



*Original Research Article*

## **Pulmonary Function Tests in Young Healthy Male Exposed To Air Conditioned Work Environment**

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### **ABSTRACT**

Currently air conditioning systems are increasingly prevalent in professional settings. They are advertised as increasing productivity through improvement of workers' comfort in work environment. The present study was to find out effect of air conditioner on pulmonary functions. Study included 30 young healthy male software professionals exposed to air conditioner work environment as a subject (group I) and 30 young healthy male volunteers not exposed to air conditioner as a control (group II). Pulmonary function tests were performed using computerised spirometer. Peak expiratory flow rate (PEFR), Mean forced expiratory flow during middle of the FVC (FEF 25-75), Forced expiratory flow - after 25% of the FVC (FEF 25%), after 50% of the FVC (FEF 50%), after 75% of the FVC (FEF 75%) were calculated and compared between two groups. Values of all the parameters were less in air conditioner users and difference was statistically significant (p value < 0.05). Findings suggest that exposure to air conditioner work environment is risk factor for development of respiratory dysfunction and prone to allergic disorders in future.

**Key Words:** Air conditioner, Pulmonary Functions, Peak Expiratory Flow Rate, Forced Expiratory Flow

### **INTRODUCTION**

In multinational industries in urban areas use of air conditioning (AC) systems, specifically central AC is suppose to be a necessary part of their luxurious life. Air inside is cooled and dehumidified for

thermal comfort by AC systems. To maintain same comfort, use of AC is very common now days in food plazas, multiplex theatres, shopping malls, while travelling, and in homes.

The existence of bronchospasm in response to nasal inhalation of cold and/or

dry air may be considered as a protective mechanism that tends to reduce the airflow rate in the upper airways and cervical trachea and limits the penetration of insufficiently conditioned inspired air into the lungs. [1] Cold dry air challenge test is the test by which bronchial responsiveness is measured by applying physical stimuli like hyperventilation of cold and dry air. [2, 3] It has been observed that hyperventilation of cold dry air causes bronchoconstriction, and eupnoeic inhalation of cold, dry air increases airway resistance in asthmatic patients. [4, 5] During working in AC environment workers inhale cooled and dehumidified that is cold and dry air which might be affecting their airways and altering pulmonary functions.

Intensive use of air conditioners in modern living has increased the risk of atopic sensitization and eosinophil activity. [6, 7] Increased prevalence of IgG induced sensitization and hypersensitivity pneumonitis was reported in persons exposed to aerosol contaminated air conditioners. [8] Hypersensitivity pneumonitis caused by bacteria, fungi and molds contaminating air conditioning systems had been also reported. [9] Conditions favourable to the growth of micro organisms are sometimes found in air conditioning system. While such micro organisms are potentially pathogenic or allergenic, it can lead to human respiratory ailments such as humidifier fever. [10, 11] Epidemiological studies had shown that, persons working in air conditioned buildings were consistently associated with increased prevalence of work related headache, lethargy and upper respiratory symptoms. [12]

All of the above studies had linked AC with respiratory dysfunction. In mega cities all the multinational companies are having central AC systems for their workers. These workers are working even more than the stipulated time in that environment to

achieve the goal of the company. Considering the problem present study was planned to evaluate the pulmonary functions in young healthy, non-smoking workers population exposed to an air conditioned work environment.

## **MATERIAL AND METHODS**

The present study was conducted in the Department of Physiology, Dr. D. Y. Patil Medical College, Pimpri, Pune. The present work was approved by the university ethics committee. 30 young healthy male adults aged between 25-30 years who were exposed to AC work environment, at least for 6 hrs per day and 5 days a week since one year were selected as study group (Subject). 30 young healthy male adults aged between 25-30 years who were not exposed to AC work environment were selected as control group. Pulmonary function tests of these two groups were assessed by using computerized Spirometer and compared. Anthropometrical measurements Age, Height and Weight were recorded for predicted values of pulmonary function tests along with preliminary clinical examination to exclude any systemic disorder affecting respiratory system.

### *Exclusion criteria*

- 1) Smokers and/or alcoholic.
- 2) Presence of any acute or chronic respiratory disorder.
- 3) Systemic illness which directly or indirectly affects the respiratory system.
- 4) Those who are doing yoga or any other kind of regular exercise.

