ISSN 2250-3153

A Comparative Study of the Effects of Ambient Air Pollution on Ventilatory Functions Tests in Urban and Rural Populations

Dr.Sayad Abdul Hamid [*], Dr. Ramya C.S [*], Dr.G.S Nellige [**]

[*] Assistant professor, department of physiology, MVJMC&RH, Bangalore
[**] Rtd. Professor, Bangalore Medical College, Bangalore

***Abstract*- Background:** Motor vehicle fumes and exhausts are the major source of ambient air pollution in Bangalore city. Healthy people who breathe polluted air, over a prolonged period of time, can present with a significant impairment in the results of their ventilatory function tests. **Materials and methods:** 292 healthy male aged between 20-60 years was taken, 144 from urban area as study group and 148 as control group from rural area of Bangalore city. Height and weight measured. Ventilatory function tests were done using a computerized spirometer COSMED. Ambient air pollutants were analyzed using Envirotech's APM 451 – Respirable Dust Sampler and APM 411 – Gaseous Sampling Attachment. **Result and analysis:** there was no significant difference in age, height and weight between control and study group. However there was significant decrease in ventilator parameters like FVC; FEV_1; FEV_1/FVC%; PEF; $FEF_{25-75\%}$; Vmax25%; Vmax50% & Vmax75% in study group compared with control group. There was an increase in ambient Air Pollutants like SO_2, NOx, SPM, RPM concentrations in urban and rural area. **Conclusion:** This study concludes that, a long-term exposure to high concentrations of ambient air pollutants is indeed responsible for the decline in the results of the ventilatory function tests.

***Index Terms*-** ventilatory function tests, ambient air pollutants, FVC, Urban and Rural area.

I. Introduction

Earth's atmosphere has a composition and pressure which is unique in the solar system. It has evolved by a complex chain of circumstances in which biological influences have been of major importance. Atmospheric air pollution is largely the result of modern industrial technology and transportation.[1]Atmospheric air pollution has been defined as the contamination of both outdoor and indoor air by one or more natural or manmade sources in such a way that air becomes less acceptable for its intended use i.e. sustenance of life and maintenance of health.[2]

Motor vehicle fumes and exhausts are the major source of ambient air pollution in Bangalore city. The ambient air pollutants are classified into primary pollutants which are directly released into the atmospheric air by stationary or mobile sources includes sulphur di oxide[SO_2], oxides of nitrogen[NO_x], carbon monoxide[CO], carbon di oxide[CO_2], polyaromated hydrocarbon[PAH] including benzene, lead etc..and secondary pollutants which are formed by chemical reactions among the primary pollutants and the normal atmospheric constituents includes PAN (peroxy acetyl nitrate) Ozone (O_3) & Smog.[1]

Healthy people who breathe polluted air, over a prolonged period of time, can present with a significant impairment in the results of their ventilatory function tests.

Among the ambient air pollutants, particulate matter [PM_{10}] having an aerodynamic diameter of 10µm or less is in the respirable range and is potentially responsible for the health ill-effects.[1] It is known to produce a significant impairment in the results of the ventilatory function tests and a long term exposure causes permanent damage to the lung tissue which contributes to chronic respiratory diseases, premature illness and death.[3,4,5] The present study is undertaken to evaluate and compare the ventilatory functional status of the respiratory system in an urban population residing in an polluted area with a rural population.

II. Materials and Methods

This study was done in Bangalore. 292 subjects of age group 20 – 60 years a healthy, male individual of ethnic South-Indian origin, a non-smoker, free from any respiratory tract infections were included in this study.

The individual with past or present history of any respiratory diseases like Tb or COPD or with any form of respiratory allergies to any substance, cardiac disorders, connective tissue disorder, endocrinological disorders, rheumatoid arthritis and those with any forms of thoracic cage deformities, spinal cord deformities or any other forms of congenital abnormalities were excluded from the study.

Procedure was explained to subjects and informed consent was taken from them.

Subjects were divided in to two groups on the basis of their exposure to high concentrations of ambient air pollutants present in their respective working environments. The 142 people in study group included coolies and shop workers, working for 8 – 10 hours a day in the K.R. market area of Bangalore city where they are exposed to a high concentrations of ambient air pollutants .and The 148 people in control group included farmers from the rural areas of Bangalore (in and around Magadi taluk) who were exposed to minimum concentrations of ambient air pollutants in their working environment for 8 – 10 hours a day.

Ventilatory function tests were done using a computerized spirometer COSMED. Each subject was given a detailed

instruction and demonstration of the method of performing this test (forced vital capacity maneuver). After which he was asked to perform it himself. A minimum of three to five repetitions were allowed and the test with the maximum values was selected as the "best test". The results of the ventilatory function tests are calculated from the "best" maximal expiratory flow-volume curves. The ventilatory parameters included in this comparative study are Forced Expiratory Vital Capacity (FVC); Forced Expiratory Volume in 1 second ($FEV_{1)}$; FEV_1 as a percentage of FVC (FEV_1/FVC%); Peak Expiratory Flow (PEF); Forced mid-expiratory flow ($FEF_{25-75\%}$); Maximal Expiratory Flow when 75% of the FVC remains to be exhaled (Vmax25%); Maximal Expiratory Flow when 50% of the FVC remains to e exhaled (Vmax50%) & Maximal Expiratory Flow when 25% of the FVC remains to be exhaled (Vmax75%).

