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## AN ANALYSIS OF DYNAMIC PULMONARY FUNCTION IN AUTOMOBILE MECHANICS

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### ABSTRACT

Automobile mechanics are exposed to organic and inorganic substances present in petrol and diesel. Chronic cough, wheezing and breathlessness have been reported in automobile mechanics. However there is limited published data regarding the dynamic pulmonary function test abnormalities in automobile mechanics. Hence we undertook this study. We studied the dynamic pulmonary function test abnormalities in a group of automobile mechanics. This study was conducted in a motor vehicle showroom in Mangalore. 70 employees between the age group 30 to 40 years who were working as mechanics for more than one year without any pre existing lung disease were included as case group in the study. 70 employees of the same age group of the same company were taken as control group. Control group used to work in their showroom in an air conditioned environment and were not exposed to any dust and fumes. Employees who had pre-existing lung diseases, smokers who had chest wall deformities, neuromuscular disease, severe obesity, previous thoracic surgery were excluded from the study. Spirometry was performed after informed consent in all these subjects. FEV1, FVC, FEV1/FVC ratio, PEF, FEF 25-75 was recorded and compared with normal predicted value. Out of 70 subjects 12(17.14%) had restrictive lung disease among whom 4 were moderate and 8 were mild restrictive lung disease. FEF 25 -75 was decreased in 6 subjects(8.57%) out of whom 1 was moderate and 5 were mild. Dynamic pulmonary function test abnormalities in automobile mechanics include restrictive lung disease and small airways obstruction.

**Keywords:** Dynamic pulmonary function test, spirometry, restrictive lung disease

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### 1. Introduction

Rapid industrialisation, urbanisation, use of motor vehicles, nuclear energy program are the major causes of environmental pollution in the world. Experimental studies indicate that airborne contaminants lead to injury to airways and lung parenchyma in subjects who are exposed to it<sup>1,2</sup>. Lungs are the target for adverse effects of noxious gases due to air pollution. The human lungs receive approximately 6-8litres of air per minute<sup>3</sup>. Airborne contaminants include Nitric oxide (NO<sub>2</sub>), Carbon monoxide (CO), Carbon dioxide(CO<sub>2</sub>), Ozone (O<sub>3</sub>) Sulphur dioxide (SO<sub>2</sub>), Hydrocarbons and Suspended particulate matters(SPM). They cause harmful effect on airways and lung parenchyma causing bronchoconstriction, increased mucous secretion and increased alveolar swelling. Exposure to Nitric oxide fumes may results in acute pulmonary oedema<sup>4</sup>. Prolonged exposure to air pollution causes bronchoconstriction, mucosal irritation and alveolar swelling leading to

obstructive and restrictive disorders of lungs<sup>5</sup>. Numerous epidemiological studies have documented decrements in pulmonary function and various other health problems due to long-term air pollution exposure<sup>6-9</sup>.

Health problems posed by the pollutants at the work environment of an individual are closely linked to the nature and level of exposure to these hazardous chemicals. Diesel exhaust is a major respiratory hazard for workers exposed to it in enclosed space<sup>10</sup>. Diesel exhaust in addition to generating pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world. Symptoms like chronic cough, wheezing and breathlessness have been reported on exposure to these pollutants<sup>8</sup>. At high ambient concentrations of pollutants, well defined and marked pulmonary inflammatory response occurs<sup>11</sup>.

Various occupational exposures to petrol /diesel exhausts have been shown to affect different

organ systems of the body<sup>12-15</sup>. Several animal studies have also demonstrated a consistent association between the air pollutants and the altered lung function<sup>16-18</sup>.

Automobile mechanics are continuously exposed to the airborne substances present in the petrol and diesel. The average duration of daily exposure to these chemicals in automobile mechanics in India generally exceeds about 8 hrs/day. The present study aims to evaluate the dynamic pulmonary function test abnormalities in automobile mechanics continuously exposed to petrol/ diesel vapour every day for more than one year in a major automobile service workshop in South India.

