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EVALUATION OF PULMONARY FUNCTIONS INCLUSIVE OF SPECIFIC AIRWAY CONDUCTANCE IN INDIVIDUALS WORKING IN AIR CONDITIONED ENVIRONMENT

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ABSTRACT

Background: Numerous studies have shown that breathing of cold dry air causes bronchospasm. But not many studies have been done regarding effect of daily exposure to air conditioners on respiratory system. So an attempt has been made to study the pulmonary function in information technology employees working in air conditioned environment.

Aim: To study the effect of regular exposure of air conditioners, on pulmonary function tests including specific airway conductance.

Materials and methods: The study group comprised of 35 healthy, male information technology employees working in air conditioned environment and 35 age, sex, BMI matched controls. Pulmonary function tests were done using MEC PFT- body box 100 system. FEV_1 (forced expiratory volume in first second), FVC (forced vital capacity), FEV_1/FVC, PEFR (peak expiratory flow rate), FEF_{25-75} (forced expiratory flow rate between 25-75% of FVC) were measured using MEC PFT and sGAW (specific airway conductance) was measured using body plethysmography.

Statistical analysis: ANOVA, Mann Whitney U, Student t test (two tailed, independent), Student t test (two tailed, dependent).

Results and conclusion: FEV_1, FVC, FEV_1/FVC, PEFR, FEF_{25-75}, and sGAW were reduced significantly (p value < 0.001) in information technology employees when compared to the controls. The decrease in sGAW, which is a specific measure for bronchomotor tone, gives definite evidence of airway obstruction in individuals exposed to air conditioners.

Key words: air conditioners; bronchoconstriction; cold dry air; pulmonary function test, specific airway conductance.

INTRODUCTION

In modern day lifestyle, air conditioners have become one of the most essential commodities. The reduction in humidity of air being cooled is due to the condensation of water vapors, [1]. Thus air conditioners provide cold, dry air to the surroundings. Previous studies have shown breathing of cold dry air causes bronchospasm, respiratory tract infection, existence of nasopulmonary reflex, [2, 3, 4].

So there is a necessity to measure lung function tests in individuals exposed to air-conditioners. Specific airway conductance is a better indicator of bronchomotor tone, [5]. It would give a better measure of the obstruction caused by cold dry air.

In this study, we aim to analyze the effect of regular usage of air-conditioners on pulmonary function parameters, especially specific airway conductance.

MATERIALS AND METHODS

35 healthy, male information technology employees working in air conditioned environments for duration of 6months to 5 years, in the age group of 18-40 years, were included as cases. 35 age, sex and BMI (body mass index) matched controls, who were not exposed to regular air-conditioned environments were chosen as controls. Individuals with history of smoking, respiratory tract infection, recent history of usage of mast cell stabilizers, history of tuberculosis, diabetes, asthma, chest wall deformities, those having claustrophobia were excluded.

Written informed consent was obtained. General examination was carried out. Anthropometric measurements including age, height, weight were recorded. Preliminary clinical examination was carried out to rule out any medical problems.

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RECORDING OF PFT

Instrument: MEC PFT body box 100 (medical electronic construction, Brussels, Belgium) was used. It contains Spiro module (pocket Spiro) and body plethysmography module.

PFT measurements included FEV_1 (forced expiratory volume in first second), FVC (forced vital capacity), FEV_1/FVC, PEFR (peak expiratory flow rate), FEF_{25-75} (forced expiratory flow rate between 25-75% of forced vital capacity) and sGAW (specific airway conductance). Pulmonary function tests were recorded in the morning between 8 AM to 9 AM. Procedure was explained and subjects were made to sit in the body box and they were made comfortable and familiarized with the procedure. Nose clip was applied. Forced spirometry was performed in MEC PFT system with door open. Total of 3 recordings were taken at an interval of 5 minutes. Best of the 3 recordings was selected.

After 15 minutes of rest, subjects were made to perform panting maneuver, [6] in body plethysmography with door closed, to measure specific airway conductance. Minimum of 3 recordings were taken at the interval of 5 minutes and best of the 3 was selected.

STATISTICAL ANALYSIS

Statistical software**:** The statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1,MedCalc 9.0.1 and Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate tables.

Descriptive statistical analysis was carried out. Results are presented in Mean $\pm$ SD (Min-Max). Results on categorical measurements are presented in number (%)**.** Assessment of significance is at 5%. Statistical tests used are ANOVA, Mann Whitney U, Student t test (two tailed, independent), Student t test (two tailed, dependent).

RESULTS

Current study was undertaken to analyze the effect of regular usage of air conditioners on lung functions. FVC, FEV_1, FEV_1/FVC, PEFR, FEF_{25-75} and sGAW of cases and controls were recorded and compared.

