Original Research Article

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20163946

Spirometric evaluation of the pulmonary functions in the petrol pump workers of Jaipur city, Rajasthan, India

Rahul*, Sangeeta Vyas, Manisha Sankhla, Jitendra Gupta

Department of Physiology, S. M. S Medical College, Jaipur, Rajasthan, India

Received: 14 September 2016 **Accepted:** 10 October 2016

*Correspondence:

Dr. Rahul,

E-mail: drrahul5@yahoo.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: With rapid urbanization and economic development, occupational health hazards have grown as one of the major public health challenges. Many groups in the society are at greater risk of developing adverse consequences owing to their working environment, one such group is the petrol pump workers who by virtue of their occupation are continously exposed to the noxious chemical compounds present in gasoline. Hence, this study was undertaken to find out the effects of gasoline vapors on pulmonary function tests among the petrol pump fuel filling attendants working at various petrol pumps of Jaipur city, Rajasthan, India.

Methods: Forty non-smokers, non-alcoholic adult males working as petrol pump workers for more than 3 years were considered as the study group. Forty matched healthy males of the institute served as the controls. The Pulmonary functions were assessed using computerized spirometer. Mean±SD values for each parameter were determined for both the study and control groups and compared using an unpaired 't' test.

Results: A significant reduction (p<0.05) in FVC, FEV₁, FEF25-75%, PEFR was found in the study group (Petrol pump workers) as compared to the controls, but the mean values of FEV₁/FVC (%) were statistically not significant between the two groups.

Conclusions: This study concludes that the petrol pump workers are at greater risk to develop pulmonary impairment (predominantly restrictive pattern of lung disease) with time and also, sensitizes for the need of medical surveillance and implementation of occupational safety programs to prevent work-related morbidities.

Keywords: Gasoline vapors, Occupational exposure, Petrol pump workers, Pulmonary function tests

INTRODUCTION

In recent years, Jaipur, the capital city of Rajasthan (India), usually known as the 'Pink city' has outgrown into an amalgamation of the traditional and modern city of amenities and has emerged as the 10th most populated mega-cities of India.¹

As per the last Census of India, held in 2011, there has been a progressive development in the population of the Jaipur city to approximately 3.11 million with a growth rate of about 4% per annum.² This rising trend of

urbanization has led to a precipitous hike in the vehicular traffic density, consequently, the establishment of more and more petrol pumps to cater the growing demands of society.

At these petrol pumps, like, the other parts of the country, there is no provision of self-service and the fuel filling attendants are employed for fueling of vehicles. These fuel dispensers work continuously for 8-12 hours a day without using any protective devices and maintaining personal hygiene like consuming food without washing hands.³

Apart from refueling vehicles, these workers also do all sorts of works like unloading of fuel and daily checking of fuel levels in the storage tanks, checking the pressure in vehicle tires. Moreover, it was observed that many of them come from extreme rural areas and do not extend back to their homes for months, but prefers to stay at the petrol station premise which makes these petrol filling workers persistently exposed to various chemical constituents present in gasoline.

Gasoline is a complex combination of aliphatic and aromatic hydrocarbons of which Benzene, Toluene, ethylbenzene, xylene (BTEX) are some of its vital constituents and considered among the most hazardous compounds for the human health, particularly benzene, which has been classified as group A and class 1 human carcinogen by the International Agency for Research on Cancer (IARC) and United State Environmental Protection Agency (USEPA) respectively. 3,5

In order to reduce the workplace exposures to these compounds, various International organizations, like OSHA, NIOSH, ACIGH, European Union, WHO have laid their standards and guidelines in the form of occupational exposure limits and air quality guideline values for exposure to benzene, toluene and xylene.⁵ In India, too, the Central pollution control board (CPCB) in 2009 revised and established the annual average ambient air quality standard concentration of benzene to be 5 micrograms per meter cube.⁶

However, Singla et al in an assessment of the volatile organic compounds (VOCs) namely benzene, toluene, and xylene (BTX) at the roadsides and the petrol pumps in Agra noted that the concentrations of VOCs at both the sites were higher than those laid down by the Indian national ambient air quality standards. Moreover, the study reported a significantly higher concentration of benzene and toluene at petrol pumps of Agra compared to the roadside measurements.⁷

