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RESEARCH ARTICLE

A study of pulmonary function test, diffusing capacity of lungs for carbon monoxide and hematological parameters among petrol pump workers

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ABSTRACT

Background: Currently, air pollution is one of the crucial issues with growing concern. Automobile exhaust consists of mixture of soot, gases including oxides of sulfur and of nitrogen, carbon monoxide and liquid aerosols and particles. It leads to various lung disorders, carcinogenesis and changes in hematological parameters. **Aims and Objective:** To detect the presence and extent of changes in pulmonary function tests and changes in hematological parameters in petrol pump workers. **Materials and Methods:** It was a cross-sectional study. Study subjects comprised 60 males working at different petrol pumps. Healthy counterparts were taken as controls. The study subjects were given pre-designed questionnaire, and data were collected in preformed case record form. Investigations such as sputum for acid fast bacilli, spirometry, diffusing capacity of lungs for carbon monoxide (DLCO), and hematological parameters like hemoglobin (Hb)% and packed cell volume (PCV) were done. Data for all parameters were analyzed by software Microsoft excel and Graph pad prism5. **Results:** There was no statistical difference in the baseline characters of study and control groups. There was a significant decline in Hb% and PCV in petrol pump workers as compared to control group. Decrease in values of forced vital capacity, forced expired volume 1, and forced expiratory flow 25-75% is noted in petrol pump workers. Values of DLCO% predicted were mildly decreased in Group II and mild to moderately in Group III. **Conclusions:** The lung function tests and hematological tests (Hb, PCV) in petrol pump workers were significantly lower than control group. Lack of awareness and protective measures during duty hours by these workers may have led to lung function abnormality and hematological changes among them.

KEY WORDS: Hematological Tests; Petrol Pump Workers; Pulmonary Function Tests; Forced Expiratory Volumes

INTRODUCTION

Air pollution from vehicles is an unavoidable part of urban life worldwide. Although the number of vehicles in India are far less than in developed countries, exhausts emissions are significantly larger due to low-grade fuel, defective engine performance, poor maintenance of engine, lack of proper traffic planning, and multiplicity of types of vehicles on same road. Automobiles contribute to pollution of our atmosphere by emission of gases and particle bound organic and inorganic compounds.[1]

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Petrol also called gasoline is a complex combination of hydrocarbons. About 95% of components in petrol vapor are aliphatic and acyclic compounds and <2% are aromatic.[2] Diesel is a distillate of petroleum which contains paraffin, alkenes, and aromatics.[3] On combustion in automobile engines exhaust fumes containing mixture of soot, gases including oxides of sulfur (SO_2) and of nitrogen, carbon monoxide (CO) and liquid aerosols and particles are produced.[4] Benzene and toluene are major monocyclic hydrocarbons in petrol with nitropyrene in diesel exhaust emission.[5] Occupational safety and health administration places permissible exposure limit for benzene is 1 ppm.[6] India does not have an air quality standard for benzene; still it is used in petroleum fractions and distillates. Petrol pump workers are exposed to an increased risk of inhaling fuel vapors.

The effect of air pollution include chronic cough, wheezing, breathlessness and alterations in the body defense system against foreign materials, damage to lung tissue and carcinogenesis.[7] In very high concentrations benzene and other products can cause marked systemic pulmonary inflammation. The particles generated from petrol exhaust are extremely small with diameters of 0.02 nm and 0.2 nm, respectively. Further, the surface area is large so they can carry much larger fraction of toxic compounds, such as hydrocarbons and metals on their surface. They deposit in greater numbers and much deeper into the lungs when compared to the large sized particles. Furthermore, transport of oxygen to cells is hindered by methemoglobin, a by-product of benzene metabolism in the body resulting in functional anemia. The hematopoietic system is highly sensitive to most of the air pollutants because these cells recycle continuously. The solvents and air pollutants may lead to defective heme synthesis and reduced life expectancy of red blood cells.

