Journal of Clinical and Biomedical Sciences

Journal homepage: www.jcbsonline.ac.in

Original Article

Evaluation and comparison of pulmonary function tests in petrol pump workers Vs individuals unexposed to petrol fumes

A V Anuja*[1], Vnbuselvam veeraiah[2], Priscilla Johnson[2], A S Subashini[2]

1. Department of Physiology, Saveetha Medical College & Hospital, Chennai, India.
2. Department of Physiology, Sri Ramachandra Medical College & Research Center, Chennai, India.

Received: 19th April -2014 Accepted: 26th May-2014 Published: 30st-June 2014

Abstract

Background: Petrol pump attendants are the norm rather than self- service, increasing the opportunity for exposure to petrol fumes during refuelling. Long term exposure to petrol vapours has shown to affect the different physiological systems in the body with the highest impact on the respiratory system.The present study aims to evaluate and compare the combined effect of petrol fumes and automobile exhaust on pulmonary functions in petrol station attendants and normal unexposed subjects. ***Methods:*** The present study was conducted among 50 petrol pump workers working in refuelling areas and 51 individuals who were not occupationally exposed to petrol fumes. Demographic and anthropometric details were collected and pulmonary function tests were performed on both the groups. ***Results:*** : The mean age of the exposed and unexposed group was 27.48 ± 6.54 and 25.12 ±6.68 respectively. The present study involved 26 females (Exposed -11 and Unexposed-15) and 56 males (Exposed- 20 and Unexposed- 36).The mean BMI of the exposed and unexposed group was 22.14±3.04 and 23.86±4.93 respectively. There were no statistically significant differences between the groups with regard to age and BMI. Forced Expiratory Volume in 1 sec (FEV_1) and Peak Expiratory Flow Rate (PEFR) declined significantly ($p < 0.005$) in the exposed group when compared to the unexposed group. ***Conclusion***: Periodic medical surveillance inclusive of pulmonary function testing should be insisted among petrol pump workers. In addition, the development of appropriate equipment for monitoring and testing for environmental elements in the community and in workers would prove to be beneficial.

Key words: FEV_1, PEFR and FVC, Petrol fumes, automobile exhaust.

Introduction

In most towns and cities, the increase in automobiles with the associated air pollution, noise pollution and road traffic accidents are causes of grave concern.(1)The associated alarming increase in fuel consumption, increased inhalation of occupational solvents into the human body and a resultant hike in the incidence of health hazards have been increasingly observed in the recent days.(2) Numerous epidemiological studies have documented decrements in pulmonary function and various other health problems associated with long term air pollution exposure.[3-6]

Petrol has become an essential commodity in our life. Its production and distribution in spite of price hikes of the crude oil is continuously soaring. In this context, occupational health hazards due to inhalation of petrol vapours are gaining significance. The average daily exposure to these chemicals amongst petrol pump workers in India generally exceeds to about 20 hours/day. The filling attendants, working in refuelling areas are continuously exposed to the organic and inorganic constituents present in the petrol. Long term exposure to petrol vapours has shown to affect the different physiological systems in the body, with the highest impact on the respiratory system. (7)

Petroleum products and its exhaust can cause significant respiratory symptoms like chronic cough, breathlessness and wheezing.(7,8) In high concentrations they cause marked systemic pulmonary inflammatory response. The particles generated from petrol exhaust are extremely small and are present in the nuclei or accumulation modes, with diameters of 0.02nm and 0.2nm respectively. Further, the surface area is large and so they can carry much larger fraction of toxic compounds, such as

*Corresponding Author
Dr A V Anuja, Department of Physiology, Saveetha Medical College & Hospital, Chennai, India.
E mail : dranujasasi@gmail.com

Quick access Code

hydrocarbons and metals on their surface. They can remain airborne for longer periods of time and deposit in greater numbers and deeper into the lungs when compared to the large sized particles. (9) Transport of oxygen to cells is hindered by MetHb, a by-product of benzene metabolism in the body resulting in functional anemia. As the level of MetHb increases, symptoms like shortness of breath, palpitation, anxiety and confusion occur. (10,11) Typical 8 hr benzene exposure concentrations in distribution and retail operations constitute an average of less than 1 ppm, although exposures can reach to 2-3 ppm for shorter periods.(12)