Earlier, in 2008, Majumdar et al also, found the benzene and toluene levels to which the petrol pumps workers in Kolkata were exposed to be 3.9 and 5.5 folds higher than that of ambient air quality standards respectively. Many research works conducted worldwide, too, has documented the presence of high levels of BTEX emission in the air of the fuel stations like Correa et al reported average value of 29.7 $\mu g/m^3$ for benzene, 47.7 $\mu g/m^3$ for toluene, 23.3 $\mu g/m^3$ for ethyl benzene, 46.9 $\mu g/m^3$ for m+p–xylene and 14.3 $\mu g/m^3$ for o–xylene at the Rio de Janeiro fuel filling stations. Esmaelnejad et al in 2013, also, observed the concentration of benzene higher than the maximum allowed level in the air of Shahreza filling stations. 10

Such, high atmospheric levels of benzene and other chemicals at petrol filling stations are mainly attributed to the vapors from fuel spillage, losses from the mechanical fuel dispenser during fueling of vehicles and continuous losses from the petrol storage tanks built on the same premises, much more evident in the regions with hot climatic conditions like the Jaipur city. 3,11

Additionally, the petrol pump workers are exposed to the emissions liberated from the exhaust pipes of the vehicles in the form of combustion-derived nano particles (CNDPs) along with other pollutant gases as many motorists usually do not turn down their vehicles at the filling stations while getting refuelled. These CNDPs are highly respirable and have a large surface area that carries a large fraction of toxic hydrocarbons and metals on their surface. They remain airborne for longer time periods and penetrate deeper into the lungs. ¹²

Although, the petroleum constituents are ubiquitous in the environment and known to be harmful, even inhaled for a short period of time, the continuous presence of such deleterious chemicals in the form of vapors in the breathing zone of these petrol pump workers brings them to a greater risk of developing potential health hazards.

Hence, this study was undertaken to find out the effects of gasoline vapors on pulmonary function tests among the petrol pump filling attendants working at various petrol pumps of Jaipur city, Rajasthan, India.

METHODS

This study was conducted in the Upgraded Department of Physiology, SMS Medical College, Jaipur, Rajasthan, India after obtaining approval from the ethical committee of our institute and the written informed consent from the volunteers of the study.

Forty non-smoker, non-alcoholic adult males in the age group of 20-40 years working at different petrol pumps as petrol filling attendants for more than 3 years, at least 8 hrs/day was considered as a study group. Forty age and sex matched non-smokers, non-alcoholic subjects working as ward boys and peons in the various departments of our institute not occupationally exposed to petroleum fumes constituted the control group.

Each subject from both the groups was interviewed with a detailed questionnaire regarding their occupation, income and personal habits. A brief physical, anthropometric (height, weight, Body Mass Index) and clinical examination were carried out and recorded in prestructured proforma. Subjects of both study and control group having a history of acute or chronic illness, any type of known allergic conditions, history of major surgery (Cardiac, pulmonary, abdominal) were excluded from the study.

The Pulmonary function tests: Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV₁), FEV₁/ FVC (%), Forced Expiratory Flow in 25-75% (FEF 25-75%) and Peak Expiratory Flow Rate (PEFR) were recorded by using a self-calibrating

computerized spirometer (Recorders and Medicare System, Chandigarh).

The volunteers in the study were instructed to avoid beverages like tea, coffee, other stimulants and exercise before reporting at the department for the tests. Subjects were briefed and familiarized, and self-demonstration of the required test was done to remove apprehension and make them conversant with the procedure.

All the tests were carried out during the morning hours between 8:30 AM to 10:00 AM to avoid possible diurnal variations. The tests were performed using the standard guidelines outlined by the American Thoracic Society and European Thoracic Society with subjects in sitting position and a nose clip was applied to them during the maneuver. Each subject was asked to take full inspiration which was followed by as much rapid and forceful expiration as possible in the mouthpiece of the Spirometer. Three consecutive readings were taken and the best reading amongst three was considered for statistical analysis.

