ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Role of Mid Expiratory Flow Rate as an Early Marker in Diagnosing Small Airway Disease in Overweight Automobile Mechanics

N Anupama*[1], Sonu Ajmani [1], M Vishnu Sharmac [2], AK Nayanatara[1], K Bhagyalakshmi [1], DK Rekha[1] and Pai R Shiela[1]

[1] Associate professor Department of Physiology, Center for Basic Sciences, Kasturba Medical college (Manipal university),Bejai, Mangalore-575004, Karnataka, India
[2] Professor and Head, Department of Pulmonary Medicine, A.J.Institute of Medical Sciences, Mangalore, Karnataka, India

ABSTRACT

Air pollution from diesel exhaust is a major respiratory hazard for workers exposed to it in enclosed space. 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. Due to the greater surface area they carry a much larger fraction of toxic compounds and remain airborne for long periods of time and deposit in greater numbers in small airways and deeper into the lungs than larger sized particle, causing chronic inflammation and obstruction of the airways. Mid expiratory flow rate is one of the spirometric variables which indicates the function of small airways. In this modern world factors associated with lifestyle have also been identified as causing a deterioration of lung function. Overweight and obesity are related with a higher risk of different co-morbidities but their relationship with small airway disease is still under discussion. The present study was conducted in a private motor vehicle showroom and garage, located in Mangalore. Study group consisted of total of 120 employees (30-40 years) who worked in the automobile industry for a minimum of 6 years and control group consisted of 120 (30-40 years) subjects who were working in air conditioned environment and were not exposed to any dust and fumes. Their body mass index was calculated and Forced expiratory flow 25-75 recorded with a spirometer. In high BMI group, the cases showed significantly low values when compared to that of controls. . Our study says that the overweight people exposed to pollution are more prone to develop small airway disease than the normal or underweight people and a decrease in the measure of FEF 25-75% has been interpreted as an early predictor for small airway obstruction

Keywords: automobile exhaust, body mass index, FEF25-75, small airways.

Corresponding author

INTRODUCTION

Industrial revolution has brought about tremendous change in the ecology and environment of man. But somewhere along with it, the health aspect is overlooked. The environmental consequences of any occupation have not received enough weightage in public health management and occupational medicine.

Worldwide increase in the number of automobiles leading to increase in air pollution is a cause of grave concern. Rapid industrialization, urbanization, use of motor vehicles are the major causes of environmental pollution in the world. Exposure to gases, vapors, and fumes can cause respiratory symptoms and bronchoconstriction by different pathophysiological mechanisms [1-3].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 [4]. Literature shows that, air pollution from diesel exhaust is a major respiratory hazard for workers exposed to it in enclosed space [5]. Diesel exhaust generates pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world [6]. Various occupational exposures to petrol/diesel products have been shown to affect different systems of our body [4]. Even though the diesel exhaust particles are extremely small, by the virtue of their greater surface area they carry a much larger fraction of toxic compounds, such as hydrocarbons and metals on their surface. Importantly, they can remain airborne for long periods of time and deposit in greater numbers and deeper into the lungs than larger sized particle [4, 7]. Hence chronic exposure to them can lead to chronic inflammation of respiratory tract and lung parenchyma.

Forced expiratory flow (FEF25-75) or the mid expiratory flow, is the flow (or speed) of air coming out of the lung during the middle portion of a forced vital capacity (FVC) and indicates the function of the small airways [8]. Any change in this value indicates the pathology in small airways. Small airways have been termed the lung's ''Achilles heel'' because of their importance in airflow and air distribution and their lack of rigidity to protect them from collapsing during exhalation, especially when diseased [9]. Small airways are a term for membranaceous bronchioles–noncartilaginous conducting airways with a fibro-muscular wall with an internal diameter less than 2mm. They consist of simple columnar cells (ciliated and non-ciliated) and rare neuroendocrine cells overlying a thin layer of connective tissue and smooth muscle. They constitute the quiet zone between the conducting and the respiratory lung zones, consisting of respiratory bronchioles, having a partially alveolated wall, and of terminal bronchioles that are devoid of cartilage and mucous secreting glands [10].

