

Research Article

Pulmonary function tests in Petrol pump workers in Karad town

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Abstract

Objectives: Polluted environment at petrol pumps is likely to have adverse effects on health of workers. Petrol filling workers as well as office workers at petrol pumps are likely to have adverse effects on lung function. We wanted to study the actual fact.

Methods: Pulmonary function tests were studied in petrol pump workers in Karad city and around. Petrol filling workers (direct exposure group, 48) and petrol pump office workers (indirect exposure group, 12) were included in study. Control group (50) of age matched healthy paramedical workers from KIMS, University was included. Approval from Institutional Ethical Committee was obtained. Informed written consent was taken from each participant. Spirometric lung function test were carried out in department of Physiology. Pulmonary function parameters included were FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in First second of FVC), FEV1% (FEV1 as % of FVC), PEFR (Peak Expiratory Flow Rate in liters/sec), FEF25-75% (Forced Expiratory Flow Rate during 25 to 75 % of expiration), FEF 0.2-1.2 (Forced Expiratory Flow between 0.2 -1.2 liters of expiration) and MVV (Maximum Voluntary Ventilation). After computing mean and SD of each parameter group comparison was done by using paired t test and ANOVA.

Results: Impairment of lung function (Predominantly restrictive type) was found in both the study groups compared to controls.

Conclusions: Exposure to polluted air and fumes of petrol/diesel causes lung function derangement in petrol pump workers.

Keywords: Petrol & diesel fumes, lung function, Petrol station workers

1. Introduction

Air pollution from various factors is major hazard of rapidly increasing urbanization throughout the world including India. Increasing number of vehicles with emission of burnt fuels (petrol and diesel) is major cause of air pollution in most towns and cities. Exposure to air pollutants for longer duration (in years) results in hazardous effects on the respiratory system. Petrol pump workers are constantly exposed to the polluted air and vapors of petrol. Petrol pump workers have duties ranging from 8-12 hours at their work place. Most of them are not using protective devices¹. So this group of workers is likely to have grave ill effects on their health. Earlier studies have documented the impairment of lung function in this group of workers. Some of them had not considered duration of exposure² whereas others had not considered various parameters of pulmonary function tests³. Such type of study is not done in this geographical region of the country. So we planned the study where duration of exposure and various parameters of ventilatory lung function were considered. In addition to this we included the office workers of petrol pumps as they are also exposed to the fumes indirectly. No other study had included them. Pre-employment assessment of lung function is neither done in petrol pump workers nor are they periodically evaluated for effect of exposure to petrol fumes on them. Petroleum products and its exhaust cause significant health problem symptoms like chronic cough, breathlessness and wheezing^{2,4}. Petrol is a mixture of volatile hydrocarbons, whereas diesel fuel is distillate of petroleum which contains paraffin, alkenes and aromatics⁵. Petrol and diesel after combustion in automobile engines give rise to particles which are highly respirable. Because of larger surface area they can adsorb organic materials. They can get deposited in large numbers and deeper into the lungs⁶. Petrol pump workers are also likely to get exposed to such burnt petroleum products from vehicular exhaust.

2. Materials & Methods

The study was conducted in Department of Physiology during the period-May 2012 to June 2012. Approval from Institutional Ethical Committee (IAC) was taken before start of the study. The subjects selected for the study were the workers at various petrol pumps, in Karad city and around. They were called in department of Physiology for testing their lung function preferably in the morning. They were divided into two groups depending upon type of exposure, direct exposure group (petrol filling workers) and the indirect exposure group (petrol pump office workers, not exposed directly to petrol fumes). In direct exposure group, subjects were further subdivided into groups depending upon duration of exposure as D1-D5 (D1-from 0 to 2 year, D2-from 2 to 5 year, D3-from 5 to 10 year, D4-from 10 to 15 year and D-5 more than 15 years). A detail history was recorded which included questions regarding duration of work at petrol pumps, smoking habits, present respiratory symptoms if any, past history of respiratory/cardiac disease. The workers having smoking habits, past history of respiratory or cardiac disease were excluded from the study. Clinical examination was done to rule out any existing pulmonary disease. Ultimately 60 workers (male) were selected for the study. There were 48 in direct group and 12 in indirect group. A control group of 50 age matched healthy paramedical male workers from Medical College was taken for comparison. Informed written consent from all the subjects and controls was taken. Anthropometric measurements i.e. height and weight were recorded for each participant.

