene in commercial petrol in India is generally between 0.5 and 3.5% and average concentration is 1.43 ppm in Kanpur and 1.17 ppm in Lucknow. The overall concentration of benzene at petrol pumps was 1.50 ppm; sulphur dioxide 0.03 ppm, photoionizable materials (0.5–160 ppm) and airborne dust concentration (0.518 mg/m^3).

Petrol evaporates more readily in hot than cold countries. In India, petrol-pump attendants are the norm rather than self-service, increasing the opportunity for exposure. Petrol-pump attendants do not wear personal protective equipment and personal hygiene is variable in the workplace. Under prevailing working conditions, benzene can be absorbed in the lungs by inhalation. Studies on health conditions in petrol-pump workers have concentrated on clinical symptoms with limited reports on lung function or respiratory morbidity of workers exposed to petrol-pump vapour. The aim of this study was to see whether petrol-pump workers exposed to petrol fume in India had an altered pulmonary function.

Two hundred and thirty out of three hundred male petrol-pump workers were selected from fifteen petrol pumps of Lucknow city limits. A list of total petrol pump workers from all over Lucknow was considered as sampling frame. Randomly, 230 samples were selected and smokers were excluded from the study. All petrol-pump workers selected were non-smokers, in order to exclude the exacerbating factor of effect of smoking exposure on lung functions in the workers. The workers were engaged in petrol filling for eight hours a day. Details of occupation (duration and nature) were collected using a pre-structured proforma.

Spirometry was performed using an electronic computerized portable spirometer according to the guidelines recommended by American Thoracic Society[5]. The best result from three attempts was accepted. Standing height and weight of all workers were also recorded. The spirometer was calibrated each day prior to use. The following parameters were studied: vital capacity (VC); forced vital capacity (FVC); forced expiratory volume in 1 s (FEV1); forced mid-expiratory flow rate (MMEF); peak expiratory flow rate (PEFR). Respiratory impairment (obstructive, restrictive, mixed and peripheral airway obstruction (PAO)) was classified on the basis of the following criteria – restriction: FVC (<80% predicted) or VC (<70% predicted); obstruction: FEV1% or FEV1/FVC% and PEFR (<80% predicted); mixed: VC (<70% predicted), FVC%, and FEV1%, MMEF% or PEFR (<80% predicted); PAO: MMEF (<80% predicted).

Predicted values of lung functions were calculated using Rastogi's prediction equation[6] and per cent predicted was calculated for alteration in lung functions among workers. Linear multiple regression analysis was carried out considering each lung function value as a dependent variable, age and years of exposure as independent variables. Since age was considered as a confounding variable while comparing the mean lung function in different exposure groups, age-adjusted least square estimates of the lung function in the different exposure groups are presented. Prevalence of various lung abnormalities in different exposure groups was compared using Mantel Haenszal procedure for calculating the age weighted odds ratio. The significance is calculated using Mantel Haenszal's chi square test.

The mean age of the study group was 30.6 years (± 11.34), with a mean height of 164.46 cm (± 5.9) and weight 57.8 kg (± 11.70). Table 1 shows observed and predicted mean value of lung functions in petrol-pump workers. Except in the case of PEFR (% predicted), all other parameters show lower observed value among workers compared to the predicted value.

Multiple regression analysis showed that regression coefficients of age were not found to be significant for all lung function parameters, whereas exposure years showed a significant regression coefficient ($P < 0.001$) for all lung functions, except PEFR. The age-adjusted mean least square estimates in the two exposure groups along with the observed values are presented in Table 2. The data showed significant reduction in all lung functions in subjects exposed for more than 5 years except PEFR, in contrast to subjects for less than or equal to 5 years.

The crude impairment rates in different exposure groups with age-weighted odds ratio are presented in Table 3, considering ≤ 5 years exposure group as base. No significant association in any of the impairment rates with exposure was observed.

