ORIGINAL RESEARCH PAPER

Volume-7 | Issue-6 | June-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EFFECT OF AIR POLLUTION ON PEAK EXPIRATORY FLOW IN TAXI DRIVERS AND TRAIN DRIVERS WORKING IN MUMBAI

Physiology

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ABSTRACT

Air pollution is increasing everyday in India and one of the main causative factor is vehicular transmission. Increased air pollution is related to decrease in pulmonary function. As taxi drivers work in congested roads throughout the day, they are one of the most affected populations. This study was aimed to assess the Peak Expiratory Flow Rate (PEFR) of taxi drivers as well as the train drivers and to compare them. PEFR was assessed in 30 train drivers (Group A) and 30 taxi drivers (Group B) between the age groups of 25 to 50 years. People in Group A (574.7 ± 2.432) performed better in this particular test compared to Group B (488 ± 6.702). Though the present study has found out that the PEFR values were less than predicted values in both the groups but taxi drivers' pulmonary function were affected more compared to the train drivers.

KEYWORDS

PEFR, Taxi Drivers, Train Drivers, Air Pollution

Introduction

In today's world air pollution has become a very big problem. Day by day the quality of air is decreasing significantly. This problem is seen more in case of cities rather than villages. The most common cause of air pollution is different compounds and gases coming from the automobiles. That is why there is air quality crisis in cities, mainly due to vehicular emissions.[1]

The human lungs encounter approximately 5 to 6 liters of air per minute. Thus it is evident that lungs are the targets for adverse effects of noxious gases due to air pollution. The airborne contaminants include: Nitric oxide (NO_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Ozone (O_3) Sulphur Dioxide (SO_2), Hydrocarbons and Suspended Particulate Matters (SPM). They are responsible for injury to airways and lung parenchyma and lead to bronchoconstriction, increased mucous secretion and increased alveolar swelling. Nitrous fumes may results acute pulmonary edema. To protect it, our body employs defence mechanisms like increased mucous secretion. Inhalation of NO_2 and SO_2 causes bronchoconstriction, mucosal irritation and alveolar swelling leading to obstructive and restrictive disorders of lungs.[2]

Automobile exhaust or vehicular emission consists of oxides of nitrogen, sulphur, carbon along with particulate matters (PM_{10}, $PM_{2.5}$) etc which cause injury to the terminal bronchioles and a decrease in the pulmonary compliance and vital capacity.[3] Other than those compounds, dust particles also play a very big role in polluting the air.

Ambient air pollution has an important impact on morbidity and mortality. The World Health Organization ascribed 3.7 million deaths to environmental pollution in 2012.[4]

In most cities, vehicular emissions represent the main source of atmospheric pollutants, and both short- and long-term exposure to traffic pollution have been associated with adverse health effects.[5,6]

Among the motor vehicle-generated air pollutants, diesel exhaust particles account for a highly significant percentage of the particles emitted in many towns and cities. Acute effects of diesel exhaust exposure include irritation of eyes and nose, lung function changes, headache, fatigue, and nausea. Chronic exposure is associated with cough, sputum production, and lung function decrements.[7] Several studies [8, 9, 10] have shown an association between lung function decline and long-term exposure to air pollution in adults. Evidence that reduction in air pollution may improve lung function, [11] as well as attenuate its decline with age, [12] is also available.

In an urban scenario, an individual's exposure to air pollution is highly variable and is dependent on the time spent in traffic, location of residence and working conditions.

Traffic gridlock in metropolitan cities all over India is extreme.[13] The average trip speed on many Indian city roads is less than 20 kilometers per hour, thus a 10 kilometer trip can take 30 minutes, or more than that. At such speeds, vehicles in India emit air pollutants 4 to 8 times more than they would with less traffic congestion. Indian vehicles also leave a lot more carbon footprint per trip, than they would if the traffic congestion would have been less. Emissions of particles and heavy metals increase over time because the growth of the fleet and mileage outpaces the efforts to curb emissions.[14]

Air pollution exposure can trigger new cases of asthma, exacerbate (worsen) a previously-existing respiratory illness, and provoke development or progression of chronic illnesses including lung cancer, chronic obstructive pulmonary disease, and emphysema. Air pollutants also negatively and significantly harm lung development, creating an additional risk factor for developing lung diseases later in life. It is important to understand the contribution of air pollutants to the underlying pathophysiological mechanisms for these observed effects of air pollution in order to optimize interventions and regulatory policies designed to protect the most susceptible children. One mechanism that may play an important role is airway inflammation.[15]

It has also been shown that the neutrophils attracted into the airways after exposure to ozone and endotoxin produce reactive oxygen species (ROS) that induce epithelial cell inflammation, airway hyper-reactivity and lung injury [16] by means of a complex mechanism.

