Evaluation of pulmonary functions in petrol pump workers

Sumathi P[1,*], N. Neelambikai[2]

[1]Associate Professor, Govt. Theni Medical College, Theni, [2]Professor, Dept. of Physiology, Coimbatore Medical College, Coimbatore

***Corresponding Author:**
Sumathi P
Associate Professor, Dept. of Physiology, Govt. Theni Medical College, Theni
Email: drsumathiper@gmail.com

Abstract

Introduction: Petrol/ Diesel vapour generates pollutants like hydrocarbons, oxides of nitrogen, carbon and particulate matter. Occupational exposure to petrol/ diesel vapours have been shown to affect the functioning of different systems of the body. Hence the present study aims to evaluate the pulmonary functions in petrol-pump workers.

Aim: Aim of the present study is to evaluate the pulmonary functions in petrol-pump workers and to compare their Pulmonary function tests (PFTs) with that of age and sex matched controls.

Methodology: Study group- Fifty healthy, non-smoker petrol-pump workers in the age group of 18-40 years. Control group-Fifty age and sex matched healthy nonsmokers. The pulmonary function tests Forced vital capacity (FVC) and Vital capacity (VC) were carried out by using computerized spirometer. The parameters Peak Expiratory Flow Rate (PEFR (L/S)) Forced Expiratory Flow (FEF25&75%(L/S), Peak Inspiratory Flow (PIF(L/S), Forced Vital Capacity (FVC(L) Forced Expiratory Volume in first second (FEV1(L)), Forced Expiratory Volume percentage(FEV1%), Forced inspiratory vital capacity (FIVC(L)), Vital capacity (VC(L)), Expiratory reserve volume (ERV(L)) were compared between the two groups.

Results: The PFTs of petrol pump workers were significantly decreased as compared to controls. The female workers and controls had significantly lower PFT than their respective male counterparts. The male petrol pump workers with more than 5 years of exposure had significantly decreased PFT.

Discussion: The decreased lung functions in petrol-pump workers may be attributed to their exposure to the volatile organic compounds like Benzene, pollutants like Lead, CO, CO2, Nitrogen oxides, Sulphur oxides ,Hydrocarbons and unburned carbon particles for more than six months, for at least 10 hours per day. The comparatively increased PFTs in males than females may be attributed to the greater inspiratory muscle strength, more number of alveoli per unit area, larger alveoli and greater compliance in males. Decreased PFT in workers with more than five years of service indicate that the decrements in pulmonary functions are worsened by increased years of exposure.

Key words: Petrol pump workers, Pulmonary function tests, Years of exposure, Gender variation

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Introduction

"Humans can go for weeks without food, for days without water, but only for minutes without oxygenated air!"

- Tony Mc Michael.

About 1.3 billion urban residents worldwide are exposed to air pollution level above recommended limits. Air quality in the developed countries has generally improved in the past two decades, but in many developing countries air quality has deteriorated. Epidemiological studies have shown that a sudden increase in air pollution has often been associated with immediate increase in morbidity and mortality.[1]

Noxious substances may be delivered airborne to the respiratory tract in molecular (gases and vapours) or particulate form. Those with high solubility are largely dissolved in the secretions lining the upper respiratory tract, those with low solubility penetrate to the gas exchanging tissues and exert their dominant effect there. However with overwhelming exposures adverse effects will occur at all levels of the respiratory tract and dose becomes a more important determinant of outcome than solubility.

Many adverse effects may follow the inhalation of irritant or toxic gases and aerosols. Most are manifested in the lung itself, but some are manifested in other organs after the lung provides a route for absorption. Several adverse health problems such as inflammation of the eyes and nose, throat irritation and breathing problems are common. Irreversible effects, e.g. cancer, birth defects, brain and nerve damage, long term injury to the lungs and breathing passages are caused by some chemicals found in the polluted air[2].

Numerous epidemiological studies have documented decrements in pulmonary function and various other health problems associated with long-term air pollution exposure.[3,4,5,6] It has been known for quite

some time that air pollution from petrol/diesel vapor and their exhaust is a major respiratory hazard for workers exposed to it.

Petrol (gasoline) is a complex combination of hydrocarbons. Petrol evaporates more readily in hot than cold countries. Petrol vapor contains volatile organic compounds (VOCs) like Benzene that will be released into the atmosphere during vehicle refuelling.