Spirometer used was RMS Helios 401 computerized spirometer, has a turbine sensor and works on the infrared interruption principle made by Recorder & Medicare System (RMS). The questionnaires and consent forms were filled

up and the relevant data name, age, sex, height, weight, occupation, smoker or non-smoker, lab temperature was entered into the computer. All the subjects were made familiar with the instrument and procedure for performing pulmonary function tests. All the tests were done on the subjects with seated comfortably in an upright position. The subject was connected to the mouthpiece and was asked to breathe in order to familiarize himself with the equipment. During the tests the subject was adequately encouraged to perform at their optimum level. Nose clip was applied during the entire manoeuvre. Test manoeuvre was repeated for 3 times and the best matching result were considered for analysis. All Parameters were measured by the machine. The algorithms used for calculation was validated for Indian population with the new software added up to the machine.

Following parameters were selected for study.

- 1) PEFR: Peak Expiratory Flow Rate in per second (L/s).
- 2) FEF 25-75: Mean Forced Expiratory Flow during the middle of the FVC in L/s
- 3) FEF 25%: Forced Expiratory Flow after 25% of the FVC has been expired in L/s

- 4) FEF 50%: Forced Expiratory Flow after 50% of the FVC has been expired in L/s
- 5) FEF 75%: Forced Expiratory Flow after 75% of the FVC has been expired in L/s

### Statistical analysis

The outcome of pulmonary function tests were presented as a mean  $\pm$  SD for each of the parameter. The two groups were compared by applying unpaired 't' test and p value of less than 0.05 (\*p<0.05) was considered as significant.

### RESULTS AND OBSERVATIONS

Table No. 1 depicts the anthropometric characteristics of the study which were expressed as mean  $\pm$  SD for both the groups. The mean age (Yrs.) of the subject was  $27.87 \pm 1.22$  and that of control was  $28.33 \pm 0.71$ . The mean height (cms) of the subject was  $171.20 \pm 4.16$  and that of control was  $170.27 \pm 5.97$ . The mean weight (kg) of the subject was  $68.03 \pm 4.13$  and that of control was  $70.03 \pm 4.18$ . There was no significant difference found between the subject and control groups on these parameters indicating that the groups were homogenous in this respect.

**TABLE 1 : Statistical analysis of Anthropometric parameters.**

PARAMETERS	GROUP I AC Users Mean $\pm$ SD n = 30	GROUP II Non AC Users Mean $\pm$ SD n = 30	t value	p value
Age (years)	$27.87 \pm 1.22$	$28.33 \pm 0.71$	1.8053	> 0.05
Height (cms)	$171.20 \pm 4.16$	$170.27 \pm 5.97$	0.7032	> 0.05
Weight (kg)	$68.03 \pm 4.13$	$70.03 \pm 4.18$	1.8637	> 0.05

\*P<0.05

Table No 2 depicts the characteristics of pulmonary function test

parameters of the study which were expressed as mean  $\pm$  SD for both the groups.

The Mean  $\pm$  SD for PEFR were observed to be  $7.6020 \pm 1.3363$  L/s in subject and  $9.4900 \pm 0.2926$  L/s in control. The Mean  $\pm$  SD for FEF 25-75 were observed to be  $3.5833 \pm 0.7627$  L/s in subject and  $4.5780 \pm 0.2328$  L/s in control. The Mean  $\pm$  SD for FEF 25% were observed to be  $6.7603 \pm 1.6156$  L/s in subject and  $9.2273 \pm 0.2418$  L/s in control. The Mean  $\pm$  SD for FEF 50%

were observed to be  $4.3560 \pm 1.0349$  L/s in subject and  $5.3077 \pm 0.1864$  L/s in control. The Mean  $\pm$  SD for FEF 75% were observed to be  $1.9060 \pm 0.1050$  L/s in subject and  $2.2583 \pm 0.1600$  L/s in control. Values of all the parameters were less in AC users (Subject group) than non AC users (Control group) and difference was statistically significant (p value < 0.05).

**TABLE 2: Statistical analysis of PEFR, FEF 25-75, FEF 25%, FEF 50%, and FEF 75%.**

PARAMETERS	GROUP I AC Users Mean $\pm$ SD n = 30	GROUP II Non AC Users Mean $\pm$ SD n = 30	't' value	P value
PEFR	$7.6020 \pm 1.3363$	$9.4900 \pm 0.2926$	7.5595	< 0.05 *
FEF 25 - 75	$3.5833 \pm 0.7627$	$4.5780 \pm 0.2328$	6.8323	< 0.05 *
FEF 25 %	$6.7603 \pm 1.6156$	$9.2273 \pm 0.2418$	8.2718	< 0.05 *
FEF 50 %	$4.3560 \pm 1.0349$	$5.3077 \pm 0.1864$	4.9568	< 0.05 *
FEF 75 %	$1.9060 \pm 0.1050$	$2.2583 \pm 0.1600$	10.0847	< 0.05 *

\*P<0.05

In present study PEFR and FEF 25-75, FEF 25%, FEF 50%, FEF 75% were significantly decreased in subjects exposed to AC work environment. These findings suggest that the airways are getting affected due to exposure to AC work environment for the duration, prescribed in the study.