Detailed study on the lung function abnormalities among petrol pump workers caused due to work exposure was lacking in this geographical region. Hence, This study was undertaken to assess whether petrol pump workers expose to air pollutants have changes in pulmonary function tests (PFTs) and to evaluate the diffusing capacity of lungs for carbon monoxide (DLCO) and changes in hematological parameters such as hemoglobin (Hb) and packed cell volume (PCV) of the study group.

MATERIALS AND METHODS

This cross-sectional study was conducted from November 2010 to June 2012. Approval by Institutional Ethics Committee was taken before commencement of the study. Study subjects comprised 60 males working at different petrol pumps located in areas having large trafficking of vehicles throughout the day. They were categorized according to their duration of service at the petrol pump. There were 60 controls which comprised healthy adult males working in a medical college and hospital as class four workers and contract basis workers.

Study Groups

Group I: Control group. 60 individuals of age range 25-35 years who were not working at petrol pumps for each test group.

Group II: 30 petrol pump workers in age group 25-35 years working at different petrol pumps for 1-5 years duration.

Group III: 30 petrol pump workers in age group 25-35 years working at different petrol pumps for 5-10 years duration.

The healthy male individuals in age group of 25-35 years were included in the control group. The study group consists of individuals in age group of 25-35 years engaged in petrol filling for more than 8 h/day for 6 days a week for duration of 1-10 years. The individuals with any history of habit of smoking, tobacco chewing, alcohol intake, history of any respiratory diseases in past or respiratory symptoms at present, any cardiac pathology, any history of abdominal or thoracic surgery anemia or any recent history of eye surgery, hemoptysis of unknown origin were excluded from the study.

Study subjects were given pre standardized questionnaire, and data were collected in preformed case record form. Written informed consent was taken from all subjects. In every study groups, age in years, height in centimeters and weight in kilograms were noted. Body mass index (BMI) was calculated and expressed in kg/m^2. Investigations such as sputum for acid-fast bacilli, spirometry, DLCO single breath ($DLCO_{SB}$), and hematological parameters such as Hb% and PCV were done in outpatient department.

PFT was recorded using medigrahics USA body plethysmograph Elite DL model no. 830002-308. This spirometer met American Thoracic Society criteria and was volume calibrated. All the gas volume was corrected to body temperature, ambient pressure, saturated with water vapor (BTPS) factor automatically by the instrument to give values at BTPS. DLCO was done on body plethysmograph machine by Ogilvie technique, and we followed the guidelines of American Thoracic Society.

Statistical Analysis

Data for all parameters were analyzed by software Microsoft excel and Graph pad prism 5. Analysis was performed using tests of significance analysis of variance (ANOVA) test and Tukey's *post-hoc* test.

RESULTS

Demographic data are as shown in Table 1. The values of mean age, height and weight for Groups I, II and III was compared by ANOVA test. Values were not statistically different from each other.

Study subjects were evaluated for hematological parameters such as Hb% and PCV. Mean values of Hb% for Groups I, II and III was taken and compared by ANOVA. Intergroup comparison was done by Tukey's *post-hoc* test. There was a progressive decline in mean values of Hb in Groups II and III as compared to Group I (control). Difference between mean values of Hb among three groups was statistically significant ($P < 0.0001$). The mean value of Hb differs statistically among Groups I, II and III ($P < 0.01$). Results were as depicted in Figure 1.

Mean values of PCV for Groups I, II and III are taken and compared by ANOVA. Intergroup comparison was done by Tukey's *post-hoc* test. There was a progressive decline in mean values of PCV in Groups II and III as compared to Group I (control). Difference between mean values of PCV among three groups was statistically significant ($P < 0.0001$). Results were as depicted in Figure 2.

Forced vital capacity (FVC) was compared among control and study groups. It was suggestive of a progressive decrease in value of FVC among three groups. After applying ANOVA test, the difference in mean values of FVC among Groups I, II and III was statistically significant ($P < 0.0001$). When compared the difference of mean FVC value was significant among Groups I and II, also between Groups I and III ($P < 0.01$). However, the difference of mean FVC value was not significant among Groups II and III ($P > 0.05$). Values were as depicted in Table 2.