For the people who work mainly in the roads of a big city, there is increased chance of affection of lung by this air pollution. One of the most exposed people is cab drivers or taxi drivers.[17] They drive almost throughout the whole day in roads of the cities. So their lungs and respiratory tracts are exposed to the polluted air all the time. In other hand local train drivers spend most of their days in the rail tracks driving the trains. While driving electric trains, they don't have to face that much of polluted air every day.

The present study is aimed at assessing the pulmonary function status in taxi drivers and train drivers working in the city of Mumbai and compare the results and to note that whether prolonged exposure to vehicular exhausts has any detrimental effects on lung functions.

Methods

The study design was observational and cross sectional. The study was conducted in the Department of Physiology, Seth G.S. Medical College and K.E.M. Hospital, Parel, Mumbai, India. The study was approved by Institutional Ethics Committee (IEC) of Seth G S Medical College and K.E.M. Hospital, Parel, Mumbai, India. The study participants were recruited from the city of Mumbai. To reduce bias, taxi drivers and train drivers (motormen) from all over the Mumbai were invited to participate in this study. After thorough counseling, 60 subjects were selected, among which 30 were taxi drivers and rest of them were train drivers. The written informed consent was obtained from all the study participants. A total 60 study participants (all of them were male) were recruited for the study. The participants were then sub categorized into following two groups on the basis of their profession.

- **Group A (Train Drivers)**

Participants between age group of 25 to 50 years driving local trains for 8 hours per day for at least 5 years in the Central or Harbor lines of Mumbai and the suburbs were included.

- **Group B (Taxi Drivers)**

Participants between age group of 25 to 50 years driving taxi for 8 hours per day for at least 5 years on the roads of Mumbai and suburbs were included.

The study participants having history of cardiovascular diseases or suffering from any pulmonary diseases like asthma, COPD, tuberculosis or any history of taking medications for any pulmonary diseases were excluded from the study.

Following equipments were used for performing the experiments
- Mercury Sphygmomanometer.
- Standard Weighing Scale.
- Standard Height Measuring Scale.
- Peak Flow Meter.
- Medgraphics Breeze-Suite software.

The participants were asked to come to the Physiology Department in the morning after having light breakfast. After informed consent, blood pressure was measured and body weight has been taken using Mercury Sphygmomanometer and Standard Weighing Scale respectively. Using the standard height measuring scale the heights of the participants were measured. History taking, general examination and systemic examination was done before the starting of actual procedure.

- **Peak Expiratory Flow Rate**

The peak expiratory flow (PEF), also called peak expiratory flow rate (PEFR) is a person's maximum speed of expiration, as measured with a small, hand-held device which is known as Peak Flow Meter, used to monitor a person's ability to breathe out air. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. Peak expiratory flow is typically measured in units of liters per minute (L/min).

For each participant the Predicted PEFR value was calculated using Medgraphics Breeze-Suite software and then the Actual PEFR value was measured using Peak Flow Meter (L/min).

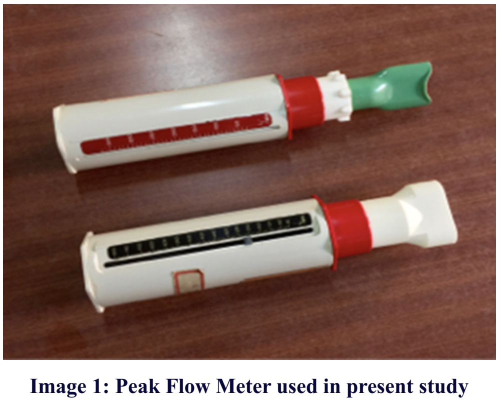

Image 1: Peak Flow Meter used in present study

- **Statistical Analysis**

Data of the different parameters measured were entered in Microsoft Excel (2010). The mean and standard deviation was calculated for all the parameters. Statistical analysis was done using n-Master 1.0 as per SPSS 16.0 and Graphpad Prism software. The statistical tests used were as per data requirement and our objectives of the study. Data was presented as Mean ± Standard deviation.

Results

Total 60 subjects were divided into two equal groups consisting of 30 people in each groups. The groups were as follows.

- **Group A :** Train drivers (Age 25 to 50 years, driving taxi for 5 years, at least 8 hrs a day)
- **Group B :** Taxi drivers (Age 25 to 50 years, driving taxi for 5 years, at least 8 hrs a day)

Table 1: Comparison of Age between Group A and Group B

Groups	Mean Age (in years)	Standard Deviation	Age Range (in years)	Sample Size
Group A (Train Drivers)	37.47	1.366	25 - 50	30
Group B (Taxi Drivers)	35.37	1.189	25 - 50	30

- Group A (Train drivers) consisted of 30 people, whose age ranges from 25 to 50 years. The mean age in Group A (Train drivers) is 37.47 (± 1.366) years.
- Group B (Taxi drivers) consisted of 30 people, whose age ranges from 25 to 50 years. The mean age in Group B (Taxi drivers) is 35.37 (± 1.189) years.
- The age differences in those two groups were statistically not significant, as p value is < 0.05 (Unpaired t-test).

