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Research Article

# A STUDY ON PULMONARY FUNCTION TEST AMONG PETROL-PUMP WORKERS IN TIRUNELVELI TOWN

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## ABSTRACT

**Objective:** In India, automobiles plying on roads are increasing every day. This has led to an increase in petrol-pump stations and an increase in pump workers. Petrol vapors and exhaust from vehicles have ill effects on the respiratory system. Petrol is a complex combination of hydrocarbons. Continuous exposure to petroleum vapours and exhaust from vehicles causes altered respiratory physiology.

**Methods:** This study involved 50 petrol-pump workers (PPWs) with another 50 age-matched healthy adults. Their age, history of past illness, smoking exposure, and working hours were noted. Pulmonary function test was done using a computerized Spirometer to measure various parameters.

**Results:** Parameters of pulmonary function in PPWs have a decline in mean values such as FVC, $FEV_1$, peak expiratory flow rate, FIVC, forced expiratory flow (FEF) (25–75%), peak inspiratory flow, VC, and ERV when compared to the control group. It reflects the development of mixed patterns of lung disease (both obstructive and restrictive).

**Conclusion:** It is suggested that reduction or control measures against air pollution including protective equipment, the future movement toward green fuels, and identifying and protecting susceptible workers occupationally exposed to petrol and diesel fumes would be beneficial to humanity and the ecosystem.

**Keywords:** Petrol, Diesel, Occupational exposure, Air pollution, Pulmonary function, Spirometry.

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## INTRODUCTION

In countries like India, which are growing in this modern world, the growth of economy, industry, and transport is linear with the population. The number of petrol pumps and allied workers is also increasing due to the increasing traffic growth. The use of petrol and diesel increases the air pollution caused by vehicles. Automobile exhaust, petrol, and diesel vapor contain oxides of nitrogen, sulfur dioxide, carbon monoxide, and benzene. Most of the particles are <10 μm, which is easily inhaled and deposited in the lungs. Diluted diesel contains hydrocarbons and lead. This polycyclic aromatic hydrocarbon adheres easily and is carried deep into the lungs. Benzene is an exaggerated cause of lung function derangement in PPWs. Pollutants from vehicle exhaust alter the properties of surfactant which causes early closure of small airways or peripheral airway obstruction. There is no denying the fact that the effect of this air pollution on PPWs is greater than on other individuals. A higher mortality like premature deaths also has been reported due to pollution caused by petrol and diesel usage [1].

Animal studies have revealed concrete evidence of the development of the restrictive pattern of pulmonary function abnormality done in the cat for 124 weeks as a result of the pulmonary interstitial response by Moorman *et al*. [2]. Although it affects many systems in the human body, the ill effects in the respiratory system such as increased airway resistance, inflammation, repeated mucosal irritation, and alveolar swelling progressing to bronchoconstriction, obstructive, and restrictive lung disorders are getting noted higher as per literature [3]. The mechanism attributed to the ill effects is that diesel emission particles (DEPs) act such as adjuvant to allergens or pollens [4]. They hasten the entry of pollen adjuvant complex to penetrate respiratory mucosa further acting on the immune system to elicit various responses including triggering asthma attacks in possibly susceptible individuals. There has been a difference in effects caused by acute and chronic low levels exposure of to DEP as well. Modification of immune response in individuals exposed to DEPs has been shown to augment IgE production and subsequent alteration of respiratory function leading to an atopic response [5-7]. Molecular chemical mechanism precedes well before clinical presentation as we experience in other disease.

This study aims to determine the effect of exposure to petrol and diesel exhausts on pulmonary function variables among male workers employed in petrol pump filling stations occupationally exposed to petrol, diesel emission, and other air pollutants exposure and age compared to normal healthy volunteers.

## METHODS

This study was approved by the Institutional Ethics Committee (TIREC) of Tirunelveli Medical College Hospital, Tamil Nadu, India. Written informed consent was obtained from each participant. It is a cross-sectional study. The study populations are 50 healthy nonsmoker male workers employed in petrol pump filling stations in Tirunelveli town who are considered as further into as exposure group and another 50 age-matched healthy volunteers from society. The exposure group worked in petrol-pump stations for more than one year, whose working hours are a minimum of 8 h/day. Subjects who were known smokers or had a chronic illness in respiratory disease or cardiac problems, with symptoms such as fever and cough were excluded from the study. Since we selected nonsmoker subjects in the exposure group, this excludes confounding factors like exposure to tobacco smoke.