Our study demonstrates altered lung function in petrol-pump workers related to duration of exposure. Decline in observed values of VC, FVC, FEV1 (Tables 1 and 2) among petrol pump workers when compared to predicted value and also exposure-wise denotes prevalence of restrictive type of lung diseases. Reduced mechanical properties of breathing due to exposure to benzene in the vapours of

Table 1. Observed and predicted mean values of lung function of petrol-pump workers

Parameter	Observed	Predicted	Per cent predicted
VC	3.26 ± 0.60	3.76 ± 0.39	64.97 ± 39.30
FVC	3.26 ± 0.67	3.76 ± 0.39	64.41 ± 39.76
FEV1	2.76 ± 0.60	2.97 ± 0.38	67.63 ± 43.16
MMEF	2.57 ± 1.07	3.02 ± 0.61	64.64 ± 52.24
PEFR	463 ± 56.53	539 ± 37.64	86.27 ± 37.31

Table 2. Observed and age-adjusted mean value of lung function of petrol-pump workers with regard to period of exposure after adjusting the age.

	Year of exposure				
	≤ 5 yrs (N = 126)		≥ 5 yrs (N = 104)		
Parameter	Observed mean ± SD	Age-adjusted mean value	Observed mean ± SD	Age-adjusted mean value	P value
VC	3.42 ± 0.54	3.42 ± 0.007	3.06 ± 0.62	3.06 ± 0.006	<0.001
FVC	3.43 ± 0.59	3.44 ± 0.04	3.04 ± 0.72	3.04 ± 0.03	<0.001
FEV1	2.90 ± 0.59	2.90 ± 0.09	2.58 ± 0.58	2.58 ± 0.07	<0.001
MMEF	2.69 ± 1.05	3.27 ± 0.01	2.41 ± 1.08	2.74 ± 0.01	<0.001
PEFR	459.68 ± 51.15	542.9 ± 4.0	466.67 ± 62.94	534.8 ± 3.5	NS

NS, Nonsignificant.

Table 3. Respiratory impairment rates in petrol-pump workers with regard to year of exposure with age-adjusted odds ratio

	N = 126 ≤ 5		N = 104 >5					
Respiratory impairment	n	%	n	%	Age-adjusted odds ratio	95% CL (LCL,UCL)	P value	
Restriction	6	4.76	6	5.8	1.82	0.43–8.51	0.54	NS
Obstruction	8	6.35	1	1.0	1.88	0.41–10.25	0.56	NS
Mixed	2	1.59	4	3.8	0.51	0.08–2.70	0.56	NS
PAO	11	8.73	12	11.5	0.77	0.30–2.01	0.72	NS
Restriction/PAO	1	0.79	5	4.8	0.30	0.03–1.55	0.18	NS
Obstruction/PAO	12	9.52	5	4.8	1.91	0.56–7.29	0.38	NS
Mixed/PAO	17	13.49	13	12.5	0.90	0.37–2.19	0.95	NS
Total	57	45.23	46	44.23	0.86	0.48–1.52	0.67	NS

LCL, Lower confidence limit, UCL, Upper confidence limit.
NS, Nonsignificant.

petrol may have resulted in respiratory impairments. Steady reduction in the capacity of MMEF denotes PAO.

Overall prevalence of mixed with PAO type of respiratory impairment was higher among petrol-pump workers (Table 3). The results show that mixed/PAO type of respiratory impairment was observed during early periods of exposure (<5 years) itself and it continued to persist in other exposure groups (> 5 yrs group). Lack of health awareness and lack of protective measures during work among petrol-pump workers may have led to lung function abnormality among them.

Although several studies[7–11] are available regarding the work exposure of petroleum products, a detailed study on lung function abnormalities among petrol-pump workers due to work exposure is lacking. The study has given an indepth view on the different types of lung function abnormalities among petrol-pump workers. A larger sample size study and a follow-up study annually on lung function abnormality among workers may have given more insights into the results.

There is lack of information from other investigators regarding the lung function abnormalities due to work exposure in petrol-pump workers from India. Hence a comparative study cannot be undertaken and strengths and weaknesses in relation to other studies have not been deciphered. Benzene in petrol may be an exacerbating factor for the symptoms observed, as most of the workers were non-smokers. Control strategies to be adopted to reduce the benzene concentration in air emission include evaporation controls, the use of catalytic converters and reducing benzene concentration in fuel. Frequent health check-up should be done among workers. As ambient air quality guidelines in India are not available, the need of the hour is to set a guideline for safe standard level for benzene for a better environment.

Quantitative analysis shows reduced lung function and thereby respiratory impairment in petrol-pump workers in the present study. Higher prevalence of mixed PAO was observed in petrol-pump workers.

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