In this modern world factors associated with lifestyle have also been identified as a cause for the deterioration of lung function. It has been observed that the rising prevalence of asthma in developed nations has coincided with the rising prevalence of obesity. In India, under nutrition coexists with obesity, thus demonstrating a "double burden of the disease." Demographic variables have been shown to affect lung function, including age, weight, smoking, and socioeconomic conditions. Obesity is a chronic medical condition characterized by an excessive accumulation of fat on the body that causes a generalized increase in body mass. It is measured by using body mass index (BMI) which is a reflection of weight and height. The effect of the increased BMI and the body fat percentage on the pulmonary functions has been studied extensively [11-13]. Overweight and obesity are related with a higher risk of different co-morbidities but their relationship with small airway disease (SAD) is still under discussion. The effect of under nutrition and mild weight gain on the pulmonary functions needs attention. Nevertheless, they are related to higher severity in asthma and other respiratory diseases. Various studies have attempted to establish the relationship between obesity and SAD, and have reached diverse conclusions. To get more insight into the interaction between BMI and SAD, the present study was conducted in a private motor vehicle showroom and garage workers having known low level exposure to airway irritants. Further this study was aimed to analyze the SAD in individuals with normal lung function without respiratory disorders, according to body mass index (BMI) calculation.

MATERIAL AND METHOD

The present study was conducted in a private motor vehicle showroom and garage, located in Mangalore. Study group consisted of total of 120 employees (30-40 years) who worked in the automobile industry for a minimum of 6 years and control group consisted of 120 (30-40 years) subjects who were working in air conditioned environment and were not exposed to any dust and fumes. Institutional Medical Ethical committee approval was obtained and written consent was obtained from all participants. The subjects were divided into three groups based on the Body Mass Index according to the WHO recommendations [14] for Asian population into normal group (BMI18.5-25), low BMI group (BMI ≤18.5) and high BMI (BMI 25-30). The subjects who accepted the invitation underwent a medical evaluation including a meticulous and thorough medical history, and a full physical examination. All the subjects who were included in this study were nonsmokers and non-alcoholics. They had no history of any respiratory complaints like cough, shortness of breath, wheezes or fever or history of upper respiratory tract infection in the past 4 weeks or history of respiratory diseases such as pulmonary tuberculosis or asthma and not having history of cardiac or thoracic surgery or features suggestive of cardiac or lung disease or evidence of chest deformities or serious medical conditions. A written informed consent was taken from all subjects before the start of the study. Anthropometric measurements such as height and weight were recorded. Height was measured to the nearest 0.5 cm with the help of a height scale. The body weight was measured by a weighing scale in kilograms without shoes, the subjects wearing light weight clotheson a Krups weighing machine with a least count of 100 grams. Body mass index was calculated using Quetelet formula BMI = weight in kilograms / height in m^2.A complete spirogramwas performed with Spirolab^{TM}portable spirometer. The test was carried out in a private and quiet room, in a standing position with the nose clip held in position on the nose. The flow, volume/ timed graphs were taken out in accordance to the criteria based on the American Thoracic Society. The subject was instructed to take a deep breath until the lungs were full and then blow out through mouth as forcibly and as fast and as long as possible till his maximum capacity, sealing the lips tightly around a clean mouthpiece. Best of the three acceptable curves was selected as the recording. Spirometeric parameter Forced Expiratory Flow FEF – 25 - 75 % was recorded.

STASTICAL ANALYSIS:

The values obtained in both study and control groups were expressed as mean ± Standard deviation. Student's unpaired't'- test was done to compare the means between the two groups. A p value of < 0.05 was considered as statistically significant.

Table 1: FEF 25-75% of controls and cases (n=40, n is the number of subjects) compared in low, normal and high BMI groups. Values expressed as mean± SD

Body mass index(BMI)	CONTROLS	CASES
Low BMI	5.309 ± 1.409	4.987± 1.197
Normal BMI	5.219± 1.41	4.705± 0.967
High BMI	5.751± 1.579	5.083 ± 0.567*

P< 0.05*-Comparison between the controls versus cases of High BMI

RESULTS

The FEF 25-75% in between the controls and cases did not show any statistical significance in normal and low BMI group. Further, in high BMI group, the cases showed significantly (P< 0.05*) low values when compared to that of controls.

