ORIGINAL RESEARCH PAPER

Volume-8 | Issue-6 | June-2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ESTIMATION OF $FEF_{25-75\%}$ TO ASSESS EARLY CHANGES IN SMALL AIRWAYS OF PETROL PUMP WORKERS

Medical Physiology

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ABSTRACT

Petrol pump workers are continuously exposed to the air pollutants and volatile organic compounds because the location of pumps are usually on busy roads. The deposition and clearance of particles within the respiratory system occurs in an inhomogeneous manner. This study carried out in 100 male non-smoker, working for more than 1 year, within 20-50 years age Petrol Pump workers to find out the status of small airways in them by means of spirometry. FEF25–75% indicates flow rates in small airways. In this study, mean value of FEF25–75% (% predicted) in Study Group was significantly less than Control Group. Also as the age and duration of exposure of the petrol pump workers increased FEF25–75% decreased significantly. The accumulation of fuel particles in peri-bronchial lymphoid and connective tissues leads to varying degrees of bronchial wall thickening and remodeling of terminal and respiratory bronchioles which can cause small airway obstruction. Pre-employment checkup and monitoring, usage of protective mask, vapour recovery system establishment and proper maintenance may provide the best approach to control the exposure to these fumes.

KEYWORDS

INTRODUCTION :

Petrol is a complex combination of aliphatic (95%) and aromatic hydrocarbons (<2%) of which Benzene, Toluene, Ethylbenzene, Xylene (BTEX) are some of its vital constituents. Evaporation losses of petrol occur during the handling, distribution and storage.[1] Another source is emission from motor vehicles exhaust. Otherwise, 50% of ambient particulate matter with diameter < 10 Micro Meters (PM10) is contributed by exhaust of diesel engines.[2] So, the petrol pump workers are continuously exposed to these compounds because the location of pumps are usually on busy roads and their duty hours are long.[3] Large particles that are respired are readily removed by mucociliary clearance aided by macrophage phagocytosis.[4] The major site of impact and injury appeared to be the terminal bronchiole and adjacent first-generation respiratory bronchioles. It is also a region with highly specialized cells, including alveolar epithelial cells (type I and II), ciliated cells, nonciliated bronchiolar epithelial (Clara) cells, neuroendocrine cells which may be particularly vulnerable to damage associated with particle retention. In this region, chaotic mixing may be the important mechanism of particle deposition and dispersion.[5,6] Furthermore, this region is the point of entry and exit to the ventilatory unit; gases and airborne particles entering and leaving the acinus have to pass through this constricted zone.[7] $FEF_{25-75\%}$ indicates flow rates in small airways[8] and hence this study was choosen to assess involvement of small airways in petrol pump workers by estimating $FEF_{25-75\%}$.

MATERIAL AND METHODS:

This cross-sectional study was done in 2015- 2016 in the Dept. of Physiology, Rohilkhand Medical College & Hospital after obtaining ethical approval. Sample size was calculated with the formula $4pq/L^2$; where P(Prevalence)=50%, Q=100–P=50%, L(allowable error)=20% of prevalence=10. A total of 100 male Petrol Pump workers, non-smokers, working for more than 1 year and within 20-50 years of age were selected by Simple Random Sampling from different petrol stations of Bareilly. They comprised the Study Group and 100 age and sex-matched nonsmokers from general population were selected as controls. The exclusion criteria comprised of the presence of respiratory diseases like tuberculosis, bronchial asthma, COPD, chronic diseases like diabetes mellitus, hypertension, history of regular medication like sedatives or hypnotics, major abdominal or thoracic surgery in past or inability to perform pulmonary function test. Those who were not in direct exposure to petroleum fumes were also excluded.

After obtaining informed consent, anthropometric measurements were recorded. Electronic Spirometer Helios 401was used for recording $FEF_{25-75\%}$ and guidelines of American Thoracic Society were adhered to while recording.[11] The subject was made to sit and relax for minimum 5 minutes prior to performing the procedure. The procedure was thoroughly explained to each subject and asked to take full inspiration which was followed by rapid and forceful expiration with closed nostrils in the mouthpiece. The best reading of percent predicted values of $FEF_{25-75\%}$ was selected for analysis. Data was analyzed with SPSS and P value of <0.05 was considered statistically significant.

OBSERVATION & RESULTS :

As the mean ± SD of anthropometric parameters and age were non-significantly different between Study and Control groups, so their $FEF_{25-75\%}$ was compared using Independent sample t-test.