Lung functions were measured by using a computerized "MEDSPIROR" (RMS Chandigarh, India) instrument. Spirometry was carried out as per guidelines of American Thoracic Society⁷. Before recording lung functions; subjects were shown a demonstration of the test. Consequently minimum three readings of each test were taken for every subject and the best of the three was selected for having reproducibility and validity of the recorded parameters. The lung function parameters included were FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in First second of FVC), FEV1% (FEV1 as %

of FVC), PEFR (Peak Expiratory Flow Rate in liters/sec), FEF25-75% (Forced Expiratory Flow Rate during 25 % to 75 % of expiration), FEF 0.2-1.2 (Forced Expiratory Flow between 0.2 -1.2 liters of expiration) and MVV (Maximum Voluntary Ventilation).All the procedure of recording pulmonary function tests was followed as per guidelines of IAC and with the Helsinki Declaration of 1975,as revised in 2000.

2.1 Statistical Methods

Statistical analysis was carried out after summarizing the data by computing mean and standard deviation (SD) of each study variable. The significance of difference of each variable among Direct, Indirect and Control groups was studied applying ANOVA (Analysis of variance).Student t test was applied to compare the findings of lung function between direct exposure group and indirect exposure group.

3. Results

After applying student t test it was found that petrol filling workers (Direct exposure group) and control group were age matched ($T=1.962$, $P=0.0527$) and office workers (Indirect exposure group) were also age matched with control group ($T=1.360$, $P=0.1788$).Anthropometric measurements are shown in table 1.

Table1: Anthropometric measurements

Group	Age in years Mean \pm SD	Height in cms Mean \pm SD	Weight in Kg Mean \pm SD
Direct Exposure group(48)	32.89 \pm 7.60 ^{ns}	165.06 \pm 7.39	64.08 \pm 10.32
Indirect Exposure group(12)	41.83 \pm 14.65 ^{ns}	160.00 \pm 4.84	57.25 \pm 8.01
Control group(50)	36.88 \pm 11.06	168.98 \pm 6.49	63.38 \pm 10.30

ns, no significant difference compared to control

ANOVA analysis for various lung function parameters among groups was carried out after computing mean and standard deviation of each parameter (Table2).

Table 2: Mean \pm SD of Lung function parameters in study groups and in control group

Lung function parameter	Direct exposure group Mean \pm SD	Indirect exposure group Mean \pm SD	Control group Mean \pm SD	P value
FVC (Liters)	2.82 \pm 0.50	2.79 \pm 0.55	3.23 \pm 0.50	0.0003**
FEV1(Liters)	2.55 \pm 0.47	2.55 \pm 0.61	2.80 \pm 0.60	0.064
FEV1/FVC %	90.45 \pm 0.61	90.74 \pm 5.60	88.67 \pm 6.38	0.44
FEF25-75 (L/S)	3.45 \pm 0.96	3.23 \pm 0.98	3.47 \pm 0.98	0.7352
FEF.2-1.2 (L/S)	4.83 \pm 1.42	4.84 \pm 1.47	6.33 \pm 1.58	< 0.0001**
PEFR (L/S)	5.80 \pm 1.60	6.14 \pm 1.48	7.61 \pm 1.87	<0.0001**
MVV (L/min)	97.93 \pm 20.60	92.08 \pm 20.38	125.24 \pm 22.40	<0.0001**

FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in First second of FVC), FEV1% (FEV1 as % of FVC), PEFR (Peak Expiratory Flow Rate in liters/sec), FEF25-75% (Forced Expiratory Flow Rate during 25 to 75 % of expiration), FEF 0.2-1.2 (Forced Expiratory Flow between 0.2 -1.2 liters of expiration) and MVV (Maximum Voluntary Ventilation)

The FVC was less in direct group compared to that in indirect group; this difference was not statistically significant. However compared to control group FVC was significantly reduced in direct group ($p<0.001$) and indirect group also ($p<0.05$).There was reduction in mean value of FEV1 in study groups (direct& indirect) than in control one, but the difference was not significant ($p>0.05$).There was no significant difference in FEV1/FVC % in various groups. There was reduction in FEF25-75 in petrol pump workers compared to controls but the difference was not statistically significant.FEF.2-1.2 was significantly reduced in direct exposure group ($p<0.001$) and in indirect exposure group ($p<0.01$) compared to that of control group. There was also significant reduction in MVV in both the study groups compared to control group ($p<0.001$).PEFR was significantly reduced in direct group ($p<0.05$) and indirect group ($p<0.001$) compared to control group (Table 3, 4).