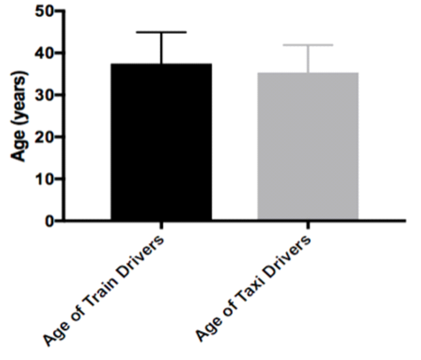

Figure 1: Comparison of Age between Group A and Group B

Table 2: Comparison of BMI between Group A and Group B

Groups	Mean BMI (kg/m^2)	Standard Deviation	BMI Range (kg/m^2)	Sample Size
Group A (Train Drivers)	26.67	0.619	23.68 - 28.14	30
Group B (Taxi Drivers)	25.51	0.6812	23.41 - 27.89	30

- Group A (Train drivers) consisted of 30 people, whose BMI ranges from 23.68 to 28.14. The mean BMI in Group A (Train drivers) is 26.67 ± 0.619 kg/m^2.
- Group B (Taxi drivers) consisted of 30 people, whose BMI ranges from 23.41 to 27.89. The mean BMI in Group B (Taxi drivers) is 25.51 ± 0.6812 kg/m^2.
- The differences in BMI among these two groups were statistically not significant, as p value is < 0.05 (Unpaired t-test).

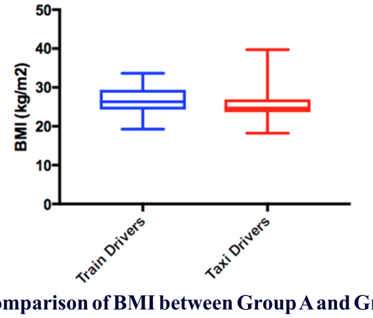

Figure 2: Comparison of BMI between Group A and Group B

Table 3: Comparison of PEFR (Predicted & Actual) between Group A and Group B

Groups	Predicted PEFR (L/min)	Standard Deviation	Actual PEFR (L/min)	Standard Deviation
Group A (Train Drivers)	608.3	2.968	574.7	2.432
Group B (Taxi Drivers)	605.2	3.317	488	6.702

- Group A consisted of Train drivers, whose mean Predicted PEFR is 608.3 (± 2.968) L/min. Their actual PEFR is 574.7 (± 2.432) L/min. The comparison between the Predicted and Actual PEFR (with Unpaired t-test) value is statistically significant as p value is < 0.05.

- Group B consisted of Taxi drivers, whose mean Predicted PEFR is 605.2 (± 3.317) L/min. Their actual PEFR is 488 (± 6.702) L/min. The comparison between the Predicted and Actual PEFR (with Unpaired t-test) value is statistically significant as p value is < 0.05.

- The comparison between the Actual PEFR value between Group A and Group B came out as statistically significant with the Unpaired t-test as p value < 0.05.

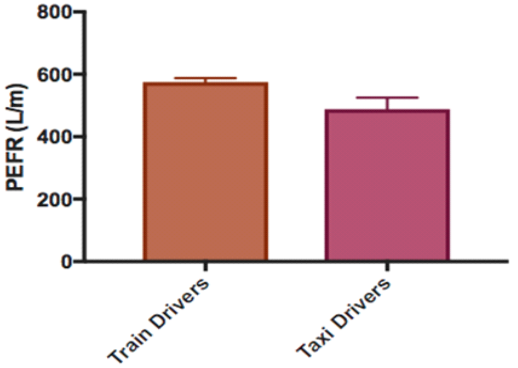

Figure 3: Comparison of PEFR (Actual) between Group A and Group B

Discussion

With increased industrialization and advances in the urbanization the number of vehicles on the road is increasing every day. This large number of motor vehicles not only increasing traffic load but also increasing the amount of air pollution.

Mumbai is one of the most polluted cities in India. According to the Maharashtra Pollution Control Board during the study period the concentration of the air pollutants level were higher than acceptable limit in most of the days. Though the concentration level of SO_2 was within normal acceptable limit, but the concentration of NO_2 was high in most of the days and the concentration of Particulate Matter was high in almost all the days.[18,19]

In this present study we have tried to find out the relationship of air pollution with the Peak Expiratory Flow Rate (PEFR). The 60 subjects were divided into two equal groups, train drivers and taxi drivers.