Ambient air pollutants were analyzed using Envirotech's APM 451 – Respirable Dust Sampler and APM 411 – Gaseous Sampling Attachment.

Data was analyzed using appropriate statistical method.

III. RESULTS AND ANALYSIS

Table – 1 Comparison of the Mean Values of Age, Height &Weight between Study Group & Control Group

	Control	*Study*	p value
AGE(In years)	29.96 ±7.90	31.03±8.28	>0.05
Height(in Cms)	167.6 ±6.91	168.4±5.89	>0.05
Weight(in Kgs)	57.16 ±7.06	58.52±6.51	>0.05

Table 1 shows no significant difference in age, height and weight between control and study group.

Table – 2 Comparison of the Mean Values Of Ventilatory Parameters Between Study Group & Control Group

	Control	*Study*	p value
FVC(LITERS)	3.88±0.51	3.62±0.59	**
FEV_1(LITERS)	3.30±0.43	2.78±0.44	**
PEF(L/SEC)	9.11±1.26	7.56±1.55	**
FEV_1 / FVC %	85.23±4.3	77.25±7.10	**
$FEF_{25-75\%}$ (L/Sec)	4.28±0.88	2.49±0.67	**
$FEF_{25-75\%}$ (L/Sec)	4.28±0.88	2.49±0.67	**
Vmax25% (L/Sec)	7.63±1.17	5.49±1.44	**
Vmax50% (L/Sec)	4.83±0.96	2.97±0.80	**
Vmax75% (L/Sec)	2.07±0.57	1.10±0.39	**

** P value <o.oo1

Table 2 shows that all the ventilatory parameters had statistically significant difference between the study group & control group.

Table 3: comparision of Ambient Air Pollutants concentrations in urban and rural area

	Normal limits µg/m^3	**Urban area µg/m^3**	**Rural area µg/m^3**
SO_2	30	31	2
NOx	30	51	2
SPM	100	172	50
RPM	75	44	30

Table 3 shows the comparison of ambient Air Pollutants concentrations in urban and rural area.

IV. DISCUSSION

Rising levels of ambient air pollutants in cities has been attributed to increased rates of mortality & morbidity in the developed and developing countries.[6] It is been found that the prevalence of health morbidity was higher in the urban people when compared to their rural counter-parts. Respiratory morbidity was higher in those areas, where SO_2 and SPM levels in the ambient air were high and cardiac morbidity was higher in those areas, where NO_X & SPM levels in the ambient air were high.[7, 8, 9]

Similar to other studies In this present cross-sectional study, the extent of damage ambient air pollution has done to the lung parenchyma and airways is estimated by comparing the results of the ventilatory function tests of the urban populations with those of the rural populations in and around Bangalore city.

The factors that affect the normal values for ventilatory lung function are ethnic variation, physical activity, altitude of the dwelling, environmental conditions, and tobacco smoking. [10] In our study, both the groups included subjects from the same ethnic South-Indian origin, undergoing strenuous physical activity, residing at the same altitude, besides being non-smokers but differing only in the environmental exposure to varying concentration of ambient air pollutants. This difference in exposure to varying concentrations of ambient air pollutants is the only factor, which may be responsible for the decline in the results of the ventilatory function tests of the study group.

The ventilatory function tests like $FEF_{25-75\%}$ and Vmax75% are indicators of medium and small airways patency, [11] which was declined in the urban population compared to rural population. The pollutants which act as irritants stimulate the receptors under the tight junction of bronchial epithelium resulting in an increased parasympathetic discharge to the bronchial smooth muscle via the vagus nerve. Through the release of acetylcholine, which acts on the muscarinic receptors present in the bronchial smooth muscle, resulting in an enhancement of the bronchoconstrictor tone of the smooth muscle in the small airways.

As showed in other studies, there is also decline in Ventilatory parameters like FVC and FEV_1 in study group which may be due to changes in the airway size or in the elastic recoil of the lungs, produced by the damaging effects of ambient air pollution. [10,12,13] Peak expiratory flow rate is an indicator of the patency of the large airways,[14] is also reduced in study group which heralds the onset of a mild form of Chronic Obstructive Pulmonary Disease (C.O.P.D.) in proportion of such subjects. [12,15] The role of genetics in this is yet uncharacterized.[16]

. Rise in the ambient air pollutant levels is associated with an increase in the number of (1) emergency room visits for asthma (2) hospitalization for chronic obstructive pulmonary disorders (3) hospitalization for cardio-vascular diseases (4) elementary school absenteeism and (5) low birth weight, pre-term birth & other adverse birth outcomes.[17,18]

V. CONCLUSION

Thus the study concludes that, a long-term exposure to high concentrations of ambient air pollutants is indeed responsible for the decline in the results of the ventilatory function tests. This calls for an enactment of new legislations like the 'Clean Air Act' of 1956, which brought about a tremendous change in the health status of the London population, besides proper enforcement of the existing laws. In addition to all these, people should be made aware of the dangerous consequences of ambient air pollution, and should be motivated to prevent it's occurrence in all stages.