There are many components of diesel exhaust, including (1) carbon monoxide (2) nitrogen oxides (3) sulphur oxides (4) hydrocarbons (5) unburned carbon particles [soot] and (6) water. Exhaust from diesel engines is considered to contribute to more than 50% of ambient particulate matter with a mass median aerodynamic diameter less than 10 micrometers (PM10), greatly contributing to overall air pollution.

In addition to decrements in lung functions symptoms like chronic cough, sputum production, wheezing and breathlessness have also been reported on exposure to these pollutants.[3] At high ambient concentrations, well-defined and marked systemic pulmonary inflammatory response is also observed, notably before changes in pulmonary function can be detected.[7] Various occupational exposures to petrol/diesel products have been shown to affect different systems of the body.[8,9,10,11] Several animal studies have also demonstrated a consistent association between air pollutants and the altered lung function.[12,13]

In India, petrol-pump attendants are the norm rather than self-service, increasing the opportunity for exposure. Petrol-pump workers are continuously exposed to the organic and inorganic substances present in the petrol/diesel. The average daily exposure to these chemicals in India generally exceeds 10 h/day. Some of them are working for more than ten years now. 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. Hence, the present study aims to evaluate the pulmonary functions in subjects continuously exposed to petrol/diesel vapour for more than six months.

Materials and Methods

This is a cross sectional study. This study was carried out in the Research laboratory, Department of Physiology, Coimbatore Medical College-Coimbatore and in the office rooms of the petrol bunks located in the vicinity of Coimbatore Medical College in the lower pollution zones. This study was carried out from January 2007 to June 2008. A total of 100 subjects were recruited for this study including both sexes in the age group of 18 to 40 years (44 females and 56 males). The subjects were divided into study group and control group.

Study group comprised of 50 adults (28 males and 22 females) who were healthy non-smokers in the age group of 18-40 years working in petrol bunk as petrol/diesel filling attendants for more than six months. (Group-1) 50 age and sex matched healthy non-smokers including the laboratory attendants and students of Coimbatore Medical College served as controls (Group-2). The ethical committee clearance was obtained and an informed consent was taken after explaining the procedure to the subjects. Subjects with the pre-existing lung disease, cardiac disease, history of smoking and alcohol, subjects with family history especially in relation to respiratory disorders like asthma, allergies and history of contact with open tuberculosis, other petrol bunk staff not involved directly in petrol/diesel filling were excluded from the study. A detailed history was obtained. Height (in cms) of the subjects was measured in standing and erect posture. Weight (in kgs) was recorded using standard weighing machine both for study and control group in standing posture. Clinical examination of the subjects was done. Pulmonary function tests were carried out by using the computerized Spirometer- Spirobank-G.

The pulmonary function tests forced vital capacity test and vital capacity test were carried out by using the computerized Spirometer- Spirobank-G using the standard laboratory methods. All the pulmonary function tests were done on the subjects comfortably seated in an upright position. During the test the subject was adequately encouraged to perform his/her optimum level.

FVC test: The subject was asked to breathe at rest for a few moments, then inspire slowly as much air as possible and then make a complete expiration as fast as possible, to complete the cycle by inspiring again as quickly as possible

Parameters recorded during FVC test: FVC(forced vital capacity), FEV1(forced expiratory volume at the end of first second), PEF(peak expiratory flow), FEV1%(Forced expiratory volume percentage), FEF25-75% (forced expiratory flow in 25-75% of vital capacity), PIF (peak inspiratory flow), FIVC(Forced inspiratory vital capacity).

VC test: The subject was asked to inspire slowly, as much air as possible and then expire slowly as much air as possible.

Parameters recorded during VC test Vital capacity (VC), Inspiratory vital capacity (IVC), Expiratory reserve volume (ERV), Tidal volume (TV), Minute ventilation at rest (VE), Respiratory frequency (fr), Average time of inspiration at rest (ti), Average time of expiration at rest (te), Three trials were given to each test. The best Spirometric values of three attempts were taken. A complete flow volume loop was obtained from the Spirometer. The Spirogram (flow-volume loop) was directly down loaded from the instrument and printed. The results obtained were tabulated and analyzed.