A pulmonary function test was done using a computerized Spirometer. Forced vital capacity (FVC), forced expiratory volume ($FEV_1$) at 1 s, ($FEV_1$/FVC) ratio, maximum voluntary ventilation, peak inspiratory flow (PIF), forced inspiratory vital capacity (FIVC), and expiratory reserve volume (ERV) are estimated using computerized spirometer. Data collected were analyzed statistically using an unpaired "t" test, $p<0.05$ was considered significant.

## RESULTS

Age and anthropometric parameters of the PPW and control group were matched as evidenced by Table 1 and Fig. 1 below. Mean values from the parameters FVC, FEV1, peak expiratory flow rate (PEFR), FIVC, FEF (25–75)%, PIF, VC, and ERV of PPW within the age group were plotted in the chart that showed a trend in age as expected, as seen in control group population as well from Tables 2 and 3, Figs. 2-5.

The parameters of spirometry, namely, FVC, FEV1, PEFR, FIVC, FEF (25–75%), PIF, VC, ERV, and $FEV_1$/FVC (%) showed an increase in trend in middle age group workers thereafter decreases in age group 51–60 of PPW. Similar kinds of changes with age group occur in control group individuals, but the parameter $FEV_1$/FVC has not shown a reduction regarding age group of 51–60 years in control group with other age groups (Fig. 5).Table 4 shows the comparison of the mean values with the standard deviation of spirometric parameters between the PPW and control group. All the parameters FVC (L), FEV1 (L), PEFR (L/s), FIVC (L), FEF (25–75%) (L/s), PIF (L/min), VC (L), and ERV (L) were

**Table 1: Anthropometric parameters of the study group**

| Anthropometric parameters | PPW (n=50) | Controls (n=50) |
|---|---|---|
| | Mean±SD | Mean±SD |
| Age (years) | 43.88±11.03 | 43.58±8.66 |
| Height (cm) | 166.18±6.09 | 166.06±5.13 |
| Weight (kg) | 69.50±7.50 | 69.54±7.13 |