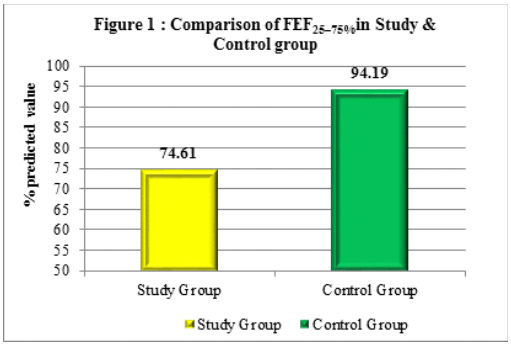

Figure 1 shows $FEF_{25-75\%}$ (% predicted) mean ± SD in Study Group and Control Group was 74.61 ± 21.25 and 94.19 ± 20.54 respectively and the difference was statistically significant (p=0.001). Each of Study Group and Control group were divided into three age groups i.e Group I (20 - <30 years), Group II (30 - <40 years) and Group III (40 - <50 years). Mean values of anthropometric parameters were non-significantly different in each age group between Study and Control groups, so their $FEF_{25-75\%}$ was compared using Independent sample t-test as depicted in Table 1.

Table 1 : Comparison of $FEF_{25-75\%}$ in different age groups

Groups		Mean	SD	Std error	Sig (p)
Group I	Study Group	80.89	25.57	4.32	**0.198**
	Control Group	87.79	19.62	3.18	
Group II	Study Group	73.03	18.75	3.12	**0.001**
	Control Group	98.64	21.69	3.34	
Group III	Study Group	69.00	16.68	3.10	**0.001**
	Control Group	97.00	17.35	3.88	

Study Group was also divided into three groups according to their duration of exposure i.e Group A (more than 1 year to 3 years) 38 workers , Group B (more than 3 years to 5 years) 32 workers and Group C (more than 5 years to 7 years) 30 workers. As their anthropometric parameters do not differ, they form comparable groups.

Table 2 :'One-way ANOVA' Comparison of FEF25–75% among different exposure groups

Parameter	Exposure duration Group	Mean	Std. Deviation	Std. Error	Significance
$FEF_{25-75\%}$	>1year-3 years	82.61	24.52	3.97	**0.011***
	>3 years-5 years	70.25	19.08	3.37	
	>5 years-7 years	69.13	15.80	2.88	

Table 2 displays that, there was a statistically significant difference of mean $FEF_{25-75\%}$ between the duration of exposure groups {F(2,97)=4.682, p=0.011}(effect size 0.088). Post-Hoc analysis shows: $FEF_{25-75\%}$ values of Group B (p=0.036) and Group C (p=0.023) was significantly less compared to Group A. But, there was non-significant (p=0.975) difference between Group B and Group C. So, initially increased exposure duration more than 3 years caused significant reduction in $FEF_{25-75\%}$ but later on the reduction was not significant as exposure increased more than 5 years.

DISCUSSION :

In this study, $FEF_{25-75\%}$ (% predicted values) in petrol pump workers was significantly less than Control Group . This finding is consistent with other studies.[9,10] This indicate that small airways probably bear the brunt of the air pollution & fuel vapour related lung injury. Particles generated from diesel exhaust are extremely small, hence they can remain airborne for long periods of time and deposit in greater numbers and deeper into the lungs.[11] Fuel vapours in combination with particulate pollutants and automobile exhaust gases may also alter the properties and concentration of surfactant and may thus contribute to the early closure of small airways.[12] The walls of the bronchioles are almost entirely smooth muscle supplied by parasympathetic nerves which mostly get stimulated by leukotrienes, irritants, chemicals. It causes cholinergic discharge producing broncho-constriction and increased bronchial secretion via muscarinic receptors.[13] In contrast, Sinha A *et al* found that control group mean $FEF_{25-75\%}$ was non-significantly different from study group. This could be due to unequal distribution of samples between the groups.[14]

In this study, mean $FEF_{25-75\%}$ comparison in each age group between study and control group revealed an insignificant (p=0.198) decline in Group I but significant decline (p<0.001) in two other groups. Priyadarsini G *et al* also had similar study outcome which supports that in early stage most of the workers unnoticed but advancement of age make them more susceptible, noticeable for the effect of these detrimental vapours. Reduction in supporting tissue around airways with age leads to early closure of small airways which may be undetectable until a much more damage has occurred. [15]

In the present study, $FEF_{25-75\%}$ differed statistically significantly in successive exposure groups of petrol pump workers. There are studies which are in agreement with this finding.[16,17] In my study, significant deterioration of $FEF_{25-75\%}$ was observed in more than 3 years exposure group but when the exposure increased more than 5 years there was not so much significant reduction. This can be explained by the fact that exposure to fuel for first few years might have involved the maximum number of small airways, hence availability of small airways to cause significant damage was comparatively less on chronic exposure.

CONCLUSION:

Petrol pump workers are vulnerable to develop impairment in lung function and small airways are probably the most crucial site of lung injury among them. Aging and gradual increase in exposure over the years increases the susceptibility of small airways dysfunction in petrol pump workers. Preventive strategies like vapour recovery system establishment and proper maintenance; improvement in the engine design, soot filters and fuel modification, pre-employment checkup and monitoring, usage of protective mask may provide the best approach to control the exposure to these fumes. Awareness of the sources of air pollution in the community would help individuals avoid them.

ACKNOWLEDGEMENT:

I acknowledge all the study participants for their help and co-operation.

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