Statistical Analysis

Mean and standard deviation were calculated. Student‘t’ test has been carried out to test the

significance of mean between the study group and the control group. Linear regression model has been carried out to find the age-adjusted mean values of lung function parameters in male petrol-pump workers with regard to the duration of exposure. Statistical software namely SPSS 12 version was used for the analysis of the data and Microsoft word and Excel have been used to create text documents, graphs.

Results and Analysis

Table 1: Anthropometric measurements of Group 1 and 2

Parameters	Range		Mean ± SD	
	Petrol pump workers	Controls	Petrol pump workers	Controls
Age(yrs)	18-40	18-40	28.24 ± 8.9	28.24 ± 8.9
Height(cms)	141-175	146-177	157.98± 8.37	162.7± 9.9
Weight(kgs)	33-80	38-82	56.82±11.57	58.2± 12.87

The two groups did not differ significantly on these parameters.

Comparison of observed mean values of lung function parameters between Group 1 and 2

Table 2: Flow rates in the two groups

Parameter	Petrol-pump workers Group – 1 (n = 50)	Controls Group – 2 (n = 50)
PEFR(Litres/Second) (L/S)	5.1± 1.86*	6.88±1.97
FEF 25-75% (L/S)	3.23± 0.97*	3.91±1.036
PIF (L/S)	2.03± 0.87*	2.60± 1.19

*p< 0.01.

PEFR, FEF 25-75% & PIF were found to be significantly decreased (P<0.01) in petrol pump workers as compared to controls.

Table 3: Lung volumes and capacities in the two groups

Parameter	Petrol-pump workers Group – 1 (n = 50)	Controls Group – 2 (n = 50)
FVC (Litres)	2.398± 0.596*	3.186±0.76
FEV_1(Litres)	2.28± 0.54*	2.92±0.64
FEV_1 %	95.17± 6.18	97.14± 10.08
FIVC (Litres)	2.16± 0.59*	3.03±0.85
VC(Litres)	2.25± 0.73*	3.11± 0.97
ERV(Litres)	0.29± 0.29*	0.79± 0.57

*p< 0.01.

FVC & FEV_1 were decreased significantly (p<0.01) in petrol-pump workers as compared to controls while their ratio did not differ much between the two groups. FIVC, VC & ERV were also significantly decreased (p<0.01) in petrol-pump workers as compared to controls.

Gender wise comparison of observed mean values of lung function parameters among the petrol – pump workers

Table 4: Flow rates in petrol-pump workers

Parameter	Male workers Group – 1(A) (n = 28)	Female workers Group – 1(B) (n = 22)
PEFR (L/S)	6.05± 1.86	3.89±0.97*
FEF 25-75% (L/S)	3.48± 1.05	2.91±0.76
PIF (L/S)	2.32± 0.90	1.66± 0.69*

*p< 0.01.

PEFR & PIFR were found to be significantly decreased (P<0.01) in female petrol-pump workers as compared to male workers. FEF 25-75% was decreased in female workers but was not significantly decreased.

Table 5: Lung volumes and capacities in petrol-pump workers

Parameter	Male workers Group – 1(A) (n = 28)	Female workers Group – 1(B) (n = 22)
FVC (Litres)	2.70± 0.57	2.02±0.37*
FEV_1(Litres)	2.53± 0.51	1.96±0.39*
FEV_1 %	94.10± 6.90	96.52± 4.93
FIVC (Litres)	2.44± 0.57	1.80±0.39*
VC(Litres)	2.53± 0.60	1.89± 0.73*
ERV(Litres)	0.31± 0.30	0.27± 0.27

*p< 0.01.

FVC, FEV_1, FIVC & VC were significantly decreased (p<0.01) in female petrol-pump workers when compared to male work.

Observed mean values and age adjusted mean values of lung function parameters of male petrol-pump workers with regard to period of exposure