Carbon monoxide also has stronger affinity for haemoglobin when compared to oxygen (230 times) resulting in tissue hypoxia Effects of sulphur dioxide on the respiratory system range from reversible decrease in lung function to constriction of the bronchioles to severe airways obstruction, hypoxemia, pulmonary edema and death in minutes. (13) Further NO_2 impairs the lung's immune defence mechanisms. It increases the susceptibility to infections, asthma attacks and it induces inflammatory changes. Solid particulate matter produced from emissions gets adsorbed onto soot particles and penetrates into the lungs increasing the risk of pneumoconiosis and malignancies. (14)

In India, petrol pump attendants are the norm rather than self- service, increasing the opportunity for exposure. During refueling, people may easily get exposed to extremely high levels of gasoline vapor. Moreover, as the petrol pumps are located on busy roads, these workers in addition to diesel exhaust are also exposed to other air pollutants. The volume of gasoline sold in refueling operations and ambient temperature can significantly increase the environmental level of benzene, toluene and xylene (BTX) vapors and subsequently, the occupational risk of service station attendants despite the growing use of diesel, unleaded and reformulated gasoline. The present study aims to compare the combined effect of inhalation of petrol fumes and automobile exhaust fumes on the dynamic ventilator lung functions in petrol station attendants working in re fuelling areas and normal unexposed subjects. It was also planned to correlate the pulmonary functions of petrol pump workers to their age and the duration of exposure.

Material and Methods

Study design and Sample selection criteria:

The present study was conducted to evaluate the pulmonary function in petrol pump workers working in the refuelling areas of various petrol bunks in Chennai for more than 8 hrs a day. The study was carried out among 50 petrol pump workers and 51 healthy individuals of both sexes in the age group of 18-50 years. Subjects were included by convenient sampling after taking permissions from various petrol bunk managers. The benefits of the study were explained and informed consent was obtained from the study participants

Demographic details:

Information regarding the demographic details, smoking status and years of exposure to petrol fumes was obtained by administering a questionnaire. General and clinical examination of the respiratory system, evaluation of anthropometric parameters and pulmonary function tests were performed on both the groups. Subjects were selected based on the following inclusion criteria: age range of 18-50 yrs,exposure duration >1yr. Exclusion criteria comprised of age < 18yrs, exposure < 1yr, smokers and family history of bronchial asthma.

Anthropometric measurements:

Measuring tape was used to measure the standard height in centimetres. Weight in kgs was recorded using the portable weighing machine and the body mass index (BMI) was calculated by using Quetelet's index.

Pulmonary function tests:

Koko legend spirometer (606055G) which performs as per the specifications of the American Thoracic Society was used to assess pulmonary function. It is a desktop portable device capable of performing both pre and post- bronchodilator forced and slow expiratory manoeuvres and calculating the standard spirometric indices. PFT was done after ruling out recent surgery of thorax or abdomen, thoracic, abdominal or cerebral aneurysms, recent eye surgery (e.g., cataract), unstable cardiovascular status or recent myocardial infarction or pulmonary embolus and haemoptysis of unknown origin as per the AARC Clinical Practice Guidelines – Spirometry, 1996. (15)

The selected volunteers were advised not to have meals 1 hour prior to the test and also not to smoke or consume alcohol or inhale bronchodilators 6 hours prior to the test. The following parameters were assessed by spirometry-FVC (Forced vital Capacity), FEV_1 (Forced expiratory volume in 1 sec) and PEFR (Peak expiratory flow rate). The best values of three attempts were taken. A complete flow-volume loop was obtained from the spirometer. The spirograms

(flow-volume loop) were directly downloaded from the instrument and a print out was taken. All the volumes were corrected to conditions of the body temperature and pressure saturable with water vapour (BTPS). ATS criteria were followed for excluding the poor invalid efforts. Most of the sources of variation in pulmonary function assessment such as motivation, effort and body position were controlled. Single investigator was involved in the recording of the pulmonary function and anthropometric measurements to control inter- investigator variability. A total of 31valid records of petrol pump workers and 51 healthy individuals were obtained for final analysis.

Results

The exposed group (petrol pump workers in the refuelling areas n=50) were in the age group of 27.48± 6.54 years, while the non exposed group (n= 51) were in the age group of 25.12± 6.68 years. Our study included 26 female participants (Exposed= 11, unexposed=15) and 56 male participants (Exposed=20, unexposed= 36). Both the genders were included in the study to evaluate the sex predilection with regard to occupational exposure. Chi square test of distribution of men and women in the exposed (Males- 20, Females- 11) and unexposed group (Males-36, Females-15) was not statistically significant (p value= 0.369).