Statistical analysis

The data of pulmonary function tests were presented as the Mean ± Standard deviation for each of the parameters. The two groups were compared by using unpaired 't' test and p value of less than 0.05 was considered significant. Analyses were processed using Graph Pad Instat software for Windows (version 3.1, GraphPad Software, Inc., San Diego, CA).

RESULTS

No statistically significant difference was observed in the means of age, height, weight and BMI between the study and control groups as depicted in Table 1. Mean exposure years of gasoline in the study group were observed to be 9.78 ± 3.29 . Table '2' shows that all the studied parameters of the pulmonary function tests were decreased in the study group than the control group. This difference was observed statistically significant (p value <0.05) in all parameters of pulmonary function tests except in ratio FEV₁/FVC (%).

Table 1: Characteristics comparison of subjects in petrol pump workers and control.

Characteristics of Subjects		Mean ± SD		P value	Significance
		Petrol pump workers (N=40)	Control group (N=40)		
Age (Years)		30.70±3.04	29.90±2.72	0.21	NS
Anthropometric Parameters	Height (Cms)	167.55±3.12	168.18±2.78	0.34	NS
	Weight (Kg)	61.70±3.95	63.25 ± 4.89	0.12	NS
	BMI (Kg/m^2)	21.97±1.07	22.34±1.25	0.15	NS
Gasoline Exposure (Years)		9.78±3.29	-	-	-

NS: Non significant (p value >0.05); S=Significant (p value≤0.05).

Table 2: Comparison of pulmonary function tests parameters with petrol pump workers and control.

Pulmonary function tests	Mean ± SD		P value	Significance
parameters	Petrol pump workers (N=40)	Control Group (N=40)		
FVC (L)	3.43±0.35	3.76±0.19	< 0.0001	S
FEV1 (L)	2.84±0.39	3.17±0.18	< 0.0001	S
FEV1/FVC (%)	82.55±5.65	84.46±3.00	0.06	NS
FEF25-75% (L/S)	2.95±0.92	3.47±0.56	0.003	S
PEFR (L/S)	7.16±1.33	8.16±1.11	0.0005	S

NS: Non significant (p value >0.05); S=Significant (p value ≤ 0.05).

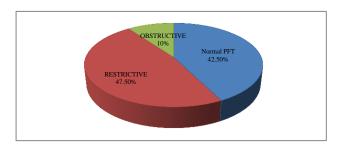


Figure 1: Comparison of pulmonary functions in the Petrol pump workers with their own predictive values.

Figure 1 shows on comparison of the individual subjects of the study group (Petrol pump workers) with their own predictive values, it was found that 47.50 % subjects had a restrictive pattern of pulmonary involvement, 10% subject's were with obstructive pattern and 42.50% had normal pulmonary function tests.

DISCUSSION

The present study was conducted to determine the respiratory health of the petrol pump workers who by virtue of their occupation are continuously exposed to the

gasoline vapors. It was observed that the mean values of Forced vital capacity (FVC) and the Forced expiratory volume in first second (FEV₁) were significantly reduced in the petrol pump workers when compared to the control subjects, however, the ratio of Forced Expiratory Volume in 1st second/Forced Vital Capacity (FEV₁/FVC) was seen statistically insignificant between both the groups.

These findings were in agreement with the studies conducted by Singhal et al, Madhuri et al, Begum and Ratna, which described a substantial decline in FVC and FEV_1 in the petrol pump workers with insignificant differences in the ratio FEV_1 / FVC between the petrol pump workers and control group. ¹⁴⁻¹⁶

Also, the mean values of the flow rates: Forced Expiratory Flow in 25-75% (FEF 25-75%), Peak Expiratory Flow Rate (PEFR), in the present study were found significantly decreased among the petrol pump workers as compared to the control group. These findings were in compliance with the previous studies conducted by Sharma et al, Choudhari et al which also demonstrated a significant decline in FEF25-75%, PEFR. ^{17,18}

Furthermore, when the individual subjects in the study group (Petrol filling attendants) were compared with their own predictive values, 57.50% were found to have pulmonary impairment with predominance of a restrictive pattern of the lung involvement. This was particularly more evident in the fuel filling attendants working continuously at the various filling stations for more than 10 years.