Table 6

Parameters	Years of exposure			
	<5 years of service (n = 14)		> 5 years of service (n = 14)	
	Observed mean values	Age adjusted mean values	Observed mean values	Age adjusted mean values
VC (L)	2.48 ± 0.66	2.48 ± 0.093	2.48 ± 0.54	2.486 ± 0.091
FVC (L)	2.75 ± 0.56	2.75 ± 0.252	2.64 ± 0.62	2.64 ± 0.168
FEV_1 (L)	2.64 ± 0.484	2.628 ± 0.254	2.423 ± 0.53	2.421 ± 0.156*
PEF (L/S)	5.71 ± 1.77	5.691 ± 0.522	5.64 ± 1.94	5.645 ± 0.286
FEV_1 %	96.16 ± 6.02	96.133 ± 0.876	92.04 ± 7.32	91.906 ± 0.735
FEF 25-75% (L/S)	3.78 ± 0.96	3.77 ± 0.601	3.18 ± 1.09	3.171 ± 0.345*
FIVC (L)	2.41 ± 0.57	2.404 ± 0.329	2.33 ± 0.59	2.376 ± 0.245
PIF (L/S)	2.51 ± 091	2.513 ± 0.134	2.12 ± 088	2.133 ± 0.102*
ERV (L)	0.43 ± 0.37	0.424 ± 0.064	0.198 ±0.147	0.203 ± 0.051*

*p< 0.05.

Since the female petrol-pump workers have worked only for less than five years exposure wise comparison was done only among the male petrol-pump workers. Age adjusted mean values FEV_1, FEF 25-75%, PIF & ERV were found to be significantly decreased (p<0.05) in male petrol-pump workers with more than five years of service when compared to male workers with less than five years of service. About 24% of the petrol-pump workers were found to be symptomatic. They complained of symptoms like irritation of eyes, watering of eyes, headache, running nose, cough phlegm production.

Discussion

The present study has shown that the pulmonary function parameters like the forced vital capacity (FVC), the forced expiratory volume at first second (FEV1), the forced expiratory flow in 25-75% of vital capacity (FEF25-75%), the peak expiratory flow rate (PEFR), the peak inspiratory flow rate (PIF), the forced inspiratory vital capacity (FIVC), the vital capacity (VC), and the expiratory reserve volume (ERV) were significantly decreased in petrol-pump workers as compared to controls.

Although both FEV1 and FVC were 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. Similar findings were observed in previous studies on pulmonary functions in petrol-pump workers.[14,15,16,17]

Long term exposure to diesel exhaust in cats also proved the restrictive nature of pulmonary involvement.[12] While short-term exposure to diesel exhaust in healthy human volunteers have demonstrated marked systemic and pulmonary inflammatory response, the lung function measurements did not show a significant change.[9] In the present study, expiratory and inspiratory flow rates i.e. PEFR, PIFR, FEF25-75% are also decreased in the study group. Similar results were shown in the previous studies on petrol-pump workers.[14,15] PEFR was also decreased in the experimental study of cats which otherwise showed a classic pattern of restrictive lung disease.

Since petrol pumps are located on busy roads, these workers in addition to petrol/diesel vapor are exposed to other pollutants. The flow rates at low volumes i.e. FEF25-75% indicate flow rates in small airways i.e. those with internal diameters of less than 2mm. These are reduced at low lung volumes both in restrictive and

obstructive diseases. The decrease in FEF25-75% suggests greater involvement of small airways.

On gender wise comparison, the PFT parameters were significantly decreased in females when compared to males in both the petrol-pump workers and controls. These results correlated well with the previous studies on gender differences in pulmonary functions.[18,19] The reason for this sex difference may be attributed to the greater inspiratory muscle strength of males and more number of alveoli per unit area, larger alveoli and greater compliance in males as compared with females. All pulmonary volumes and capacities are about 20-25% less in women.

Further it was found that the pulmonary function parameters of male petrol pump workers were significantly lower than the male controls. With regard to female workers, except for FEF 25-75% and PIF all the other parameters were significantly lower than the female controls. This may be probably due to their lesser duration of exposure than the male workers. Previous studies on petrol-pump workers were done only on male petrol-pump workers. So a comparison cannot be done with previous studies.

The male petrol-pump workers with more than five years of service showed significantly decreased values for FEV1, FEF25-75%, PIF and ERV when compared to male workers with less than five years of service. These findings correlated well with a previous study indicating that the decrements in pulmonary function are worsened by increased years of exposure.

About 24% of the petrol-pump workers were found to be symptomatic. They complained of symptoms like irritation of eyes, watering of eyes, headache, running nose, cough and phlegm production. These symptoms may be due to exposure to NO_2, respirable particulate and other components in petrol/diesel vapor and their exhaust. Particles generated from petrol/diesel exhaust are extremely small and 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. Importantly they can remain airborne for long periods of time and deposit in greater numbers and deeper into the lungs than large sized particle. Hence chronic exposure to them can lead to chronic inflammation of respiratory tract and lung parenchyma.