## DISCUSSION

Modern living in urban areas is potentially responsible for development of various disorders and use of AC is a part of it. Tough competition between professional settings forces young adults to work for hours in central AC environment. Present study has shown that working in air conditioner environment causes impairment in respiratory functions which may lead to serious complications in future. The present study findings were supported by the studies conducted in various populations by Farah K. S. et al, [13] and R. Babitha et al. [14]

Spirometry is a simple and useful test to identify and monitor respiratory impairment. With the proper equipment and the correct technique, maximal results can be obtained. [15] PEFR is the convenient method for monitoring airflow obstruction in patients with bronchial asthma recommended in international guidelines for asthma management. [16] Therefore we planned to perform pulmonary function tests to find out effect of AC work environment on respiratory system.

PEFR is the maximum velocity with which air is forced out of the lung. PEFR depends on expiratory efforts exerted during forceful expiration as well as status of upper airways which are subjected to reflex bronchoconstriction. [17] In asthmatic subjects bronchoconstriction has been reported due to hyperventilation of cold dry air. [18] In present study PEFR was significantly decreased in subjects exposed to AC work environment. This finding

suggests that the upper airways are being affected due to exposure to AC environment for the duration, prescribed in the study.

FEF 25-75 represents the flow rate over the middle half of FVC and it is effort independent flow rate. FEF 25% is the flow rate at the 25% of the total FVC, indicative of the condition of medium sized bronchi. FEF 50% is the flow rate at the 50% of the total FVC, indicates the status of medium to small airways. FEF 75% is the flow rate at the 75% of the total FVC, indicates the status of small airways. More specifically FEF25-75 has been recommended to identify small airway impairment. [19] Small airways obstruction plays an important role in asthma and abnormalities of small airways function precede the abnormalities of the large airways function in future. [20] In the present study the values of FEF 25-75, FEF 25%, FEF 50%, and FEF 75% were significantly decreased in AC users suggesting that small airways are influenced by exposure to AC work environment for the duration, prescribed in the study.

Nasal inhalation of cold dry air causes activation of cold receptors or osmoreceptors in the nasal mucosa and activation of these receptors induces protective bronchoconstrictor responses. [1] Cold and dry air causes the release of inflammatory mediators possibly associated with mast cells and causes bronchospasm. [21] Nasal cold air provocation causes mast cell activation and sensory nerve stimulation. [22] Histamine released by the mast cells causes bronchospasm, increases airway resistance and decreases dynamic compliance. [23] Respiratory tract of the subject exposed to AC work environment is hyperresponsive and the patency of the airways is decreased. [14] Therefore probable reason for the findings of the present study is hyperresponsive airways, inflammation and mast cell activation due to cold injury which

leads to bronchoconstriction and decreases dynamic compliance.

There is a positive relationship between small airway disease, defined by a reduction in FEF25-75 and allergic parameters such as eosinophils. [24] Urban styles of living are involved in atopic sensitization and enhanced eosinophil activity, probably due to living conditions such as indoor dampness and poor home ventilation caused by tight insulation. This increases exposure to indoor air pollutants, such as respirable mite allergens. [7] Tight insulation is always required to maintain proper temperature and humidity in AC rooms so this may be the additional risk factor for development of allergic disorders in future along with the reduced FEF 25-75.

Further detailed studies are required on a large scale for which we are planning to considering more parameters as various duration of exposure to AC, velocity of cold air of AC, humidity of the environment, level of allergy markers as to obtain more precise correlation between use of AC and extent of its effect on respiratory system.

## CONCLUSION

Present study suggests that upper airways as well as smaller airways are getting affected by exposure to AC work environment for the duration, prescribed in the study. Probable cause is cold injury to respiratory passage causing inflammation and activation of the mast cells along with the nervous stimulation by cold and dry air. All of these responses may be causing hyperresponsive airways, bronchoconstriction and reduces dynamic compliance. Working in AC environment is also risk factor for the development of allergic disorders. We suggest frequent spirometry of the workers who work in AC environment. This will ensure early detection of any underlying respiratory dysfunction, its treatment and

prevention of complications arising later in life.

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