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Lung Function Abnormalities in Petrol Pump Workers in Suburban Areas of Chennai.

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ABSTRACT

Background: The response of the human lungs to exposure to various particles like seen in atmospheric pollution, work place, various gases, have been studied in different populations by various studies. The pollution level in Chennai city is moderate whereas it is quite high in the suburbs of Chennai. **Aim:** To understand the effect of petrol and diesel vapours on lungs in persons working at petrol pump stations in the suburbs of Chennai through Spirometry. **Methods:** This study was conducted at 20 Petrol pumps in the suburbs of Chennai. Total participants were 250. Of these, 123 were workers [Group I] and 127 were office employees working in the pump stations [Group II]. Spirometry was successfully performed on 102 workers [GroupI] and on 102 office employees [Group II] who were also used as healthy controls. **Result:** The Spirometry values were significantly reduced in participants working in the petrol pumps as compared to the controls. The reduction further increased with prolonged duration of exposure. **Conclusion:** This study concludes that the respiratory function declines in those persons working in petrol pumps due to constant exposure to petrol and diesel fumes and the degree of impairment increases with the duration of exposure.

Keywords: Air pollution, Petrol/Diesel Fumes, Restrictive lung abnormality, Spirometry.

INTRODUCTION

In the current scenario, the health-related issues at the workplace are steadily increasing. The reasons behind this increase are

- Poor environmental conditions
- Lack of protective gear
- Growth of industry

There is a high prevalence of occupational diseases like Pneumoconiosis, Asbestosis, Silicosis etc., among workers in various industrial environments in India[1]. Amongst various factors, one of the reason for the atmospheric pollution to be raised, is an increase in the number of vehicles, as there is a marked rapid trend towards urbanisation. This has resulted in increased consumption of petrol/diesel, leading to an increase in the number of petrol pumps across the country.

On an average, the workers at the petrol pumps work for more than 8 hours continuously without any protective gears such as masks thus exposing them to hazardous effects of petrol and diesel resulting in occupational health-related issues. The lungs are the only internal organs, which are constantly exposed to external atmosphere and are liable to get badly damaged when exposed to petrol/diesel fumes. Thus, this study focuses on the lung function abnormalities in these petrol pump station workers by Spirometry.

As per the global burden of disease report, air pollution is the fifth largest killer in India. The annual premature deaths caused by particulate air pollution have increased by 6 times since 2000. India shows the greatest impact of outdoor air pollution with 1/5th of global deaths occurring in India.[1]

The survey conducted by Centre for Science and Environment (CSE), New Delhi shows that 80% of cities in India exceed the PM10 (Pollutants that emit particulate matter of less than 10µm in size). 90 cities have a critical level of PM10 and 26 cities have very critical PM10.[2]

In a study involving 6 cities of India[3] (Chennai, Pune, Indore, Rajkot, Surat and Ahmedabad) the measured annual PM10 concentration in µg/ m^3 averaged 73.1± 33.7 in Chennai, exceeding the annual standard of 60 µg/ m^3. Currently the PM10 in the suburbs of Chennai ismuch higher than the Chennai city. Also, the quality of air in Chennai is much worser than in Delhi.[4,5]

It has been found that an increase of 10µg/m^3 of PM10 is associated with a decrease of 3% in

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FEV1.[6] Generally the FEV1 tends to decrease from the age of 25 at the rate of 25-30 ml/year and this is being further increased by the atmospheric pollution. Motor vehicles emit pollutants[6] in the form of

a) Evaporative emission
b) Exhaust emission

In a city like Chennai, where the atmospheric temperature is very high and due to the volatile nature of petrol/diesel, hydrocarbon vapours evaporate constantly into the atmosphere. Therefore the petrol pump workers are not only exposed to exhaust emission (as the general public) but also to evaporative emission.