Forced expired volume in 1 second (FEV1) was compared among control and study groups. It was suggestive of a progressive decrease in value of FEV1 among three groups. After applying ANOVA test, the difference in mean values of FVC among Groups I, II and III was statistically significant ($P < 0.0001$). When compared the difference of mean FEV1 value was significant among Groups I and II, also between Groups I and III ($P < 0.01$). However, the difference of mean FEV1 value was not significant among Groups II and III ($P > 0.05$). Values were as depicted in Table 3.

Forced expiratory flow 25-75% (FEF 25-75%) was compared among control and study groups. It was suggestive of a progressive decrease in value of FEF 25-75% among three groups. After applying ANOVA test, the difference in mean values of FEF 25-75% among Groups I, II and III was statistically significant ($P < 0.0001$). When compared the difference of mean FEF 25-75% value was significant among Groups I and II, also between Groups I and III ($P < 0.01$). However, the difference of mean FEV1 value was not significant among Groups II and III ($P > 0.05$). Values were as depicted in Table 4.

$DLCO_{SB}$ was recorded and compared among control and study groups. Decrease in $DLCO_{SB}$ was noted in Groups II and III as compared to Group I. Value of $DLCO_{SB}$ was decreased more in Group III. After applying ANOVA test, the difference in mean values of $DLCO_{SB}$ among Groups I, II and III was statistically significant ($P < 0.0001$). Intergroup comparison was statistically significant ($P < 0.01$). Values were as given in Table 5.

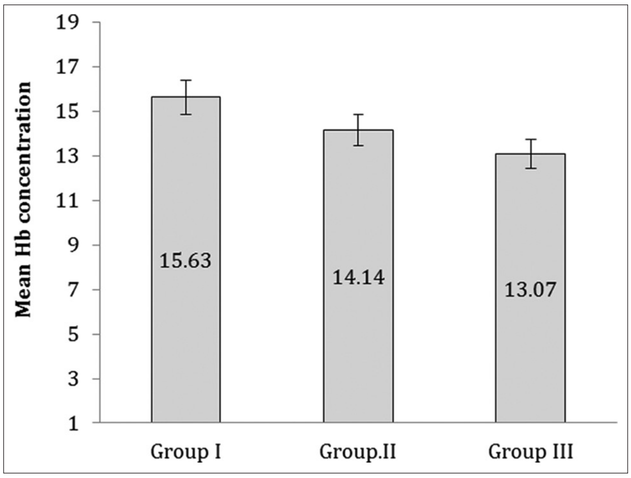

Figure 1: Comparison of mean hemoglobin among control and study groups

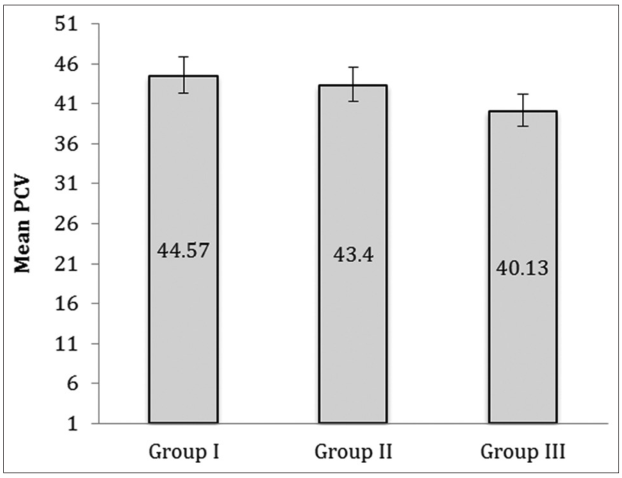

Figure 2: Comparison of mean packed cell volume among control and study groups

Table 1: Comparison of demographic variables among control and study groups

Variables	Mean±SD			*F* ratio	*P* value
	Group I (*n*=60)	Group II (*n*=30)	Group III (*n*=30)		
Age (years)	29.78±3.38	29.3±3.02	31±3.32	2.2	0.11
Weight (Kg)	65.48±5.38	64.5±5.44	62.83±6.53	2.17	0.12
Height (cm)	167.73±4.11	166.93±5.87	166.03±5.57	1.19	0.31
BMI (Kg/m^2)	23.26±1.52	23.25±1.70	22.95±1.59	0.42	0.65