## 2. Material and Methods

Seventy automobile mechanics in the age group of 20 to 40 years, with no previous history of respiratory disease and minimum one year exposure to automobile exhaust in the workplace were included in the study along with seventy age matched controls who were working in air conditioned environment and were not exposed to any dust and fumes.

Workers with any pre-existing respiratory diseases, history of smoking and alcohol consumption; chest wall deformities, any neuromuscular diseases, uncooperative Subjects, previous thoracic Surgery, Severe Obesity (BMI >30) and history of Pulmonary Tuberculosis were excluded from the study.

A detailed history of both groups was taken. Relevant past history, family history, any drug history, personal history like smoking, alcoholism and occupational history was taken. General physical examination, vital signs were recorded. A complete spirogram was performed after informed consent.

Forced Expiratory volume in 1 second (FEV1) forced Vital Capacity (FVC), FEV1 / FVC Ratio, Peak Expiratory Flow Rate (PEFR), Forced expiratory flow FEF – 25 - 75 % were recorded.

## 3. Statistics

Statistical analysis was done by using *Student's unpaired 't' test*. P value was taken as significant at 5 percent confidence level ( $p < 0.05$ ).

## 4. Results

**Table: Comparison of the dynamic pulmonary function test between the case and the control group**

Parameters	Control (n=70) Mean± SD	Case(n=70) Mean± SD	P value
FVC (ltrs)	3.47±0.59	3.21±0.64	< 0.009**
FEV1(ltrs)	3.36±0.54	3.08± 0.57	<0.001**
FEV1/FVC (ltrs)	96.97±3.87	96.27±4.43	<0.29
PEFR (ltrs)	8.91±1.63	8.66±1.47	<0.323
FEF25-75 (ltrs)	5.23±1.18	4.87±1.01	<0.043

\*\*P value highly significant

FVC, FEV1 and FEF 25-75 is reduced in the cases, it points out that there is more of restrictive disease and Small airway disease developing in the cases. There is no significant change in FEV1/FVC ratio and PEFR values, cases are not showing obstructive diseases.

One hundred forty subjects were recruited for the study. 70 belonged to the case group and the rest 70 were control group. All the subjects were males. Out of 70 cases, 12 cases (17.14%) had restrictive disease, among which 4 cases (5.71%) were moderate while 8 (11.43%) showed mild restrictive disease. Forced expiratory flow FEF 25-75% was decreased in 6 cases (8.57%), out of which 1 case (1.43%) was moderate and 5 cases (7.14%) were mild, which indicates small airway disease. In the control group, one subject showed mild restrictive disorder and no obstructive disorder was found as FEF25-75 was normal.

## 5. Discussions

Automobile exhaust can lead to acute and chronic respiratory problems. High exposure for a short period leads to acute symptoms affecting the upper respiratory tract that are nearly reversible within a few days provided there is no further exposure. Prolonged exposure causes decrement in lung functions.

The most useful measures of dynamic pulmonary function tests are FVC, FEV1, FEV1/FVC ratio, PEFR, FEF 25-75.

The present study included 70 automobile mechanics and 70 controls. In the present study most of the parameters were decreased significantly in automobile mechanics as compared to controls.

Reduced FEV1 indicates restrictive lung disease. This is due to damage to the tissues of the lungs due to chronic irritation by the pollutants.

One important pollutant which may have contributed to our findings is lead. Inhalation of

lead from leaded petrol emissions is an important source of lead exposure. Few studies have related lead to structural damage or impaired functions of the lungs.<sup>19,20</sup>

FEF 25–75 indicates flow rates in small airways. Airways with internal diameters of less than 2 mm are known as small airways. FEF 25–75 is reduced at low lung volumes both in restrictive and obstructive diseases. Small airway disease was present in 8.57% of cases, none in the control group in our study.