The anthropometric parameters of the participants were measured in both groups (Exposed group: Weight=57.7 ± 10.3 kg, Height=161.1 ± 9.1cms and Unexposed group: Weight= 63.0 ± 12.9kg, Height = 162.7 ± 7.0cms). Using the above measurements, BMI was calculated using Quetelet's index for both the groups and was found to be 22.14± 3.04, and 23.86± 4.93) in the exposed and unexposed groups respectively. There were no statistically significant differences in anthropometric measurements in both the groups.

Table 1 shows the observed values of the various lung function parameters such as FVC, FEV_1 and PEFR in the exposed and unexposed group. There was a statistically significant decline in the observed values of FEV_1 of exposed group compared to the unexposed group (p=0.003). Statistically significant decline in PEFR (p=0.001) was also observed. Though FEV_1 and PEFR were declined significantly (p <0.005) in the exposed group when compared to the unexposed group there was no statistically significantly decrease in FVC in the exposed group. Further, the influences of duration of exposure and age on these lung function parameters were assessed. There was a statistically significant decline in the observed values of FVC, FEV_1 and PEFR in exposed group with increase in the duration of exposure (Table2).No significant difference in the variations of the pulmonary function tests were observed between the age groups of the exposed study subjects (Table 2)

Lung function parameters	Exposed	Unexposed	p Value
	Mean ± SD	Mean ± SD	
FVC Observed	2.77±0.843	3.03±0.493	<0.075
FEV1 Observed	2.39±0.707	2.80±0.494	<0.003*
PEFR Observed	5.00±2.19	6.41±1.48	<0.001*

- - p<0.05 is considered to be statistically significant

Table 1: Lung function parameters among exposed and unexposed groups

Lung function parameters	Duration of Exposure		p Value
	< 5 yrs	>5 yrs	
	Mean ± SD	Mean ± SD	
FVC Observed	3.03± 0.633	1.87± 0.89	.001*
FEV_1 Observed	2.57± 0.554	1.78± 0.866	.006*
PEFR Observed	5.48± 2.07	3.35± 1.84	.021*

* - p<0.05 is considered to be statistically significant

Table 2: Influence of duration of exposure and age on the lung function parameters

Discussion

About 95% of compositions in the petrol vapour are aliphatic and acyclic compounds while less than 2 % are aromatic compounds.(16) Inhalation of petrol fumes is associated with risk of cancer, respiratory and cardiovascular diseases.(17) Similarly the particles generated from diesel exhaust are extremely small and are present in the accumulation modes with diameters of 0.02 and 0.2 nm respectively. These small sized particles by virtue of greater surface area to mass ratio carry a much larger fraction of toxic compounds, such as hydrocarbons and metals on their surface and there by lead to chronic inflammation of the respiratory tract and lung parenchyma.(9) The increase in the number of petrol outlets has provided work opportunities to many. However it has simultaneously exposed the people to hazardous

chemicals present in petrol and diesel fumes resulting in adverse health effects. Petrol pump workers are the most vulnerable group to the ill effects of gasoline, in whom the respiratory symptoms are the commonest.Kesavachandran et al have observed that high prevalence of respiratory symptoms was primarily a consequence of exposure to the petrol vapors found in the workplace in the petrol filling stations.(18) Ayers et al have also demonstrated that workers exposed to diesel & automobile exhaust had increased airway resistance, increasing closing volume and reversible decrease of FVC.(19) On exposure to these toxic compounds for a longer duration, the petrol pump workers present with impaired lung function.(20,21) In the present study participants belonging to both the genders were included in the exposed and unexposed groups. The influence of occupational exposure to petrol fumes on gender was studied and found to be not statistically significant. Further, there were no statistically significant differences in the anthropometric parameters and BMI in both the groups. Similar results were also observed by Sandip et al.(22) On the contrary, Nazia et al have observed a significant increase in BMI among the petrol pump workers with increase in the years of exposure.(7)