A study was conducted in Italy to determine the exposure of petrol pump workers to the Benzene content of petrol,[7] which showed the highest concentration of benzene in the breathing zone of petrol pump workers. This study also showed that almost 88% of the benzene is emitted while filling the petrol into the tank. The harmful effects of benzene has been studied in various studies on gasoline workers and was shown to have toxic effects on the haematological parameters, liver toxicity and definite neurotoxicity.[8-10]

As the petrol pump workers work constantly for more than 8 hours per day for 6 days a week and thus being constantly exposed to petrol/diesel fumes, are at a high risk of developing lung function abnormalities even though they are asymptomatic.

Hence the primary aim of this study is to assess the lung function abnormalities of these petrol pump workers working in suburban areas, by Spirometry.

Abbreviations: -
FEV1: Forced Expiratory Volume in 1 second
FVC: Forced Vital Capacity
PEFR: Peak Expiratory Flow Rate
ERS: European Respiratory Society
ECCS: European Community for Coal and Steel

MATERIALS AND METHODS

A total of 25 petrol pumps were selected randomly from the suburbs of Chennai including Mangadu, Kundrathur, Poonamallee, Avadi, Thirumazhisai, Pallikaranai, Perungalathur, Taramani, Pammal). From these 25 petrol pumps, a total of 250 subjects were screened. Of this, 102 non-smoking workers who successfully performed Spirometry were selected as study group (Group I). The Group I workers were matched with a similar number (102) of non-smoking office employees for age, sex, height and weight (Group II). Smokers in either group were excluded.

Inclusion Criteria

- Willing to participate in the study
- Age: 20-45 years
- Worked in the petrol pump for > 1 year, at least 8 hours a day
- Able to perform spirometry

Exclusion criteria

- Not willing to participate in the study
- Unable to perform Spirometry
- History of any other respiratory illness
- History of recent surgery
- History of neuromuscular abnormalities
- History of musculoskeletal abnormalities
- History of smoking – current or past

Initially the demographic data, duration of working in the petrol pump, smoking history, use of protective gears, medical and surgical history were collected from each participant and were subjected for a Spirometry, after obtaining due consent.

Spirometry

Spirometry was done using MIR Spirolab II machine. The American Thoracic Society (ATS) criteria for Spirometry was strictly followed[11]. The predicted equation utilized was ERS/ECCS. Minimum 3 attempts and maximum 8 attempts were done on these subjects. The best FEV1 and the best FVC was recorded. The lung function parameters studied were FEV1, FVC and PEFR.

RESULTS

Total number of participants: 250

Group I (Petrol pump workers)
No. of subjects screened: 123
No. of screen failures: 21
No. of eligible subjects: 102
No. of subjects working more than 5 years: 61

Group II (Controls)
No. of subjects screened: 127
No. of screen failures: 25
No. of eligible subjects: 102
No. of subjects working more than 5 years: 58

Reasons for screen failure are as follows
Subjects unable to perform Spirometry as per ATS criteria:
Subjects not willing to give consent:
Subjects with concurrent medical/surgical illness:

The demographic details of the subjects participated in the study are shown in [Table 1].
The mean age and the duration of exposure of the subjects in Group I (Petrol pump workers) are shown in [Table 2].

Table 1: Demographic details of subjects.

	Mean		
	Age (Years)	**Height (cm)**	**Weight (kg)**
Group I	31.44	164	51.95
Group II	32.58	165	54.47

Table 2: Age and duration of exposure of Group I subjects.

Variables (Years)	Mean
Age	31.44
Duration of exposure	6.06

No protective gear was worn by any subject during the working hours.

The predicted values of FEV1, FVC and PEFR were compared with the actual values in both the groups. This showed a moderate reduction in the Group I [Table 3]. Also, the observed FEV1/FVC showed an increase. In addition [Table 3] shows that the observed mean PEFR shows a reduction (76% predicted) compared to the predicted PEFR. Comparison of the predicted and observed mean values of the Spirometry parameters in the controls showed normal or near normal (more than 80% predicted) values in comparison with the predicted values [Table 4]. In comparison, the values of FEV1, FVC and PEFR were not decreased in Group II. [Table 4] also shows that the observed PEFR in the control group is more than 80% predicted. The FEV1/FVC showed an increase in Group II.