Particles generated from diesel exhaust are extremely small. These small sized particles, by virtue of their greater surface area to mass ratio, can carry a much larger fraction of toxic compounds, such as hydrocarbons and metals on their surface<sup>21</sup>. Because of the small size, they are more likely to reach the small airways to cause small airway disease. Importantly, they can remain airborne for long periods of time and deposit in greater numbers and deeper into the lungs than larger sized particle<sup>22</sup>. Therefore future study could be extended to evaluate status of alveolocapillary membrane, by determining lung diffusion capacities in these workers.

FEF25-75 is considered a fairly good test to identify early small airway disease. The findings of the present study indicate that small airways probably bear the brunt of the air pollution and fuel vapour related lung injury. This finding is in agreement with most studies on pollution inflicted changes in lung function<sup>23</sup>.

In combination with particulate pollutants, SO<sub>2</sub> and NO<sub>2</sub> have a greater chance to reach the deeper parts of the lungs. The gaseous pollutants may also alter the properties and concentration of surfactant and may thus contribute to the early closure of small airways. Many terminal bronchioles may be compromised before other pulmonary function tests such as FEV1 are affected. Histopathological studies have provided evidence that the small airways are the site of damage in people living in areas of high air pollution<sup>22</sup>.

The gaseous pollutants and volatile organic compounds are formed from the fuels and the diesel exhaust emitted by the vehicles. Oxides of nitrogen present in garage air causes injury in the terminal bronchioles, decrease the pulmonary compliance, and reduce vital capacity<sup>23; 24</sup>. The present study results corroborate this report. Moorman et al. stated that long term inhalation of diesel exhaust by cats produced classic patterns of restrictive disease<sup>17</sup>.

Speizer and Ferris found a significant association between automobile exposure and

the development of chronic non specific respiratory diseases<sup>25</sup>. The flow rates measured at different levels showed greater changes in FVC and FEV1 on exposure to exhaust fumes. The present study noticed the same results.

A study by Rao et al. revealed that exposure to auto exhaust pollutants produced both restrictive and obstructive lung disease<sup>26</sup>.

In order to prevent lung damage among automobile mechanics, we suggest that pre employment Check-up and periodic medical check-up should be performed which should include pulmonary function test. Early identification of the workers who develop pulmonary function abnormalities will help in preventing further exposure.

Awareness of the sources of air pollution in the community would help individuals avoid them. The development of appropriate equipment for monitoring and testing for environmental elements in the community and in workers would be beneficial.

Researcher's effort should be increased to identify genetic and other factors that predispose workers to environmental agents and to assess the health impacts among them. Further long term prospective studies of automobile mechanics and garage workers will help us get a more comprehensive picture of long term effects of these pollutants as the present study would serve as a bench mark.

## Reference

1. Lewis TR, Moorman WJ, Yang YY, Stara JF. Long term exposure to autoexhaust and other pollutants mixture. *Arch Env Health* 1974; 21:102–6.
2. Chhabra SK. Air pollution and health. *Indian J Chest Dis Allied Sci* 2002; 44: 9–11.
3. Ganong WF. Review of Medical Physiology. Lange Medical Publications. (23rd Edition) 2010. p.588.
4. Nichols BH. The clinical effects of the inhalation of nitrogen dioxide. *Am J Roentgenol* 1930; 23:516–20.
5. Waldron HA. Lecture notes on Occupational Medicine, 3<sup>rd</sup>Edn. Oxford: Blackwell Scientific Publication; 1985.p.47–163.
6. Gamble J, Jones W, Minshall S. Epidemiological- Environmental study of Diesel Bus Garage workers: Acute effects of NO<sub>2</sub> and respirable particulate on the respiratory system. *Environ Research* 1987; 42: 201–214.