Conclusion

The lung function parameters of the petrol-pump workers are significantly lower than the control group. Health awareness has to be created among the petrol-pump workers to use personal protective measures such as masks and respirators to reduce the inhaled dose of the hazardous agents in petrol/diesel vapor and their exhaust. Other preventive measures such as the use of engineering controls, ventilation systems, substitution of highly toxic agents with less toxic agents and administrative measures to remove from areas of exposure those individuals who are affected or at increased risk may also be advocated. Also self-service for petrol/diesel filling may be advocated to prevent the opportunity for exposure in petrol-pump attendants.

Limitation

This study has been carried out only in 50 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.

Scope for future work

Chronic exposure to petrol/diesel vapour and their exhaust can lead to chronic inflammation of the 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.

Bibliography

1. Park K. Text book of Preventive and Social Medicine. 18th ed. Banarsidas bhanot; 2005. P.591-5
2. Warrel, Cox, Firth, Benz. Oxford textbook of Medicine Vol. II. 4th ed. Oxford University Press; 2003. P.1504-6.
3. 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 -14.
4. Chattopadhyay BP, Alam J, Roy Chowdhurv A. Pulmonary function abnormalities associated with exposure to automobile exhaust in a diesel bus garage and roads. Lung 2003;181:291-302.
5. Chabra SK, Chabra P, Rajpal S, Gupta RK. Ambient air pollution and chronic respiratory morbidity in Delhi. Arch Environ Health 2001;56:58-63.
6. Chattopadhyay BP, Mukherjee AK, Mukherjee K Roy Chowdhury A. Exposure to vehicular Pollution and Assessment of Respiratory function in Urban Inhabitants. Lung. 2007 Sep;185(5);263-70.
7. Salvi S, Blomberg A, Rudell B, Kelly F, Sandstrom 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;159:702-9.
8. Sorgo G. Trichloroethylene, Carbon tetrachloride and gasoline – intoxication in connection with arterio and coronary sclerosis Arch Toxicol 1976;35:295–318.
9. Coppola L, Giunta R, Grassia A, Misso L, Verrazzo G, Violano PF, et al. Air Pollution by gasoline exhaust fumes, effect on platelet function and blood viscosity. Med Lav 1989;80:187-97.
10. Kilburn KH. Effect of diesel exhaust on neurobehavioral and pulmonary functions. Arch Environ Health 2000;55:11-17.
11. Lipsett M, Campleman S. Occupational exposure to diesel exhaust and lung cancer: A Meta-Analysis. Am J Public Health 1999;89:1009-1017.
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;5:301-5.
13. Vinegar A, Carson A, Pepelko WE. Pulmonary function changes in Chinese hamsters exposed six months to diesel exhaust. Env Internal 1981;5:369-71.

14. Mayank singhal, Farah Khaliq, Siddarth Singhal and Tandon OP. Pulmonary functions in petrol pump workers: a preliminary study. Indian J physiol pharmacol 2007;51(3):244-48.
15. Kesavachandran C, Rastogi SK, Anand M, Mathur N, Dhawan A. Lung function abnormalities among petrol-pump workers of Lucknow, North India. Current Science 2006 May;90(9):1177-8.
16. Chidri SV, Patil S. Assesment of pulmonary function tests in petrol pump workers: A cross sectional study. Ind J Basic Appl Med Res.2014;3(2):507-510.
17. Sharma H, Agarwal S. Forced vital capacity (FVC), Forced expiratory volume in 1st second(FEV1) and Forced expiratory ratio (FEV1/FVC) in petrol pump workers at Jhalawar and Jhalarapatan (Rajasthan). Ind J Clin Anat Physiol. 2015;2(4):177-180.
18. Dikshit MB, Raje S, Agarwal MJ. Lung functions with spirometry: an Indian perspective- II: On the vital capacity of Indians. Indian J Physiol Pharmacol 2005 Jul – Sep;49(3):257–70.
19. Ali Baig MI, Qureshi RH. Pulmonary Function Tests: Normal values in non-smoking students and staff at the AGA Khan University, Karachi. J Coll Physicians Surg Pak 2007 May;17(5):265-68.