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Original Research Paper

Physiology

COMPARISON OF FEV1/FVC BETWEEN TRAIN DRIVERS AND TAXI DRIVERS IN A METROPOLITAN CITY

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ABSTRACT FEV1/FVC is an important tool which can estimate the pulmonary function in an individual. Pulmonary function may be affected by various factors, among which air pollution is the most significant. Air pollution is increasing everyday in India and one of the main causative factors is vehicular transmission. Increased vehicular transmission causes increased air pollution, which is related to decreased 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 FEV1/FVC of taxi drivers as well as the train drivers and to compare them. FEV1/FVC was assessed in 30 train drivers (Group A) and 30 taxi drivers (Group B) between the age group of 25 to 50 years. In both the groups initially Predicted FEV1/FVC ratio was calculated and then the Actual FEV1/FVC was estimated with the help of Computerised Spirometer. People in Group A (82.37% ± 0.765) performed better in this lung function test compared to Group B (62.7% ± 3.814). Though there was a difference in Predicted and Actual values of FEV1/FVC ratio in train drivers, it was not statistically significant. Whereas in case of taxi drivers the ratio was highly significant. As a result of increased exposure to polluted air, taxi drivers' pulmonary function were affected more compared to the train drivers.

KEYWORDS : FEV1/FVC, Taxi Drivers, Train Drivers, Air Pollution, Metropolitan City

INTRODUCTION:

In human beings Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC) ratio is an important index to assess the Pulmonary Function. The ratio is usually affected when the lung function is decreased. On the other hand, lung function depends on various things, but air pollution is one of the major causes in today's world which is affecting the pulmonary function the most. Day by day the quality of air is decreasing significantly. This problem is seen more in the case of cities rather than villages. The most common cause of air pollution is different compounds and gases coming from automobiles. That is why there is air quality crisis in cities, mainly due to vehicular emissions.[1]

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 result in acute pulmonary oedema. 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 Organisation 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 have shown an association between lung function decline and long-term exposure to air pollution in adults. [8,9,10] Evidence that reduction in air pollution may improve lung function, as well as attenuate its decline with age, is also available.[11,12]

Traffic gridlock in metropolitan cities all over India is extreme.[13] The average trip speed on many Indian city roads is less than 20 kilometres per hour, thus a 10 kilometre 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 pollutants 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 optimise 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 by means of a complex mechanism.[16] For the people who work mainly in the roads of a big city, there is an increased chance of affection of lung by this air pollution. One of the most exposed people are cab drivers or taxi drivers.[17] They drive almost throughout the whole day on roads of the cities. So, their lungs and respiratory tracts are exposed to the polluted air all the time. On 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 polluted air everyday.

After a few years there won't be any roads left in the cities for new cars. Gradual increase in the human population and use of motor vehicles will jeopardise the cities. At that time, public transport specially the electric trains can be beneficial for the cities as well as the environment. Though living in a polluted city has its ill effect on the individual's overall lung function but the damage in the pulmonary function may vary from person to person. The actual area of work is very different between the taxi drivers and train drivers working in the same city. Whether the effect of air pollution on their pulmonary function is the same or different, is an interesting question.

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

METHODS

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

Group A (Train Drivers)

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

Group B (Taxi Drivers)

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

The study participants having a history of cardiovascular diseases or suffering from any pulmonary diseases like asthma, tuberculosis, any history of smoking or taking any 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.
- Computerised Spirometer with Medgraphics Breeze-Suite software.
- Mouth pieces.

The participants were asked to come to the Physiology Department in the morning after having a 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.

FVC, FEV1 and FEV1/FVC

- Forced vital capacity (FVC) is the volume of air that can forcibly be blown out after full inspiration, measured in liters. It varies according to the age, built and gender of the individual.
- FEV1 is the volume of air that can forcibly be blown out in the first 1 second, after full inspiration.
- FEV1/FVC is usually expressed as a ratio.

For each participant the Predicted FVC and FEV1 values were calculated using Medgraphics Breeze-Suite software and then the Actual data was collected in the same Computerised Spirometer.

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 group. 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 I : 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).

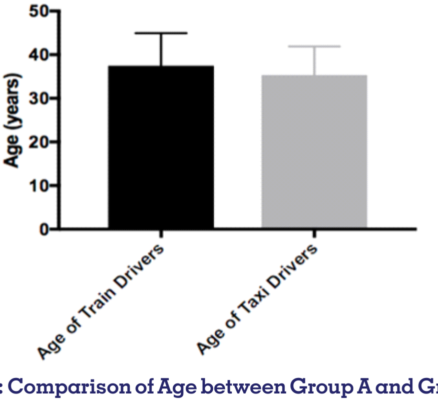

Figure I : Comparison of Age between Group A and Group B

Table II : 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 $26.67 \pm 0.619\ kg/m^2$.
- 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 $25.51 \pm 0.6812\ kg/m^2$.
- The differences in BMI among these two groups were statistically not significant, as p value is > 0.05 (Unpaired t-test).