DISCUSSION

Obesity is an emerging global public health challenge. The prevalence of obesity has increased greatly in all parts of the world, Overweight leads to an increased risk of wide range of health conditions including respiratory diseases. A number of studies have reported an inverse relation between respiratory function and various indices of obesity or body fat distribution [15-17]. High exposure to automobile exhaust leads to acute symptoms affecting the upper respiratory tract that are nearly reversible without exposure within a few days. Sustained work in that environment causes excessive decrement in lung functions which is a reliable indicator of occupational illness [18]. FEF 25-75 is one of the useful measures of dynamic pulmonary function tests. The forced expiratory flow at 25 to 75 percent of force vital capacity (FEF25-75%) is the spirometric variable cited as an indicator of small airways disease. By excluding the initial peak of expiratory flow and averaging flow rate over the mid-quartile range of FVC, the FEF25-75% is sensitive to the small airways characteristics and flow limitation [19].

The exhaust from diesel engines is gases and soot. The gas contains carbon monoxide, carbon dioxide, nitrogen oxides, nitric oxide, sulfur oxides and polycyclic aromatic hydrocarbons [20]. Soot is unburned carbon particles with a diameter below 2.5 µm and ultra-fine particles with a diameter below 0.1µm [21]. These carbon particles are small enough to be inhaled and deposited in the small airways but have a large surface area. Organic compounds from diesel exhaust with known toxic and carcinogenic properties, such as polycyclic aromatic hydrocarbons (PAH), adhere easily to the surface of the carbon particles and are carried deep into the lung [22]. Diesel exhaust particles have been demonstrated to increase the production of inflammatory cytokines such as interleukin1, interleukin 8, and granulocyte-macrophage colony-stimulating factor from cyclo-oxygenase stimulation in bronchial epithelial cells [23]. This in turn results in decreased adhesion between cells, reduction of structural integrity, and inhibits repair of lung tissue. One of the substances in diesel exhaust, ozone, formed from nitrogen oxides can contribute to lung tissue destruction. Working in areas with high concentration of diesel exhaust accelerates pulmonary disease. Macrophages, the first line of immunologic defense within the lung, are severely impaired from exposure to high concentrations of diesel exhaust, resulting in an increased risk of bacterial and viral bronchitis and pneumonia [24].

In this study, we investigated the correlation of the body mass index [BMI] and FEF25-75. The present study is based on the hypothesis that not only an increase in the BMI but also a decrease in the BMI in the underweight population will lead to a decrement in the pulmonary functions. We found that the low and normal BMI cases showed reduction in mid expiratory flow rate compared to controls but the values were not statistically significant. This indicates prolonged exposure to diesel exhaust along with lack of energy due to malnutrition has reduced the pulmonary function. But the lung function reduction in high BMI cases was statistically significant, saying that body fat percentage along with exposure to diesel exhausts has reduced the pulmonary function. Our study says that the overweight people exposed to pollution are more prone to develop small airway disease than the normal or underweight people. Literature survey shows that obesity has a significant obstructive effect on small airways. The possible explanation may be through the influence of obesity on airway smooth muscle function. In obese individuals, even in the absence of an overt inflammatory insult, there is chronic, low-grade systemic inflammation characterized by increased circulating leukocytes and increased serum concentrations of cytokines, cytokine receptors, chemokines, and acute-phase proteins that could predispose to airway hyper responsiveness .In addition, there are also changes in the serum concentrations of hormones and other factors derived from adipose tissue that could affect airway function [25]. A decrease in the measure of FEF 25-75% has been interpreted as an early predictor for small airway obstruction. Other lung functions which can be done to evaluate Small airway disease are residual volume (RV) which will be elevated, total lung capacity (TLC) which will be increased in small airway obstruction. Imaging with high resolution computed tomography (HRCT) also allows assessment of small airways.

CONCLUSION

The result of the present study suggests that, the degree of exposure and increased BMI may have an effect on small airways which can be assessed by the mid expiratory flow rate. Further, there is a need to improve control measures along with the proper life style modifications and regular check-up of the health status of automobile mechanics. Most individuals are likely to remain asymptomatic till significant pulmonary damage results, regular monitoring of lung function is desirable.

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