Keshavchandran et al, ascertained that a decline in observed values of FVC, FEV₁ among petrol pump workers when compared to predicted values and also exposure-wise denotes prevalence of restrictive type of lung diseases.³ This was supported by Uzma et al who also reported a prevalence of a restrictive pattern of lung disease in the petrol filling attendants working for longer durations at the petrol pumps.¹⁹ This holds true to some extent in the present study also.

Adverse effects of petrol vapor on the lung functions may occur through several ways. Azeez et al in an endeavor to find out the effects and potential mechanism of petroleum hydrocarbons on lung tissue conducted blood assay for the lung tissue malondialdehyde (MDA), superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) and histo-morphology of lung tissue in some experimental animals exposed to the petroleum hydrocarbons and explained that the petroleum hydrocarbons causes an increase in lung tissue malondialdehyde (MDA), an indicator of lipid peroxidation. These petroleum hydrocarbons also, decrease the glutathione content and the activities of superoxide dismutase that serve as a primary line of defense in destroying the free radicals. Hence, triggering of oxidative stress leading to the loss of cellular and tissue integrity.²⁰

Further, the study of Azeez et al projected that the exposure to the petroleum hydrocarbons impairs the type II pneumocytes resulting in a decreased production of surfactant and consequently alveolar collapse, ventilation-perfusion mismatch, and hypoxemia. This ultimately leads to hemorrhagic alveolitis, interstitial inflammation, intra-alveolar hemorrhage and edema, bronchial necrosis and vascular necrosis causing defective lung parenchyma. Since, the consequences of such occupational hazards may not become evident for many years, it is important to identify the potential dangers early and adopt necessary measures before they result into permanent morbidities.

Moreover, a large segment of the workers engaged in such occupations is either illiterate or with elementary education and are largely unaware of the risks related to their tasks. Similarly, the owners are also not aware about the potential hazards resulting in poor implementation of restraint measures and enforcement of laws.²²

So, to prevent such occupational hazards, health education and training programs for safe handling of the petrochemical substances should be carried out for the workers, supervisors and the owners.^{22,23} Also, periodic health checkups and mandatory use of the personal protective equipments like safety wears, respirators, gloves, shoes at the filling stations are needed to be instituted by the employer for the protection of their workers.²³ Alike, many developed establishment of vapor recovery systems at the gasoline filling stations and exploration of alternative energy sources like bio-fuels are perhaps some of the other substantial measures that might prove beneficial in protection of our environment and ensuing of healthy wellbeing of these petrol filling workers. 10,24

CONCLUSION

This study has revealed that the petrol pump workers are at greater risk to develop pulmonary impairment with time, however, longitudinal studies with large sample size and studies on diffusion capacities of the lung are required which will help to give a robust understanding of the respiratory health of these fuel dispensers. Further, this study also sensitizes for the need of regular medical surveillance and implementation of occupational safety programs to prevent work related morbidities.

