Original Article

Low Pulmonary Function in Petrol Pump Workers in Trivandrum City

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Abstract

Background : Petrol pump employees are constantly exposed to petroleum vapours and vehicular exhaust. This causes various health problems, particularly in the lungs. Although studies have been conducted in other parts of the country on lung function in petrol pump workers, none have been published from Kerala. This study aims at determining whether these workers in Kerala have any abnormality in pulmonary function.

Objective : To determine whether the pulmonary function (as measured by Forced Expiratory Volume in 6 seconds (FEV_6)-% predicted, Forced expiratory volume in first second(FEV_1)-%predicted and ratio of FEV_1 to FEV_6 (FEV_1 / FEV_6 ratio)) is different in petrol pump workers as compared to age-sex matched controls in Trivandrum.

Method : Cross sectional study. Study population consisted of 30 petrol pump workers who have been working for more than one year and 30 age-sex matched individuals from various residential areas in Trivandrum. Height, weight, smoking index, history of asthma were recorded. The parameters, FEV_6%-predicted, FEV_1%-predicted and the FEV_1/FEV_6 ratio were assessed using a handheld spirometer. The study was conducted from July to October 2013.

Result : Petrol pump workers and controls selected from general population were comparable for height, weight, smoking index and history of asthma. The median values (with inter quartile range) of FEV_6%-predicted in petrol pump workers and general population were 77.5(67-87) and 87(82-91) respectively; of FEV_1%-predicted were 78 (66-88) and 86 (78.6-89.7) respectively and FEV_1/FEV_6% were 82.5 (80-87) and 82.5(79-86) respectively. The difference in the median FEV_1%-predicted and FEV_6%-predicted between petrol pump workers and general population were statistically significant. Proportion of Petrol pump workers with FEV_1%-predicted and FEV_6%-predicted below 80% and FEV_1/FEV_6% below 70% were higher and the difference in proportions was statistically significant.

Conclusion : Petrol pump workers have a lower lung function in terms of FEV_1%-predicted and FEV_6%-predicted. The FEV_1/FEV_6 ratio was not statistically significantly different between petrol pump workers and general population even though the proportion with a FEV_1/FEV_6 ratio less than 70% was significantly higher in petrol pump workers.

Introduction

With urbanisation and rapidly increasing number of automobiles in most of the towns and cities, there is an increase in air pollution.Health effects of occupational exposure to petroleum vapours and air pollution from vehicular sources is less explored among petrol pump workers. Petrol or gasoline is a complex combination of hydrocarbons. 95% of components in petrol vapour are aliphatic and acyclic compounds and less than 2% are aromatics. The benzene content of petrol is in the range 1–5%[1].

Petrol pump is a place where workers are exposed to both petroleum vapours and the vehicular exhaust. The combined effects of the two may result in impairment in pulmonary function.

Petrol pumps in India rather than being self serviced, employ workers, increasing the opportunity for exposure. Long-term exposure to petrol vapour has shown to affect the different physiological systems in the body. To meet the present day requirement, there are many petrol pumps getting established and there is an increased recruitment of workers. Because of the predominant role of petrol (gasoline) as a motor vehicle fuel, the effects of gasoline engine emissions pose even greater problems.

Similar studies have been done in other states of India, but no studies have been published yet from Kerala. Since Kerala is a highly literate state, with greater heath awareness, the authors wanted to determine if the petrol pump workers in Kerala had any abnormality in their pulmonary function. The present study attempts to evaluate the changes in Pulmonary Function Test (PFT) of petrol pump workers as compared to age and sex matched individuals in Trivandrum City.

Specific objectives of the study were to determine whether the following pulmonary function tests - FEV_1 as percent of predicted, FEV_6 as percent of predicted and FEV_1/ FEV_6 ratio is different in petrol pump workers as compared to age and sex matched individuals in Trivandrum.

Materials and Methods

The study was a cross sectional study. Study setting was petrol pumps and residential neighborhoods in Trivandrum. The study period was from July to October 2013. The sample size was calculated using the formula for difference in means (with results of similar studies done previously) and was found to be 13. However, as per the statistician's advice, the sample size was fixed as 30 petrol pump workers and 30 age-sex matched individuals, amounting to a total of 60.Petrol pump workers who have been working for more than one year were included in the study.Those not willing to give consent were excluded. Age-sex matched individuals were recruited from various residential areas in Trivandrum. Departmental ethics clearance was obtained from the Department of Community Medicine, Trivandrum Medical College as per institutional ethics committee norms. Verbal informed consent was obtained from all the participants of the study. Subject confidentiality was ensured.