Table 3: Spirometry parameters in petrol pump workers (Group I).

Parameters	Means	
	Predicted	Observed
FEV1 (L)	3.13	2.37
FVC (L)	3.68	3.05
FEV1/FVC (%)	85.34	79.9
PEFR (L/M)	521.43	397.08

Table 4: Spirometry parameters in controls (Group II).

Parameters	Means	
	Predicted	Observed
FEV1 (L)	3.15	3.07
FVC (L)	3.7	3.62
FEV1/FVC (%)	85%	84.3
PEFR (L/M)	521.18	462.65

[Figure 1] Show the comparison of the Spirometry parameters between Group I (Petrol Pump workers) and the Group II (Controls). This shows a significant reduction in the mean values of FEV1, FVC and PEFR in the Petrol pump workers (Group I) compared to the control group (Group II). The FEV1/FVC is increased in both the groups.

The PEFR which is taken as a parameter of obstruction is significantly reduced in the petrol pump workers (Group I) in comparison with the Control group (Group II) [Figure 2].

Also, the PEFR values are comparatively low in the petrol pump workers who had worked for more than 5 years when compared to those workers who had worked for less than 5 years [Figure 3]. This shows that as the duration of exposure is more, there is an element of obstruction seen in these workers.

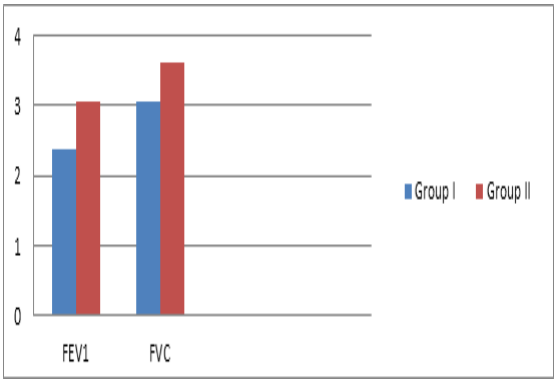

Figure 1: Comparison of observed mean values of FEV1 and FVC between Petrol pump workers (Group I) and controls (Group II)

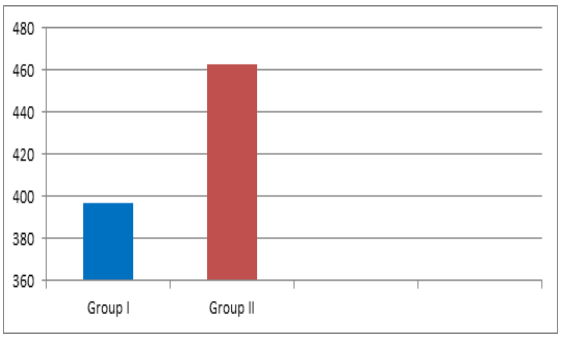

Figure 2: Comparison of observed mean values of PEFR between Petrol pump workers and controls

DISCUSSION

The actual purpose of this study is to assess the impact of petrol or diesel fumes/vapours coupled with environmental pollution on the lung function of petrol pump workers who are non-smokers, in the suburbs of Chennai.

The study's results show that the lung function parameters (FEV1, FVC, PEFR) are significantly reduced in petrol pump workers (Group I) as compared to the values for these parameters in subjects belonging to Group II (Control group). Also, the actual values are much less than their own predicted values.[11]

As the FEV1/FVC is more than 70% and since there is a decrease in FEV1 and FVC values, it can be concluded that these workers (Group I) have restrictive lung function abnormality. Since all these parameters are normal or near normal (FEV1 > 80% predicted, FVC > 80% predicted) in the control group, it can be concluded that the subjects in Group II have a better lung function as they are not exposed to petrol/diesel fumes. Prior studies also have shown similar results.[12,13] A study published in AJRCCM in 1999 showed that short-term exposure to diesel exhaust in normal subjects had marked Pulmonary and systemic inflammatory response with mild impairment in respiratory function parameters.[12]