Table 3: Mean \pm SD of Lung function parameters in direct exposure group and control group

Lung function parameter	Direct exposure group (48) Mean \pm SD	Control group (50) Mean \pm SD	p value	t value
FVC	2.82 \pm 0.50	3.23 \pm 0.50	0.0001**	4.184
FEV1	2.55 \pm 0.47	2.80 \pm 0.60	0.0393*	2.120
FEV1/FVC%	90.45 \pm 8.81	88.67 \pm 6.38	0.1840	1.348
FEF25-75	3.45 \pm 0.96	3.47 \pm 0.98	0.8661	0.1695
FEF.2-1.2	4.83 \pm 1.42	6.33 \pm 1.58	< 0.0001**	4.739
PEFR	5.80 \pm 1.60	7.61 \pm 1.87	< 0.0001**	4.980
MVV	97.93 \pm 20.60	125.24 \pm 22.40	<0.0001**	5.936

Table 4: Mean \pm SD of Lung function parameters in indirect exposure group and control group

Lung function parameter	Indirect exposure Group (12) Mean \pm SD	Control group (50) Mean \pm SD	p value	t value
FVC(L)	2.79 \pm 0.55	3.23 \pm 0.50	0.2063	1.343
FEV1(L)	2.55 \pm 0.61	2.80 \pm 0.60	0.7645	0.3071
FEV1/FVC%	90.74 \pm 5.60	88.67 \pm 6.38	0.1725	1.459
FEF25-75	3.23 \pm 0.98	3.47 \pm 0.98	0.7342	0.3482
FEF.2-1.2	4.84 \pm 1.47	6.33 \pm 1.58	0.1087	1.746
PEFR	92.08 \pm 20.38	125.24 \pm 22.40	0.0215*	2.678
MVV	6.14 \pm 1.48	7.61 \pm 1.87	0.1311	1.631

Mean values of various lung function parameters in direct exposure group as per duration of exposure at working place of petrol pumps are shown in table 5.

Table 5: Mean \pm SD of Lung function parameters in direct exposure group according to duration of exposure

Lung function parameters	D1 (8)	D2 (9)	D3 (14)	D4 (12)	D5 (5)
	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD
FVC (Liters)	3.04 \pm 0.41	2.66 \pm 0.46	2.62 \pm 0.25	2.59 \pm 0.28	2.25 \pm 0.39
FEV1(Liter)	2.78 \pm 0.37	2.34 \pm 0.46	2.33 \pm 0.25	2.26 \pm 0.21	1.91 \pm 0.27
FEV1/FVC%	91.44 \pm 4.32	88.30 \pm 8.33	88.01 \pm 7.22	86.63 \pm 7.57	85.24 \pm 5.43
FEF25-75 (L/S)	3.60 \pm 0.33	3.20 \pm 0.65	3.15 \pm 0.45	3.29 \pm 0.45	2.91 \pm 0.55
FEF.2-1.2 (L/S)	5.09 \pm 0.87	4.75 \pm 1.74	4.75 \pm 1.32	4.64 \pm 0.81	3.50 \pm 0.53
PEFR (L/S)	5.37 \pm 1.09	5.20 \pm 0.89	5.16 \pm 1.16	4.94 \pm 0.97	4.85 \pm 0.71
MVV (L/min)	99.62 \pm 15.76	92.11 \pm 14.33	91.76 \pm 9.23	89.45 \pm 12.56	88.20 \pm 4.86

D1,0-2 years; D2,2-5 years; D3,5-10 years; D4, 10-15 years; D5, > 15 years

There was progressive reduction in FVC, FEV1, FEF.2-1.2 and MVV as the duration of exposure increased above 10 years and drastic reduction was observed when exposure period exceeded 15 years. Lung function test findings in direct and indirect exposure group are shown in table 6.

Table 6: Mean \pm SD of Lung function parameters in direct exposure group and indirect exposure group

Lung function parameter	Direct exposure Group (48)	Indirect exposure group (12)	p value
	Mean \pm SD	Mean \pm SD	
FVC (Liters)	2.84 \pm 0.50	2.79 \pm 0.50	0.61
FEV1(Liter)	2.55 \pm 0.47	2.55 \pm 0.61	0.24
FEV1/FVC%	90.45 \pm 8.81	90.74 \pm 5.60	0.10
FEF25-75 (L/S)	3.45 \pm 0.96	3.23 \pm 0.98	0.84
FEF.2-1.2 (L/S)	4.83 \pm 1.42	4.84 \pm 1.47	0.80
PEFR (L/S)	5.80 \pm 1.60	6.14 \pm 1.48	0.83
MVV (L/min)	97.93 \pm 20.60	92.08 \pm 20.38	0.95