Data Collection

Study tool used was a handheld portable computerised spirometer. The subjects were familiarised with the setup and detailed instructions were given. Tests were performed in a standing position. The subjects were asked to breathe forcefully following deep inspiration into the mouthpiece attached to the spirometer. Expiration was maintained for a minimum period of 6 seconds, at least three acceptable trials were made and the highest reading obtained was taken for analysis. The absolute values of Forced Expiratory Volume in six seconds(FEV_6) (taken as surrogate for Forced Vital Capacity), Forced Expiratory Volume in the first second (FEV_1) and FEV_1/FEV_6; and the percentage of predicted for the first two were recorded.

The instrument used was Vitalograph COPD-6, model 4000. The instrument was validated in the Trivandrum scenario and Cronbach's alpha value was found to be 0.81 and 0.75 for the parameters FEV_1 and FEV_6 when compared to a full spirometer[2].

Statistical Analysis

Data was entered into Microsoft Excel and analyzed using EpiInfo 7 (©CDC Atlanta).Quantitative variables were expressed as mean (SD) and qualitative variables as proportions. The 'percent of predicted' values of FEV_1, FEV_6 and the absolute values of FEV_1 / FEV_6 were compared between the petrol pump workers and the controls. These variables were tested for significance using the Kruskal-Wallis H test. The other quantitative variables like age, height, weight and smoking index were compared using the student t test and the chi square test was used to compare qualitative variables (proportions). A p-value of less than 0.05 was considered significant.

Results

Petrol pump workers and controls from general population were found to have no difference in parameters like age, sex, height, weight, history of asthma and smoking and shown to be adequately matched. [Table no 1]. The median percent of predicted values for FEV_1 and FEV_6 were statistically significantly lower in petrol pump workers as compared to controls whereas the median FEV_1/FEV_6 ratio was not significantly lower [Table no 2]. Proportions of patients with percent of predicted values for FEV_1 and FEV_6 below 80% and FEV_1/FEV_6 ratio below 70% which could indicate obstructive lung pattern were determined. [Table no 3]. Relative risk for Percentage-predicted-FEV_1 and Percentage-predicted-FEV6 less than 80% was 1.83 (95%CI 1.1, 3.04) and 2.43 (95%CI 1.49, 3.96) respectively and for proportion of FEV_1/FEV_6 less than 70% was significant (p value 0.01). Logistic regression was done for factors associated with low FEV_1, and low FEV_6, including age, sex, height, weight, past history of Asthma and smoking in the models and the adjusted odds were still found to be statistically significant.

Table 1 :

Baseline Characteristics of petrol pump workers and general population

Baseline Characteristic	Petrol Pump Workers (30)	General Population (30)	p Value
Age (yrs)	42.27 (±14.68)	40.57(±14.69)	0.66
Sex (F)	7 (23%)	8 (26%)	0.77
Height (cm)	165.07(±7.45)	165.57(±6.85)	0.79
Weight (kg)	65.07(±8.79)	66.72(±6.65)	0.41
History of asthma (Y)	2 (6%)	1 (3%)	0.55
History of smoking(Y)	9 (30%)	6 (20%)	0.37
Smoking Index (pack years)	0.71(±1.54)	0.72(±1.79)	0.99

* Numerical variables expressed as mean (± standard deviation) and categorical variables expressed as number (%).

* Numerical variables tested for significance using students t test and categorical variables compared using chi square test.

Table 2 :

Lung function of petrol pump workers and general population

Pulmonary Function parameter	Petrol Pump Workers (30)	General Population (30)	p Value*
FEV_1% predicted	78 (66-88)	86 (78.6-89.7)	0.005
FEV_6% predicted	77.5 (67-87)	87 (82-91)	0.003
FEV_1/FEV_6%	82.5 (80-87)	82.5 (79-86)	0.739

* Values in %, expressed as median (Inter-quartile range)

* Kruskal-Wallis H test

Table 3 :