All the subjects participated in this study were male. We had measured their height and weight and calculated Body Mass Index (BMI) [20] as we know BMI = weight (kg) / height $(m)^2$.

We have found out that the age distribution of the subjects between the two groups were similar. That means 30 subjects from each of the two groups were comparable regarding their age.

When we calculated their BMI and compared them, we found that the differences between these two groups were not statistically significant. So, these two groups, train drivers and taxi drivers were not only matched regarding their gender and age, but also according to their height and weight (BMI) and these two groups represent same types of human population who were matched according to their age, gender, body weight and height.

The Predicted PEFR of these two groups was comparable to each other. But the actual value of PEFR came out quite different in these groups. The mean value of the PEFR for train drivers was 574.7 ± 2.432 (L/min) whereas the mean value for the taxi drivers was 488 ± 6.702 (L/min). We can easily see that the average PEFR value of the taxi drivers is much less compared to train drivers and it is statistically significant also.

As we know that, Peak Expiratory Flow Rate (PEFR) depends on the force of contraction of expiratory muscles, elastic recoil of lungs and resistance of the bronchial tree, reduction in PEFR values may indicate the risk of obstructive airway disease.

In our study we have found the PEFR value of the taxi drivers were affected more than the train drivers. Jie Y. et al [21] have found that the exposure to coal smoke was associated with a 23.1% decrease in PEFR in adult residents. The slope of lung function decrease for Chinese adults is approximately an 8 L/min decrease in PEFR per count per minute of $PM_{2.5}$ exposure.

Mu L. et al have done analyses comparing the during-Olympic to pre-Olympic time points and found a larger percentage change in peak expiratory flow (+17%) among female, younger and non-smoking participants.[22] The results suggest that exposure to different air pollution levels has significant effects on respiratory function. Smoking, age and gender appear to modify participants' biological response to changes in air quality. We have found that the PEFR values are better in train drivers compared to taxi drivers.

Neelam S. D et al have found out an abnormal PEFR in 43.3% of women using biofuels, 20.5% of those using kerosene, 23.4% of those using LPG and 21.4% of those using mixed fuel.[23] Because of air pollution taxi drivers' PEFR are lesser than the normal values.

Oloyede I. P et al have shown that the children in the warm rain forest are at risk of having their lung function compromised by a variety of factors, [24] including smoke from wood fires. The values for the PEFR of the subjects were significantly lower than those of the controls. The deficits were observed to be more with increasing duration of exposure to wood smoke for PEFR.

Correia-Deur J. E et al [25] have discovered that decrements in PEF associated with air pollution were observed in children independent from their allergic sensitization status. Their daily exposure to air pollution can be responsible for a chronic inflammatory process that might impair their lung growth and later their lung function in adulthood.

S. Gupta et al [26] have found out that the traffic policemen recorded a significant decline in various parameters, such as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) when compared with controls, and is probably due to exposure to vehicular pollution. They also observed that in traffic policemen with > 8 years of exposure, the values PEFR were significantly lower than those obtained in traffic policemen with < 8 years of exposure. We have found similar results.

This study suggests a significant impairment in pulmonary function for individuals, who were exposed to ambient levels of traffic pollution. Moreover, the results indicated that, in a complex urban scenario, there is a marked degree of exposure variability amongst taxi drivers and train drivers. Compared to train drivers PEFR is significantly decreased in case of taxi drivers. The reason for this type of findings can only be explained by the over exposure of taxi drivers to the air pollution.

Conclusion

From this present study we can conclude that,

- Air pollution is affecting the lung function of every individual in this world and the decreased lung function is directly proportional to the amount of time the person is spending in the polluted air.

- As taxi drivers spend major part of their day in polluted air, their lung function had decreased more compared to the local train drivers, who don't have to spend that much time in the polluted air, because their job is restricted to a particular corridor where dust & fumes of other vehicles are comparatively less.

- Though air pollution as a whole affects everyone and even the train drivers have lower than normal PEFR values, but compared to taxi drivers' values, they are still higher.

- Precautionary measures like protective masks can save the person's lungs from increasing air pollution. Also, periodic check up will be immensely helpful to detect any early abnormalities in the Pulmonary Function.

- Lastly the amount of dust particles, vehicular fumes and pollutant gases should be reduced in the environment for the betterment of the world population.

Limitations

- The study has moderate sample size from a particular region which may play an impact on the outcome.

- No female drivers were included, as they were not available at the time of study. This may influence the final outcome of the study.

Acknowledgements

Dr. D.N. Shenvi, Professor and Head, Department of Physiology, Seth G.S. Medical College and K.E.M. Hospital, Mumbai

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