4. Discussion

In earlier studies deleterious effects on lung function have been shown^{8,9}. Nazia Uzma, *et al.* demonstrated that there was physiological dysfunction in respiratory, hematological and thyroid function in petrol pump workers⁴. It was suggested that background benzene and air pollutants accounted for this. A study conducted by Mayank Singhal, *et al.* reported reduction in dynamic Spirometric parameters of these workers². In one of the study it was found that severity of respiratory dysfunction was related to duration of exposure of the workers at petrol pumps but they did not found reduction of dynamic lung function³. Prospective study done by S.S. Chaugule, *et al.* found that there was no significant association between pulmonary functional status and workplace exposure to polluted air, in petrol pump workers¹⁰. Meo S. A., *et al.* showed that subjects exposed to polluted air (crude oil spill environment), had significant reduction in static and dynamic lung function parameters compared to their matched controls¹¹. A study done by Gamble *et al.* demonstrated that there was an apparent effect of diesel exhaust on pulmonary function with tenure, but no changes in chest radiographs¹². Since petrol pumps are located on busy roads, the workers in addition to petrol fumes are exposed to other pollutants. The particles arising from this polluted air are extremely small and being in nuclei or accumulation modes, with diameters of 0.02 μ m and 0.2 μ m respectively, can carry much larger fraction of toxic compounds e.g. hydrocarbons and metals on their surface¹³. They remain airborne for longer time and deposit in greater numbers and deeper into smaller airways and lungs, than larger sized particles¹⁴.

PM_{2.5} (particulate matter having diameter <2.5 μ m), so called respiratory PM is retained by human lung parenchyma. It is highly toxic material because of its small size chemical composition. It leads to influx of leukocytes into the airspace. PM affects lung defences in various ways. Transition metals contained in PM, particularly iron, cause damage to airways by generating free radicals 7 stress¹⁵. The main cells that are involved in pro-inflammatory responses to particles are the macrophages. Oxidative stress is induced in these cells¹⁶. The inflammatory response was studied in mice, in which inhalation of 300 μ m³ of PM 2.5 caused increase in TNF- β , interferon- β , IL-6 and transforming growth factor- β ¹⁷. The carbon particles, the important constituents of PM 10, cause the release of immature neutrophils from the bone marrow, underlining the chief role of PM in pathogenesis of COPD.

Petrol is a complex mixture of aliphatic and aromatic hydrocarbons with high volatility. Pulmonary effects following inhalation of petrol vapor include persistent atelectasis. The benzene content of petrol ranges between 1-5 %. Benzene in petrol vapor may be an exacerbating factor for the lung abnormalities observed as the subjects in this study were nonsmokers. Petrol pump workers are exposed to other air pollutants in addition to automobile exhaust as petrol pumps are located on busy roads. Automobile exhaust is a combination different gases like Sulphur dioxide (SO₂), Carbon dioxide (CO₂), Carbon monoxide (CO), Nitrogen oxide (NO₂) and particulate matter. Animal studies have demonstrated that greater damage to the lungs occurs when there is combined exposure to particulate matter and an irritant gas such as NO₂, than when exposed to either substance individually¹⁸.

In combination with particulate pollutants SO₂ and NO₂ have a greater chance to reach the deeper parts of the lung. The gaseous pollutants may also alter the concentration and properties of surfactant. This may contribute to early closure of small airways. Much of the terminal bronchioles may be compromised before other pulmonary function tests such as FEV1 are affected¹⁹.

Diesel exhaust particulate constitutes a large proportion of the PM in ambient air. Diesel exhaust fumes cause bronchoconstriction, neutrophilic inflammation and dysfunction of alveolar phagocytosis together with histamine release from mast cell in healthy individuals.

Statistical analysis in this study revealed that subjects in study groups and in control groups were age matched. Previous studies have found that there was impairment of lung function among petrol pump workers^{2,4,13,14}. In this study there was significant reduction in FVC of all the workers of direct group (p< 0.001) compared to control group. This is indicative of restrictive type of lung dysfunction. There was also reduction of FEV1 value in direct group (p<0.05), which is measure of dynamic lung function. This was more so when exposure period extended beyond five years. This decline in lung function correlates with earlier studies^{3,20}. Compared to control group there was significant reduction in FEF.2-1.2 in direct group (p< 0.001) and in indirect group there was also reduction but not to significant extent. This finding may suggest involvement of larger airways. Compared to control group there was significant reduction in PEFR and reduction in values of other PFT parameters (though not to statistically significant level). The manures like FVC, PEFR and MVV requires more force generation, reduction of their mean values in petrol pump workers might suggest reduction in lung compliance over the years of exposure, that goes in favor of restrictive type of lung dysfunction. In our study we included indirect exposure group workers at petrol pumps (office staff of petrol pumps). Comparison with direct exposure group lung function parameters revealed no much difference among them. This indicates that even there is no direct exposure of these office workers to petrol/diesel fumes, as they are working in premises of petrol pumps having polluted air, are also in danger of developing lung impairment. On the contrary some of the lung function parameters were having low values in indirect group compared to direct group (though not up to statistically significant level). It might be related to sedentary work of office people. A more detailed study considering larger sample size may through a more light on this.

We noticed progressive decline in lung function of petrol pump workers. As most of them are likely to be asymptomatic till significant lung damage occurs, periodic health check up of the workers was advised. Protective measures such as use of face mask were suggested to protect from further dysfunction. A large scale study is necessary to throw a more light on this important topic.

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