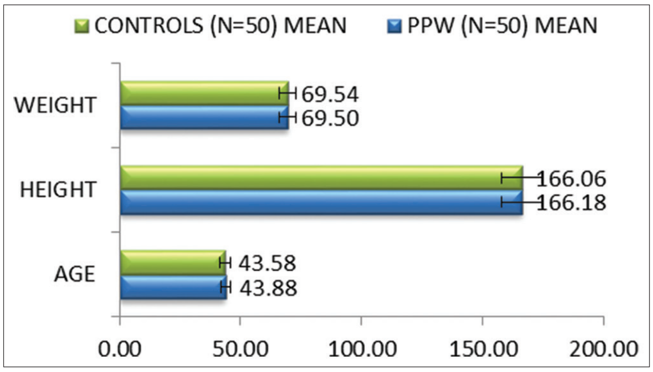


**Fig. 1: Graph comparing the age, height, and weight of the study group**

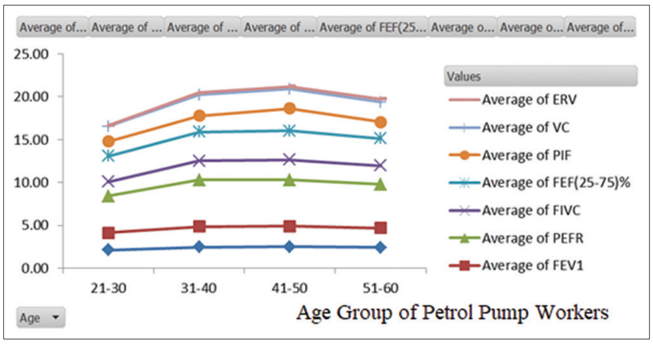


**Fig. 2: Graph showing mean values of spirometric parameters with age groups of petrol-pump worker**

**Table 2: Mean values of spirometric parameters with age groups of PPW**

| Spirometric parameter | Age group of PPW (Mean value) | | | | |
|---|---|---|---|---|---|
| | 21–30 (n=8) | 31–40 (n=12) | 41–50 (n=11) | 51–60 (n=19) | Total (n=50) |
| FVC (L) | 2.12 | 2.48 | 2.53 | 2.44 | 2.42 |
| $FEV_1$ (L) | 2.03 | 2.38 | 2.37 | 2.26 | 2.28 |
| PEFR (L/s) | 4.24 | 5.43 | 5.38 | 5.1 | 5.1 |
| FIVC (L) | 1.7 | 2.23 | 2.37 | 2.18 | 2.16 |
| FEF (25–75%) (L/s) | 2.99 | 3.38 | 3.38 | 3.15 | 3.23 |
| PIF (L/min) | 1.71 | 1.88 | 2.6 | 1.92 | 2.03 |
| VC (L) | 1.74 | 2.46 | 2.26 | 2.32 | 2.25 |
| ERV (L) | 0.15 | 0.24 | 0.29 | 0.39 | 0.29 |
| $FEV_1$/FVC (%) | 95.93 | 96.18 | 97.15 | 93.05 | 95.17 |

PPW: Petrol-pump workers, FVC: Forced vital capacity, $FEV_1$: Forced expiratory volume, PEFR: Peak expiratory flow rate, FIVC: Forced inspiratory vital capacity, FEF: Forced expiratory flow, PIF: Peak inspiratory flow, VC: Vital capacity, ERV: Expiratory reserve volume

**Table 3: Mean values of spirometric parameters with age groups of the control group**

| Spirometric parameter | Age group of controls (Mean) | | | | |
|---|---|---|---|---|---|
| | 21–30 (n=4) | 31–40 (n=13) | 41–50 (n=22) | 51–60 (n=11) | Total (n=50) |
| FVC (L) | 2.98 | 3.39 | 3.16 | 3.07 | 3.19 |
| FEV1 (L) | 2.63 | 3.2 | 2.83 | 2.87 | 2.92 |
| PEFR (L/s) | 5.9 | 7.46 | 6.84 | 6.61 | 6.88 |
| FIVC (L) | 2.97 | 3.34 | 2.91 | 2.92 | 3.03 |
| FEF (25–75%) (L/s) | 3.23 | 4.37 | 3.66 | 4.1 | 3.91 |
| PIF (L/min) | 2.38 | 3.29 | 2.23 | 2.6 | 2.6 |
| VC (L) | 2.83 | 3.5 | 3.06 | 2.86 | 3.11 |
| ERV (L) | 0.58 | 0.91 | 0.74 | 0.82 | 0.79 |
| $FEV_1$/FVC (%) | 87.83 | 99.18 | 97.01 | 96.47 | 96.72 |

FVC: Forced vital capacity, $FEV_1$: Forced expiratory volume, PEFR: Peak expiratory flow rate, FIVC: Forced inspiratory vital capacity, FEF: Forced expiratory flow, PIF: Peak inspiratory flow, VC: Vital capacity, ERV: Expiratory reserve volume

**Table 4: Spirometric parameters of PPW (petrol-pump workers) and control subjects**

| Spirometric parameters | PPW (n=50) | Controls (n=50) | p | Significance |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | | |
| FVC (L) | 2.42±0.61 | 3.19±0.75 | 0.0000 | HS |
| $FEV_1$ (L) | 2.28±0.54 | 2.92±0.64 | 0.0000 | HS |
| PEFR (L/s) | 5.10±1.86 | 6.88±1.97 | 0.0000 | HS |
| FIVC (L) | 2.16±0.59 | 3.03±0.85 | 0.0000 | HS |
| FEF (25–75%) (L/Sec) | 3.23±0.97 | 3.91±1.04 | 0.00111 | HS |
| PIF (L/min) | 2.03±0.87 | 2.60±1.19 | 0.00712 | HS |
| VC (L) | 2.25±0.73 | 3.11±0.97 | 0.0000 | HS |
| ERV (L) | 0.29±0.29 | 0.79±0.57 | 0.0000 | HS |
| $FEV_1$/FVC (%) | 95.17±6.18 | 96.72±9.48 | 0.332 | NS |