.

REFERENCES

1. Mahashu A A. Ravi Shankar P. Effect of Air Pollution on Respiratory System. Int J Clin Pract,1999;10:55.
2. Gong H, Linn WS.Health Effects of Criteria Air Pollutants. Curr Pulmonol,1994;15:341–397.
3. Peters A, Wichmann HE, Tuch T, Heinrich J, Heyder J. Respiratory effects are associated with the number of ultrafine particles. Am J Respir Crit Care Med. 1997 Apr;155(4):1376-83.
4. Pope CA 3rd, Kanner RE. Acute effects of PM10 pollution on pulmonary function of smokers with mild to moderate chronic obstructive pulmonary disease. Am Rev Respir Dis. 1993 Jun;147(6 Pt 1):1336-40.
5. Utell MJ, Samet JM. Particulate air pollution and health. New evidence on an old problem. Am Rev Respir Dis. 1993 Jun;147(6 Pt 1):1334-5
6. Singh HD. Mean expiratory flow volume curves in south Indian men. Lung India.1984 Nov; 2(4): 293-6.
7. S. R Kamat, S. V Shah, R. U Rupwate, A. V Kulkarni, J Gregrat, J. M Deshpande. The Health Effects Of Automobile Exhaust And Total Ambient Pollution In Bombay. Lung India, 1989;7:15-22.
8. Vijayan VK, Rao KV, Venkatesan P, Sankaran K. Reference values and prediction equations for maximal expiratory flow rates in non-smoking normal subjects in Madras. Indian J Physiol Pharmacol. 1993 Oct;37(4):291-7.
9. Udwadia FE , Sunavala JD , Shetye VM , Jain PK .The maximal expiratory flow-volume curve in normal subjects in India.Chest,1986;89(6):852-6.
10. Woolcock AJ, Colman MH, Blackburn CR. Factors affecting normal values for ventilatory lung function. Am Rev Respir Dis. 1972 Nov;106(5):692-709.
11. McFadden ER Jr, Linden DA. A reduction in maximum mid-expiratory flow rate. A spirographic manifestation of small airway disease. Am J Med. 1972 Jun;52(6):725-37.
12. Ackermann-Liebrich U, Leuenberger P, Schwartz J, Schindler C, Monn C, Bolognini G, et.al, Lung function and long term exposure to air pollutants in Switzerland. Study on Air Pollution and Lung Diseases in Adults (SAPALDIA) Team. Am J Respir Crit Care Med. 1997 Jan;155(1):122-9.
13. Schindler C, Künzli N, Bongard JP, Leuenberger P, Karrer W, Rapp R, et.al. Short-term variation in air pollution and in average lung function among never-smokers. The Swiss Study on Air Pollution and Lung Diseases in Adults (SAPALDIA). Am J Respir Crit Care Med. 2001 Feb;163(2):356-61.
14. Chin RC, Guenette JA, Cheng S, Raghavan N, Amornputtisathaporn N, Télles AC,et.al. Does the Respiratory System Limit Exercise in Mild Chronic Obstructive Pulmonary Disease?. Am J Respir Crit Care Med.2013;187: 1315-1323.
15. Nunn AJ, Gregg I. New regression equations for predicting peak expiratory flow in adults. BMJ. 1989 April 22; 298(6680): 1068–1070.
16. Antó JM, Vermeire P, Vestbo J, Sunyer J. Epidemiology of chronic obstructive pulmonary disease. Eur Respir J. 2001 May;17(5):982-94.
17. Chen L, Omaye ST. Air pollution and health effects in northern Nevada. Rev Environ Health. 2001 Apr-Jun;16(2):133-49.
18. Pande JN, Bhatta N, Biswas D, Pandey RM, Ahluwalia G, Siddaramaiah NH, et.al. Outdoor air pollution and emergency room visits at a hospital in Delhi. Indian J Chest Dis Allied Sci. 2002 Jan-Mar;44(1):13-9.

AUTHORS

First Author: Dr.Sayad Abdul Hamid, Assistant professor, department of physiology, MVJMC&RH, Bangalore .
Email ID: jak2stat@gmail.com.
Second Author –Dr. Ramya C.S, Assistant professor, department of physiology, MVJMC&RH, Bangalore .
Email ID:ramyacs05@gmail.com.
Third Author –Dr.G.S Nellige, Rtd.Professor,Bangalore Medical College, Bangalore.
Correspondence Author –
Dr. Ramya C.S, Assistant professor, department of physiology, MVJMC&RH, Bangalore .
Email ID:ramyacs05@gmail.com.