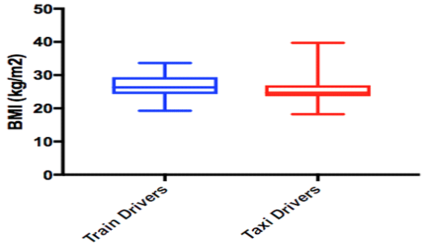

Figure II : Comparison of BMI between Group A and Group B

Table III : Comparison of Predicted & Actual FEV1/FVC between Group A and Group B

Groups	Predicted FEV1/FVC (%)	Standard Deviation	Actual FEV1/FVC (%)	Standard Deviation
Group A (Train Drivers)	80.67	0.372	82.37	0.765
Group B (Taxi Drivers)	82.33	0.264	62.7	3.814

- Group A consisted of Train drivers, whose mean Predicted FEV1/FVC is 80.67% (± 0.372). Their Actual FEV1/FVC is 82.37% (± 0.765). The comparison between the Predicted and Actual FEV1/FVC (with Unpaired t-test) value is statistically not significant as p value is > 0.05
- Group B consisted of Taxi drivers, whose mean Predicted FEV1/FVC is 82.33% (± 0.264). Their Actual FEV1/FVC is 62.7% (± 3.814). The comparison between the Predicted and Actual FEV1/FVC (with Unpaired t-test) value is statistically significant as p value is < 0.05
- The comparison between the Actual FEV1/FVC value between Group A and Group B came out as statistically significant with the Unpaired t-test as p value < 0.05

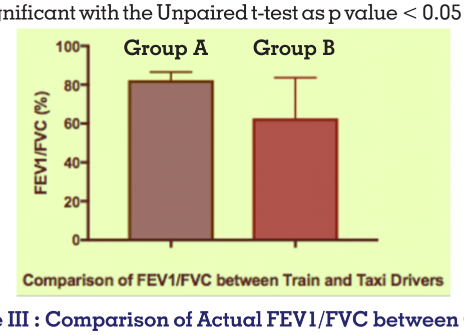

Figure III : Comparison of Actual FEV1/FVC between Group A and Group B

DISCUSSION

The number of vehicles on the road are increasing everyday with increased industrialisation and advances in urbanisation.This large number of motor vehicles not only increases traffic load but also increases 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 was higher than the 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 compare the FEV1 and FVC ratio between two different 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 $(m)^2$.

It was found 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 had calculated their BMI and compared them, we had 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 the same types of human population who were matched according to their age, gender, body weight and height.

The Predicted FEV1/FVC ratio of these two groups were comparable to each other. But the actual value of FEV1/FVC came out quite different in these groups. The mean value of the FEV1/FVC for train drivers was 82.37% (± 0.765) whereas the mean value for the taxi drivers was 62.7% (± 3.814). We can easily see that the average FEV1/FVC value of the taxi drivers are much less compared to train drivers and it is statistically significant also. According to GOLD criteria for the diagnosis of Chronic Obstructive Pulmonary Disease (COPD), Group A (train drivers) came out as normal but the Group B (taxi drivers) qualified as mild to moderate levels of COPD.

The explanation for the reduced FEV1/FVC ratio for the taxi drivers may be because of the fact that FEV1 has decreased more than FVC. Though air pollution causes mixed changes in lung parenchyma but here chronic obstructive changes are more profound. This can be attributed to a characteristic of fine particles that tend to deposit in the small airways, causing wall inflammation, thickening and remodelling, as suggested by studies using lungs from autopsies.[21,22]

In this present study we have found that the FEV1/FVC ratio in taxi drivers is lesser than the train drivers. Badyda A J et al investigated the influence of traffic-related air pollutants on respiratory function, with a focus on the non-smoking residents of the capital city of Warsaw in Poland, who lived close to busy streets.[23] The results demonstrate that people living in some parts of the city show symptoms of bronchial obstruction over four times more often than those from the control group consisting of the inhabitants of a remote region in eastern Poland, with considerably less air pollution. Using multiple regression models it was shown that, apart from the place of living, the floor the apartment is situated on, the length of residence, allergy, and physical activity are the factors that significantly influence the forced expiratory volume in 1 second (FEV1) and the Pseudo-Tiffeneau index (FEV1/FVC).

Kan H. et al have shown that,[24] after controlling for potential confounders including demographic factors, personal and neighbourhood level socioeconomic characteristics, cigarette smoking and background air pollution, higher traffic density was significantly associated with lower forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) in women. We have also found that the taxi drivers are affected more than the train drivers.

Wang B. et al estimated the differences between the urban and suburban areas in FEV1, FVC, and FEV1/FVC (%), with adjustment for potential confounding factors, including sex, age, height, education, passive smoking, and occupational exposures to dust, gas, or fumes.[25] Estimated differences in FEV1 between the two areas were statistically significant. When the men and women were pooled, similar trends were observed for FVC and FEV1/FVC (%). However, the effects on FEV1 and FEV1/FVC (%) remained significant for both men and women. We have also found results similar to this.

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 FEV1/FVC ratio 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 air pollution.

CONCLUSION

From this present study we can conclude that,

- In today's world air pollution is affecting the lung function of every individual 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 (FEV1/FVC ratio), 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.
- 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 population is not very big.
- No female subjects were included in this study

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