FVC: Forced vital capacity, $FEV_1$: Forced expiratory volume, PEFR: Peak expiratory flow rate, FIVC: Forced inspiratory vital capacity, FEF: Forced expiratory flow, PIF: Peak inspiratory flow, VC: Vital capacity, ERV: Expiratory reserve volume

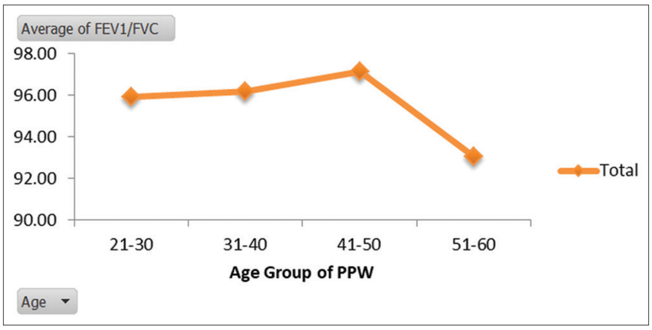


**Fig. 3: Graph showing mean values of $FEV_1$/FVC with age groups of petrol-pump worker**

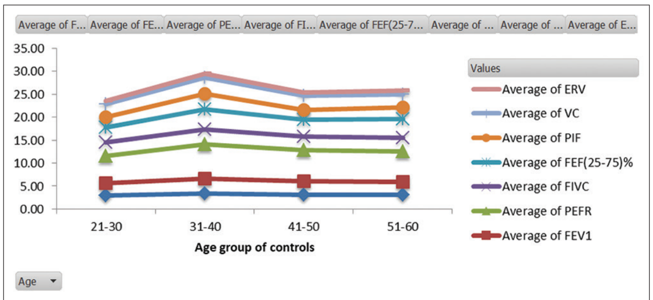


**Fig. 4: Graph showing mean values of parameters with age groups of control group**

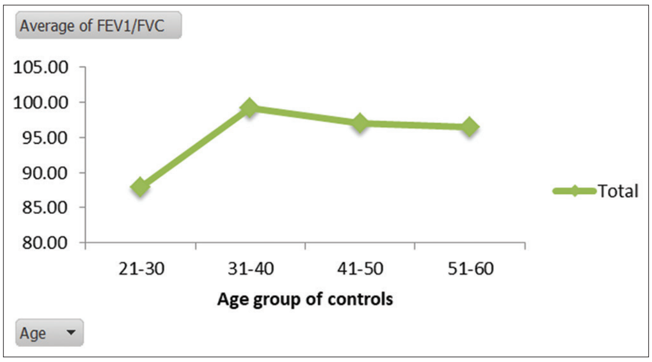


**Fig. 5: Graph showing mean values of $FEV_1$/FVC with age groups of control group**

noted with highly significant difference levels of <1% confidence interval (Figs. 6 and 7). The parameter $FEV_1$/FVC (%) was noted to be a statistically insignificant difference with a p=0.332 (Fig. 8) between the PPW and control group.

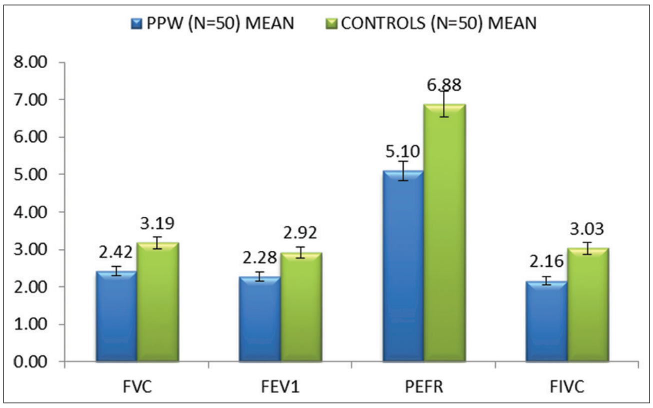


**Fig. 6: Graph showing the comparison of the mean of functional vital capacity forced expiratory volume in 1st second (FEV1), peak expiratory flow rate, and forced inspiratory vital capacity**