7. Nakai S, Maeda K, Crest JST. Respiratory health associated with exposure to automobile exhaust. III. Results of a cross sectional study in 1987, and repeated pulmonary function tests from 1987 to 1990. *Arch Environ Health* 1999; 54: 26–32.
8. Chabra SK, Chabra P, Rajpal S, Gupta RK. Ambient air pollution and chronic respiratory morbidity in Delhi. *Arch Environ Health* 2001; 56: 58–63.
9. Ware JH, Spengler JD, Neas LM, Samet JM, Wagner GR, Coultas D et al. Respiratory and irritant health effects of ambient volatile organic compounds. The Kanawa county health study. *Am J Epidemiol* 1993; 137: 1287–1301.
10. Kilburn KH. Effects of diesel exhaust on neurobehavioral and pulmonary functions. *Arch Environ Health* 2000; 55: 11–17.
11. Salvi S, Blomberg A, Rudell B, Kelly F, Sandstorm T, Holgate ST, Frew A. Acute inflammatory responses in the airways and peripheral blood after short-term exposure to diesel exhaust in healthy human volunteers. *Am J Respir Crit Care Med* 1999; 159: 702–709.
12. Niazi GA, Fleming AF, Siziya S. Blood dyscrasia in unofficial vendors of petrol and heavy oil and motor mechanics in Nigeria. *Trop Doct* 1989; 19:55–58.
13. Bergdahl IA, Toren K, Eriksson K, Hedhind U, Nilsson T, Flodin R, Jarvholm B. Increased mortality in COPD among construction workers exposed to inorganic dust. *Eur Respir J* 2004; 23: 402–406.
14. Lipsett M, Campleman S. Occupational exposure to diesel exhaust and lung cancer: a meta analysis. *Am J Public Health* 1999; 89: 1009–1017.
15. Bice DE, Mauderly JL, Jones RK, McClellan RO. Effects of inhaled diesel exhaust on immune responses after lung immunization. *Fundam Appl Toxicol* 1985; 5(6 Pt 1): 1075–1086.
16. Gross KB. Pulmonary function testing of animals chronically exposed to diluted diesel exhaust. *J Appl Toxicol* 1981, 10: 116–123.
17. Moorman WJ, Clark JC, Pepelko WE, Mattox J. Pulmonary function responses in cats following long-term exposure to diesel exhaust. *J Appl Toxicol* 1985; 5: 301–305.
18. Ikeda M, Suzuki M, Watarai K, Sagai M, Tomita T. Impairment of endothelium-dependent relaxation by diesel exhaust particles in rat thoracic aorta. *Jpn J Pharmacol* 1995; 680: 183–189.
19. Fortoul TI, Osorio LS, Tovar AT, Salazar D, Castella ME and Olaiz-Fernandez G. Metals in lung tissue from autopsy cases in Mexico city residents : Comparison of cases from the 1950's and the 1980's. *Environmental Health Perspectives* 1996; 104: 630–632.
20. Lippman MB Lead and human health: Background and recent findings. *Environ Res* 1990; 51: 1–24.
21. Levsen K. The analysis of diesel particulate. *Fresenius Z Anal Chem* 1988; 331: 467–478.
22. Harrison RM, Brimblecombe P, Derwent RG. Health effects of non biological particles. In Airborne Particulate Matter in the United Kingdom: Third Report of the Quality of Urban Air Review Group. Department of Environment, London. 1996; 115–118.
23. Chawla A, Lavania AK. Air pollution and fuel vapour induced changes in lung functions: are fuel handlers safe? *Indian J Physiol Pharmacol* 2008; 52 (3): 255–261.
24. Singhal M, Khaliq F, Singhal S, Tandon OP. Pulmonary function in petrol pump workers: a preliminary study. *Indian J Physiol Pharmacol* 2007; 51 (3): 244–248.
25. Speizer FE, Ferris BG Jr. Exposure to automobile exhaust. *Arch Environ Health* 1973; 26:313-329.
26. Rao NM, Petals TS, Raiyani CV, Kulkarni PK, Aggarwal AL, Kashyap SK, Chatterjee SK. A dose response relationship between pollution index and pulmonary function in shopkeepers exposed to auto exhaust. *Indian J Environ Protect* 1991; 11(10):737-740.