Proportion of subjects with abnormal values of lung function parameters

PFT Value	Petrol Pump Workers (30)	General Population (30)	p Value*	RR (95% CI)*
FEV_1% predicted <80%	17(56.67%)	8(26.67%)	0.018	1.83 (1.1, 3.04)
FEV_6% predicted <80%	17(56.67%)	4(13.33%)	<0.001	2.43 (1.49, 3.96)
FEV_1/FEV_6% <70%	6(20%)	0(0%)	0.011	Undefined

* OR – Relative risk; 95% CI – (95% confidence interval)

* Chi square test was used for comparison

Discussion

Similar studies were conducted in petrol pump workers and general population of Mysore, Kancheepuram, Delhi and Jammu[3,4,5,6]. These studies also showed significant lowering of PFT values except FEV_1/FEV_6 ratio in petrol pump workers.We have obtained similar results in Trivandrum i.e. both the FEV_6%predicted and FEV_1% predicted are significantly lower in petrol pump workers as compared to the general population but the absolute val-

ues of FEV_1/FEV_6 ratio were not statistically significantly different in petrol pump workers as compared to controls. However 20% of petrol pump workers were seen to have obstructive lung pattern i.e. FEV_1/FEV_6 ratio < 70% whereas none among the general population had FEV_1/FEV_6 ratio <70%, this difference in proportions was statistically significant (p=0.011). This obstructive pattern among the petrol pump workers (20%) is possibly explainable by the vehicular exhaust and fumes [7,8]. Automobile emissions are known to enhance airway response to inhaled allergens in suceptible subjects and vehicular fumes can also result in COPD in such subjects.

Petrol constituents (hydrocarbons) are the source of exhaust. However petroleum hydrocarbons have been shown to have a different effect on the lung. They cause an increase in lung tissue malondialdehyde (MDA), an index of lipid peroxidation. They also cause decrease in glutathione content and activities of superoxide dismutase. Hence a lowering of antioxidant activity is seen. All these cause oxidative stress which causes loss of cell and tissue integrity. This could explain the edema and hemorrhagic necrosis of lung tissue following exposure to petroleum hydrocarbons. Studies have reported that exposure to petroleum hydrocarbons impairs type II pneumocytes resulting in a decreased production of surfactant and consequent alveolar collapse, ventilation-perfusion mismatch, and hypoxemia. This ultimately leads to hemorrhagic alveolitis, interstitial inflammation, intra-alveolar hemorrhage and edema, hyperemia, bronchial necrosis, and vascular necrosis which leads to defective lung parenchyma and causes a restrictive pattern[9].

In this study also FEV_1 and FEV_6 percentage of predicted values are statistically significantly lowered. FEV_1/FEV_6 values did not show any statistically significant lowering, even though the porportion of those with values less than 70% was different between the two groups.About 20% of petrol pump workers had obstructive pattern on spirometry. Workers have exposure to vehicle fumes thereby leading to probable COPD.The restrictive changes indicate some form of parenchymal lung damage, which needs to be further evaluated. Further tests including body plethysmography, DLCO measurement and HRCT in cases with higher degree of restriction, may provide further information on the pattern of lung damage in these patients and whether these changes indicate early interstitial lung disease. Such evaluation would also lead to findings which will lead to providing information on safety measures needed for the petrol pump workers.

Recommendations

Obstructive and restrictive lung pattern suggest that workers may be given protective masks to escape petrol vapour and vehicular exhausts. However further studies, as described above need to be done to determine if dust masks, which provide protection against fine particulate matter or half/full facepiece gas masks/chemical cartridge respirators, which filter and clean chemical gases and particles out of the air, are more appropriate for these workers[10]. Periodic health checkups of workers may be planned to identify those at risk early and provide them with alternative career options. Also, they can be educated about additive risk factors (like smoking) that may aggravate their risk of developing lung pathologies[11].

Limitations

Lung function was measured using a portable hand held spirometer. The community controls were not chosen from the same community as that of the petrol pump workers, so there could be potential confounders. While a history of Asthma was elicited, detailed clinical examination for other diseases like COPD or other respiratory illnesses, were not done and other investigations like a chest skiagram were not obtained.

Conclusion

FEV_1%-predicted and FEV_6%-predicted are significantly lower in petrol pump workers compared to age and sex matched controls whereas FEV_1/FEV_6 ratio was not significantly lower even though the proportion of those with FEV_1/FEV_6 ratio less than 70% was higher.The proportion of those with subnormal lung function were more in petrol pump workers and the difference was statistically significant between the two groups for all three parameters.

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