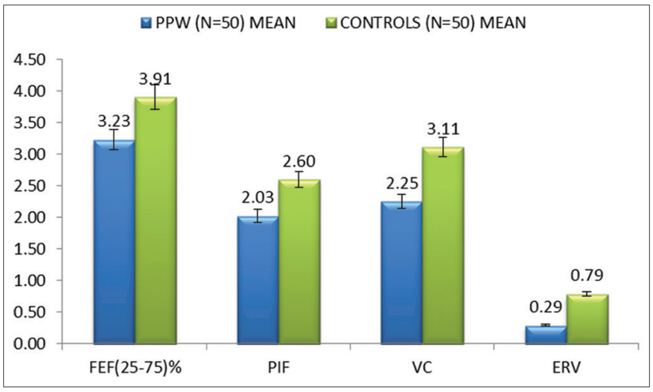


**Fig. 7: Graph showing the comparison of the mean of forced expiratory volume between 25 and 75%, vital capacity, peak inspiratory flow, and expiratory reserve volume**

## DISCUSSION

Similar studies are available with compared to different other variables such as hematopoietic system and endocrine biomarkers. One such study by uzma *et al*. [8] showed a decline in pulmonary function toward restrictive pattern initially until 10 years later on progressing toward mixed pattern in PPWs compared with predicted values regarding the duration of exposure. Duration of exposure may be a pitfall in our study which did not take into account to development of altered pulmonary function. In a study with duration of exposure taken to categorize, the subject population, that showed a significant difference between 1 year, 1–5 years, and more than 5 years, when compared to the control group population, except the <1 year and 1–5 years exposure groups. The

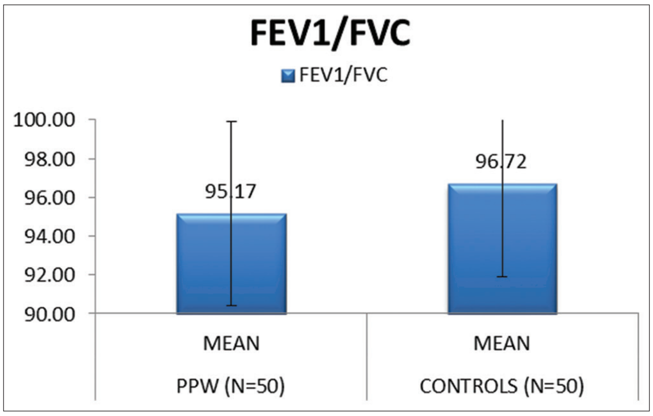


**Fig. 8: Graph showing the comparison of the mean ratio of forced expiratory volume of 1st second and forced vital capacity between petrol-pump workers and control subjects**

obstructive pattern is shown by Aprajita *et al.* [9]. However, a study by Singhal *et al.* [10] showed a restrictive pattern of pulmonary function derangement in petrol-pump attendants having a decline in the value of FVC, and $FEV_1$ while the exposure period restriction taken was a minimum of 1 year.

One particular cohort study conducted on bridge and tunnel officers concerning automobile pollution by Evans *et al.* [11] showed a decline in pulmonary function related to the duration of exposure as both restrictive and obstructive patterns.

## CONCLUSION

Many parameters of pulmonary function in PPWs have a decline in mean values such as FVC, $FEV_1$, PEFR, FIVC, FEF (25–75%), PIF, VC, and ERV. It reflects the development of mixed patterns of lung disease (both obstructive and restrictive). It is suggested that periodic medical checkups, and screening for lung function abnormalities at regular intervals, make it easier to identify the susceptible worker with anticipated lung function abnormality. Removing the susceptible from further offending exposure with a switchover of job place, provision of protective equipment such as masks and goggles, gloves will facilitate to reduce exposure through air, as well as skin and better recovery before the worker gets his next turn to pump filling station job. Further, extension of such studies with other parameters of biochemical markers immunoglobulin like IgE levels will pave a path for understanding more of immune mechanism toward pathophysiology before permanent damage to pulmonary interstitial tissues occurs.

## AUTHORS' CONTRIBUTIONS

First author: concept, protocol, design of study, and collection of data; second/corresponding author – manuscript preparation, data analysis, interpretation, designing, submission to the journal, review of literature, and analysis.

## CONFLICTS OF INTEREST

Nil.

## AUTHORS FUNDING

Nil.

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