ACKNOWLEDGEMENTS

Authors would like to thank Dr. Kusum Lata Gaur, Professor, Department of Community Medicine, S.M.S Medical College, Jaipur for her valuable support and timely guidance to carry out this research work.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- 1. Gururaja KV, Sudhira HS. Population crunch in India: is it urban or still rural? Current Science. 2012;103(1):37-40.
- 2. Amit D, Jethoo AS, Poonia MP. Impact of drought on urban water supply: a case study of Jaipur city. Int J Eng Innov Technol. 2012;1:170-4.
- 3. Kesavachandran C, Rastogi SK, Anand M, Mathur N, Dhawan A. Lung function abnormalities among petrol-pump workers of Lucknow, North India. Current Science. 2006;90(9):1177-8.
- 4. Periago JF, Prado C. Evolution of occupational exposure to environmental levels of aromatic hydrocarbons in service stations. Ann Occup Hyg. 2005;49(3):233-40.
- 5. Edokpolo B, Yu QJ, Connell D. Health risk assessment of ambient air concentrations of benzene, toluene and xylene (btx) in service station environments. Int J Environ Res Publ Health. 2014:11(6):6354-74.
- National ambient air quality status 2009. Central pollution control board, Ministry of Environment & Forests, Government of India, New-Delhi. Available online: http://cpcb.nic.in/ upload/ Publications/ Publication_514_airqualitystatus2009.pdf.
- 7. Singla V, Pachauri T, Satsangi A, Kumari KM, Lakhani A. Comparison of BTX profiles and their mutagenicity assessment at two sites of Agra, India. Scie Wor J. 2012;2012. doi:10.1100/2012/272853.
- 8. Majumdar D, Dutta C, Mukherjee AK, Sen S. Source apportionment of VOCs at the petrol pumps in Kolkata, India; exposure of workers and assessment of associated health risk. Transportation Research Part D: Transport and Environment. 2008;13(8):524-30.
- 9. Correa SM, Arbilla G, Marques MR, Oliveira KM. The impact of BTEX emissions from gas stations into the atmosphere. Atmospheric Pollution Research. 2012;3(2):163-9.
- 10. Esmaelnejad F, Hajizadeh Y, Pourzamani H, Amin MM. Monitoring of benzene, toluene, ethyl benzene, and xylene isomers emission from Shahreza gas stations in 2013. Inter J Env Health Eng. 2015;4(1):1-7.
- 11. Aleemuddin M, Girish Babu M, Manjunath ML, Quadri SS. Effects of chronic inhalation of petroleum products on hematological parameters. International Journal of Current Research and Academic Review. 2015;3(4):196-201.

- 12. Wichmann HE. Diesel exhaust particles. Inhalation toxicology. 2007;19 (Sup1): 241-4.
- 13. Miller MR, Hankinson J, Brusasco V. Series "ATS/ERS Task Force: Standardisation of lung function testing". Eur Respir J. 2005;26:319-38.
- 14. Singhal M, Khaliq F, Singhal S, Tandon OP. Pulmonary functions in petrol pump workers: a preliminary study. Indian J Physiol Pharmacol. 2007;51 (3):244-8.
- 15. Madhuri BA, Chandrashekar M, Ambareesha K. A study on pulmonary function test in petrol pump workers in Kanchepuram population. Int J Biol Med Res. 2012;3(2):1712-4.
- 16. Begum S, Rathna MB. Pulmonary function test in petrol filling workers in Mysore city. Pak J Physiol. 2012;8(1):12-4.
- 17. Sharma N, Gupta N, Gupta R. Ventilatory impairment in petrol pump workers. J Med Edu & Res. 2012;14(1):5-8
- Choudhari SP, Doiphode RS, Zingade US, Munibuddin A, Badaam KM. Evaluation of Airway resistance and Spirometry in Petrol Pump Workers: A Cross sectional study. IOSR J Den Med Sci. 2013; 5(2):69-71.
- 19. Uzma N, Khaja Mohinuddin 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 Publ Health. 2008;5(3):139-46.
- 20. Azeez OM, Akhigbe RE, Anigbogu CN. Exposure to petroleum hydrocarbon: Implications in lung lipid peroxidation and antioxidant defense system in rat. Toxicol Int. 2012;19(3):306-9.
- 21. Benjamin OA. Fundamental principles of occupational health and safety. 2nd ed. Geneva: Int Labor Organization. 2008:65
- Saiyed HN, Tiwari RR. Occupational health research in India. Industrial Health. 2004;42(2):141-8.
- 23. Abd EMS, Aal EMA. Occupational program for improving the health of gasoline workers. J Ameri Sci. 2012;8(7):33-41.
- 24. Annamalai K. The Status of Biodiesel as an Alternative Fuel for Diesel Engine-An Overview. J Sustain Energy & Environ. 2011;2(2):71-5.

Cite this article as: Rahul, Vyas S, Sankhla M, Gupta J. Spirometric evaluation of the pulmonary functions in the petrol pump workers of Jaipur city, Rajasthan, India. Int J Community Med Public Health 2016;3:3256-60.