SD: Standard deviation, BMI: Body mass index

Alveolar volume (VA) was compared among control and study groups. It was suggestive of a progressive decrease in value of VA among three groups. After applying ANOVA test, the difference in mean values of VA among Groups I, II and III was statistically significant (P <0.0001). Intergroup comparison was statistically significant (P < 0.01). Values were as given in Table 6.

Depending on the data, decreased DLCO% was predicted. Significantly more number of study subjects in Group III has decreased DLCO% predicted than Group II. Results were as plotted in Figure 3.

Table 2: Comparison of mean FVC among control and study groups

Groups	FVC (mean±SD)	*F* ratio	*P* value
Group I	4.16±0.58	17.4	<0.0001
Group II	3.5±0.54		
Group III	3.48±0.78		

FVC: Forced vital capacity, SD: Standard deviation

Table 3: Comparison of mean FEV1 among control and study groups

Groups	FEV1 (mean±SD)	*F* ratio	*P* value
Group I	3.95±0.6	32.04	<0.0001
Group II	3.18±0.53		
Group III	2.95±0.72		

FEV: Forced expired volume, SD: Standard deviation

Table 4: Comparison of mean FEF (25-75%) among control and study groups

Groups	FEF (25-75%) (mean±SD)	*F* ratio	*P* value
Group I	5.06±0.75	102.96	<0.0001
Group II	3.16±0.66		
Group III	3.34±0.60		

FEF: Forced expiratory flow, SD: Standard deviation

Table 5: Comparison of mean $DLCO_{SB}$ among control and study groups

Groups	$DLCO_{SB}$ (mean±SD)	*F* ratio	*P* value
Group I	17.84±1.12	67.24	<0.0001
Group II	16.47±1.7		
Group III	12.96±3		

$DLCO_{SB}$: Diffusing capacity of lungs for carbon monoxide-single breath, SD: Standard deviation

Table 6: Comparison of mean AV among control and study groups

Groups	VA (mean±SD)	*F* ratio	*P* value
Group I	4.62±0.4	63.78	<0.0001
Group II	4.32±0.54		
Group III	3.31±0.69		

AV: Alveolar volume, SD: Standard deviation

DISCUSSION

This study was designed to quantify resulting abnormalities in lung function in subjects exposed to petrol vapors as compared to their age and BMI matched controls.

A progressive decline in the mean value of FVC among petrol pump workers was seen. FEV1 values were calculated. On comparison FEV1 values were lower in both the groups of petrol pump workers as compared to control subjects. These observations were consistent with the observations of various studies.[8-12] This study results are pointing toward increased risk of development of restrictive airway diseases in petrol pump workers.

FEF 25-75% mean values from the study were demonstrating more declines in petrol pump workers than in control subjects. This decline was not related to the increasing years of exposure at petrol pumps. These findings are consistent to that reported in a study carried out in Delhi where both inspiratory and expiratory flow rates were decreased.[13] Decreased flow rates in small airways are suggestive of restrictive lung diseases. It is a sensitive indicator of small airway disease.