In human lung, the major site of impact and injury for the particulate matter is at the level of terminal

bronchioles and the adjacent 1st generation respiratory bronchioles.[15] These particulate matter are usually not seen deposited in the larger bronchi as they are probably cleared from this area rapidly.[16]

Also, the present study shows that the lung function abnormalities are increased if the duration of work in the petrol pumps are more. (More than 5 years of work compared with those who worked less than 5 years- [Figure 3]. The PEFR is comparatively less the Study group (Group I) than the Control group (Group II). Further, the PEFR is low in those persons in Group I, who had worked for more than 5 years compared with those petrol pump workers who had worked less than 5 years. This proves that the duration of exposure is more, there is an element of obstruction also in addition to restrictive abnormality [Figure 3]. Similar results were obtained in a study published in Medical Science by Priyadarshini et al.[17]

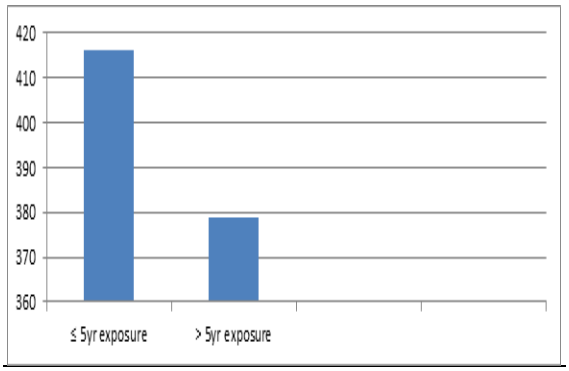

Figure 3: Comparison of PEFR in Group I subjects based on duration of exposure.

Petrol is a combination of complex hydrocarbons. On emission, particles of size 0.02nm are generated. Due to the large surface area, these particles carry various toxic particles, which remain in the atmosphere for longer period and get deposited in the small airways of the lung.[18]

Also, in a study done by Uzma et al,[19] it has been proved that Carbonmonoxide (CO) concentration is very high in those areas surrounding the petrol pumps during the peak hours in comparison with the residential areas, subjecting those in the vicinity of petrol pumps at a high risk of respiratory abnormalities.

In addition, as these petrol pump workers are not wearing any protective gear, this exposes them to have more of lung function abnormalities. In India there is no standardisation regarding the number of petrol pumps in a particular area. Further, most of the petrol pump workers belong to the lower socioeconomic class predisposing them to various illnesses. This study had excluded those petrol pump workers who had or have a history of smoking. It can be easily postulated that these persons who smoke will be having an even more amount of respiratory dysfunction compared to the non-smoking petrol pump workers.

Installation of a petrol vapour recovery system has controlled the occupational exposure to petrol/diesel compounds in many countries. The Department of Environment, Climate change and Water, Government of New South Wales has published standards and guidelines for vapour recovery at the petrol pumps.[20] The Stage I vapour recovery system limits the emissions of volatile organic compounds that result from unloading petrol from the tanker into the petrol pump storage tanks. The Stage II vapour recovery system is designed to capture the vapour during the refuelling of the vehicles at the petrol pumps. A study done by Agip Petroli showed that introduction of the vapour recovery system will be capable of reducing up to 80% benzene emission.[5]

Thus in india the installation of petrol vapour recovery systems across various petrol pumps would help to bring down the pollution by petrol/diesel fumes.

Periodical lung function measurements like Spirometry should be undertaken for the workers at the petrol pumps.

CONCLUSION

This study shows that persons working in petrol pumps have respiratory abnormalities in the form of restrictive lung impairment. This impairment increases as the duration of exposure at workplace increases.

Further studies in the form of Diffusion Capacity of the lung for Carbon monoxide [DLCO], other markers of pulmonary impairment like exhaled Nitric Oxide levels (FeNO) are needed to explore the effects of these toxic substances.

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