In the present study, there was decrease in observed values of FVC, FEV_1 and PEFR in the exposed group when compared to the unexposed group . However, statistically significant decline was noted only in FEV_1 and PEFR, not in FVC. These findings could be attributed to the exposure to high ambient concentrations of petrol vapours that can cause well defined and marked systemic pulmonary inflammatory response.(23) Decline in observed values of VC, FVC, FEV_1 among petrol pump workers indicating restrictive type of lung disease was also observed by Kesavachandran et al. (18) Sadiqua Begum et al have showed a statistically significant decrease in FVC, and FEV_1 in petrol pump workers when compared to their controls. However, their ratio (FEV_1 %) did not differ between the groups. These findings indicate the restrictive pattern of pulmonary involvement in the study group.(24) A decline in FVC and FEV_1 has also been reported in tunnel and bridge workers and traffic police men due to exposure to automobile exhausts.(25,26,27,28) Paggiaro et al have shown that occupational exposure to organic solvents might cause chronic air way impairment with non specific bronchial hyper responsiveness in shoe factory workers.(29) In addition, diesel particulates in the ambient air enhance the allergenicity of certain allergens. Not only can diesel particles enhance allergenicity, they also act as allergen carriers thus making allergens more accessible to the deep lung regions .(30) Moreover, in combination with particulate pollutants, SO_2 and NO_2 have a greater chance to reach the deeper parts of the lungs causing permanent pulmonary impairment.(13) Workers exposed to daily average values of SO_2 present with respiratory symptoms leading to allergic and chronic bronchitis probably due to repeated episodes of bronchoconstriction. (14) Moreover, flow rates in small airways (FEF25–75 and FEF50) with internal diameters of less than 2 mm may be reduced leading to both obstructive and restrictive changes.(13)The lung function parameters such as FVC, FEV_1 and PEFR were altered in accordance to the duration of exposure. It was also observed that as the number of years of exposure increased there was a decline in FVC and FEV_1 indicating a restrictive airway disease. This could be due to the trapping of the burnt products of fuel vapour by the small airways leading to lung injury.(1) In addition, chronic exposure to petroleum products can lead to chronic inflammation of respiratory tract and lung parenchyma. The gaseous pollutants may also alter the properties and concentration of surfactant and may thus contribute to early closure of small airways. (13) The present study had few limitations. Air analysis was not done, hence the quantification of the amount of fuel vapour inhaled by the subjects could not be commented on. It was also not possible to carry out urine analysis for the metabolites of benzene and toluene to indicate the magnitude of fuel vapour inhalation in the subjects studied.

Conclusion

This preliminary study highlights the adverse effects of petrol fumes in the respiratory system and the deterioration of lung functions in the petrol pump workers. Lung function abnormalities could be attributed to the lack of health awareness and protective measures during work among petrol pump workers. Hence, considerably improved awareness of the sources of toxins in the community would help the individuals to avoid them. Improvement in the engine design, soot filters and fuel modification may provide the best approach to control the exposure to these fumes.(31) 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. Further, medical screening and screening of benzene and CO in air may protect workers from developing chronic respiratory disorders. Early recognition and possibly the removal of sensitive workers from the working place before chronic impairment develops will help. Periodic medical surveillance inclusive of pulmonary function testing should be insisted among petrol pump workers. In addition, the development of appropriate equipment for monitoring and testing for environmental elements in the community and in

workers would prove to be beneficial. Finally, the researcher's effort should be increased to identify genetic and other factors that predispose workers to environmental agents and to assess risk factors among them. Further longer term perspective studies of petrol pump workers would help us to get a more comprehensive picture of the long term effects of these pollutants, as the present study would serve as a bench mark.