Above findings could be attributed to exposure to high ambient concentrations of petrol vapors that can cause well defined and marked systemic pulmonary inflammation.[14] Diesel particles can enhance the allergenicity of certain allergens and they can also act as an allergen carrier thus making allergens more accessible to deeper lung tissues.[15] Moreover, SO_2 and NO_2 in combination with particular pollutants may reach the deeper parts of lungs causing permanent pulmonary impairment. Exposure to high concentration of SO_2 for long duration can cause

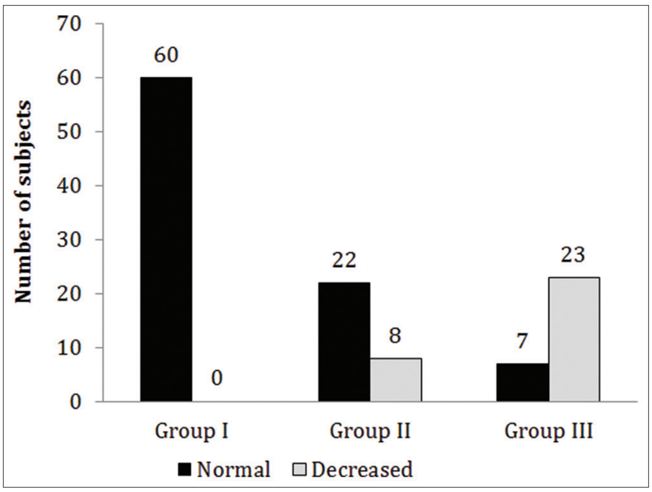

Figure 3: Distribution of control and study subjects with decreased capacity of lungs for carbon monoxide % predicted

allergic and chronic bronchitis due to repeated episodes of bronchoconstriction.

The study results demonstrated decreased values of DLCO% predicted in 31 petrol pump workers out of 60 workers. The values of DLCO% predicted where within normal limits in control subjects. Among 31 petrol pump workers, these values are mildly decreased in 17 workers and 14 workers shown moderately decreased values. With increasing years of exposure to petrol fumes at workplace, decreases DLCO and degree of severity changes from mild to moderate. DLCO reflects surface area of the lung available for diffusion, the volume of blood present in pulmonary capillaries, as well as thickness of alveolar capillary membrane. NO present in automobile exhaust can cause pulmonary toxicity with higher levels. Chronic doses of inhaled NO can cause surfactant inactivation, loss of cilia, focal hyperplasia, and hypertrophy in the epithelium of terminal bronchioles leading to thickening of alveolar capillary membrane.

This study showed a progressive decrease of mean values of Hb% in two groups of petrol pump workers as compared to controls. This decline was statistically significant. Hb levels decreased with increasing years of exposure in Group III workers. These findings were suggesting occurrence of mild anemia with increased years of occupational exposure in the Group III workers. Related studies have reported a decrease in Hb concentration among petrol pump workers.[13,16] This was in line with findings of our study.

This study showed that there was a progressive decline in mean values of PCV among two Groups (II and III) of petrol pump workers as compared to Group I of control subjects. Group III workers showed significantly decreased PCV levels. Related studies in petrol pump workers shown decreased PCV levels among these workers following occupational exposure; these findings were in agreement with our study.[13,17] The hematopoietic system is highly sensitive to most of the air pollutants because these cells recycle continuously. The solvents and air pollutants may lead to defective heme synthesis and reduced life expectancy of red blood cells.

Limitations of the Study

This study has been carried out only in 60 petrol pump workers. A large sample size study and a follow-up study annually on lung function abnormality among workers may have given more insights into the results. Furthermore, we could not get the ambient air quality data near the petrol pump from the pollution control board.

CONCLUSIONS

Decrease in values of FVC and FEV1 is suggestive of restrictive type of impairment in petrol pump workers. Lowered values of FEF 25-75% indicated greater involvement of smaller airways. Values of DLCO% predicted were mildly decreased in Group II and mild to moderately in Group III. This is suggestive of the fact that with increasing years or exposure to petrol and automobile exhaust resulted in damage to alveolar capillary membrane. There was a significant decline in Hb% and PCV in petrol pump workers. Lack of awareness and protective measures during duty hours by these workers may have led to lung function abnormality and hematological changes among them.

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