References

1. Chawla A, Lavania AK. Air pollution and fuel vapour induced changes in lung functions: are fuel handlers safe?Indian J Physiol Pharmacol. 2008 Jul-Sep;52(3):255-61.
2. Kuang S, Liang W. Clinical analysis of 43 cases of chronic benzene poisoning Chem Biol Interact. 2005 May 30;153-154:129-35. Epub 2005 Apr 2.
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 Res. 1987 Feb;42(1):201-14.
4. Nakai S, Nitta H, Maeda K Respiratory health associated with exposure to automobile exhaust. III. Results of a cross-sectional study in 1987, and repeated pulmonary function tests from 1987 to 1990. Arch Environ Health. 1999 Jan-Feb; 54 (1):26-33.
5. Chhabra SK, Chhabra P, Rajpal S, Gupta RK. Ambient air pollution and chronic respiratory morbidity in Delhi. Arch Environ Health. 2001 Jan-Feb;56(1):58-64.
6. Ware JH Spengler JD, Neas LM, Samet JM, Wagner GR, Coultas D, Ozkaynak H, Schwab M Am J Epidemiol. Respiratory and irritant health effects of ambient volatile organic compounds. The Kanawha County Health Study 1993 Diesel exhaust particles.Inhal Toxicol Jun 15; 137(12):1287-301.
7. Uzma N, Salar BM, Kumar BS, Aziz N, David MA, Reddy VD Impact of organic solvents and environmental pollutants on the physiological function in petrol filling workers Int J Environ Res Public Health. 2008 Sep;5(3):139-46.
8. Singhal M, Khaliq F, Singhal S, Tandon OP. Pulmonary functions in petrol pump workers: a preliminary study. Indian J Physiol Pharmacol. 2007 Jul-Sep; 51(3):244-82007; 19(1): 241-44.
9. Wichmann HE. Diesel exhaust particles.Inhal Toxicol 2007; 19(1): 241-44.
10. D.C Lee, A.V.Tuyl Methemoglobin, http: // www.emedicine.com.
11. M.Denshaw Burke, J.Schoffstall, P.Schick and M.Bouchard Methemoglobin, http:www emedicine.com .
12. Schnatter,R., J. Toxicol. Environ.Health. 2000; 61,433-437.
13. Cotes JE. Lung function assessment and application in medicine.5thed.Oxford Blackwell Scientific Publications. 1993. Pg122.
14. Lewis TR, Campbell KI, Vaughan TR Jr.Effects on canine pulmonary function via induced NO_2 impairment, particulate interaction and subsequent SOx 1969 Apr;18(4):596-601.
15. Respir Care 1996; 41 (7): 629-636.
16. Gupta S ,Dogra TD Air Pollution and human health hazards. India J Occup Environ Med 2002; 6 (2): 89-93.
17. Boffetta P,Cherric J.Hughson G et al (2002). Cancer risk from diesel emission exposure in central and EasternEurope : A feasibility study. Institute HE; pp. 59-78.
18. Kesavachandran C, Mathur N, Anand M, DhawanA. Lung function abnormalities among petrol pump workers of lucknow,Northindia. Current Science.2006, 90, 1177-1178.
19. Ayres SM, Evans R, Licht D, Griesbach J, Reimold F, Ferrand EF, Criscitiello A Health effects of exposure to high concentrations of automotive emissions. Studies in bridge and tunnel workers in New York City. Arch Environ Health. 1973 Sep; 27(3):168-78.
20. Fortoul TI, Osorio LS, Tovar AT, Salazar D, Castilla ME, Olaiz-Fernández G. Metals in lung tissue from autopsy cases in Mexico City residents: comparison of cases from the 1950s and the 1980s. Environ Health Perspect. 1996 Jun; 104 (6):630-2.
21. Lippman MB. Lead and human health: Background and recent findings. Environ Res 1990; 51: 1–24.
22. Sandip M Hulke et al Lung function test in petrol pump workers. National journal of physiology, Pharmacy and Pharmacology/ 2012/ Vol 2/ issue 1/ 71-75.
23. 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.

24. Sadiqua Begum, MB Rathna. Pulmonary function tests in petrol filling workers in Mysore city. Pak J Physiol 201 2; 8(1).

25. Evans RG, Webb K, Homan S, Ayres SM. Cross-sectional and longitudinal changes in pulmonary function associated with automobile pollution among bridge and tunnel officers.Am J Ind Med. 1988; 14(1):25-36.

26. Rostogisk, Gupta BN,Hussain T. Spirometry abnormalities among welders. Ind J Occup Health 1991; 34(2): 67-74.

27. Rao NM, Patel TS, Raiyani CV, Aggarwal AL, Kulkarni PK, Chatterjee SK, Kashyap SK. Pulmonary function status of shopkeepers of Ahmedabad exposed to autoexhaust pollutants Indian J Physiol Pharmacol. 1992 Jan; 36(1):60-4.

28. Ingle ST, Pachpande BG, Wagh ND, Patel VS,Attarde SB. Exposure to vehicular pollution and respiratory impairment of traffic policemen in Jalgaon City, India. Ind Health. 2005 Oct; 43(4):656-62.

29. Paggiaro P, Lastrucci L, Di Pede C, Bacci E, Rossi O, Talini D. Respiratory pathology caused by exposure to solvents in the shoe industry: description of 3 clinical cases. J Ital Med Lav. 1985 Jul; 7(4):149-52

30. Von Mutius E. The environmental predictors of allergic disease. J Allergy Vol.11 (2) 197-200.

31. Sushil Dube, Mungal.S.U.Evaluation of respiratory functions in petrol pump workers. International journal of recent trends in science and technology,ISSN 2277-2812 E-ISSN 2249-8109,volume 8,issue 2,2013 PP 149-152