Table I: Anthropometric parameters in cases (air conditioner user) and controls

Anthropometric Variables	Controls	Cases (AC User)	P Value
Age in years	25.77±1.57	25.97±1.61	0.60
Height in cm	172.11±6.51	172.45±6.86	0.83
Weight in Kg	70.17±5.18	69.51±3.89	0.55
BMI (Kg/m2)	23.77±2.44	23.44±1.78	0.52

Table 1 shows the comparison of anthropometric parameters of all the subjects in two groups. The two groups did not differ in age, height, weight and BMI and were well matched with respect to the mean of the above parameters.

Table II: Comparison of Pulmonary Function tests in cases and controls.

Pulmonary Function Test	Controls	Cases (AC user)	t value	P value
FVC(Liters)	4.56±0.44	3.65±0.51	10.5561	<0.001**
FEV_1(liters)	3.81±0.41	2.78±0.4	15.2339	<0.001**
FEV_1/FVC	0.83±0.04	0.76±0.06	6.902	<0.001**
PEFR(l/s)	9.04±0.85	7±1.63	7.4041	<0.001**
FEF_{25-75}(l/s)	4.52±0.23	3.56±0.9	6.3104	<0.001**
SGAW(l/kPa/s)	1.42±0.14	0.99±0.31	8.2061	<0.001**

*P- value< 0.01 is considered significant

Table 2 shows comparison of mean values of pulmonary function tests in both groups. It can be seen that in cases (air conditioner users) FEV_1, FVC, FEV_1/FVC, PEFR, FEF_{25-75}, and sGAW are reduced significantly (p value < 0.001) when compared to the controls. Information Technology employees working in air conditioned environment showed significant decline in pulmonary function tests.

DISCUSSION

In the era of affluence, usage of air conditioners has immensely increased. Especially in information technology industry, air conditioners have become mandatory to continuously maintain low temperatures

for optimum functioning of computers. There by employees working there are constantly exposed to cold dry air. Previous studies have emphasized that repeated exposure to cold dry air leads to respiratory dysfunction. So, the present study was undertaken to evaluate the effect of air conditioners on pulmonary functions.

The results of the present study showed that employees working in air conditioned environment had significant decline in FEV_1, FVC, FEV_1/FVC, PEFR, FEF_{25-75}, and sGAW when compared to controls. Hence they seem to be more predisposed to respiratory dysfunction.

Fontanari et al showed existence of naso pulmonary bronchoconstriction reflex to cold dry air in healthy individuals under realistic circumstances of eupneic inhalation of moderately cold air, [3]. Heaton et al showed reduction in FEV_1 and sGAW on exposure to cold air challenge test, [7].

This study was in agreement with the study conducted by Babitha R et al, which showed that occupational exposure to air conditioners lead to significant reduction in FEV_1, $FEF_{25-75\%}$, PEFR, [8]. It also correlates with the study done by Khaliq F et al, which showed that AC users had mild airflow obstruction, [1]. Jammers Y et al, showed one year occupational exposure to cold environment leads to modest but significant airflow limitation, airway hyper-responsiveness effects beginning within 6 months of exposure, [9]

Reduction in FEV_1, FVC and $FEV1_/FVC$ in employees exposed to air conditioners shows that there is generalized airway obstruction. Reduction in $FEF_{25-75\%}$ shows that small airways are also affected. Reduction in PEFR is a sign of airway obstruction. Reduction in sGAW shows that there is increased bronchomotor tone.

The measurement of specific airway conductance shows that there is increase in bronchomotor tone in subjects exposed to air conditioners. There have been no past studies to compare this particular finding. This measure is much more specific than other pulmonary function parameters. So this may be taken as comprehensive evidence that there is a high probability of airway obstruction in these individuals.

Several pathophysiological mechanisms have been proposed for this. When cold dry air is inhaled, there is a reflex bronchospasm which acts as a protective mechanism to reduce airflow rate in upper airways. It also increases the secretion of cervical mucosa, thereby limiting the penetration of insufficiently conditioned inspired air into the lungs, [3,4] .Cold dry air enhances the reactivity of smooth muscles, which elevates the contractile response to vagally mediated reflex including that induced by stimulation of cold receptors in the lungs, [4].

Nasal cold air breathing increases the number of epithelial cells, granulocytes in nasal lavage fluid, [10,11] and hence induces airway inflammation. This leads to increased airway exudates, airway wall thickening and increased smooth muscle tone. It also results in remodeling of airway mucosa leading to changes in airway wall structure and function, [12,13].

Repeated dry air challenge tests have shown eosinophilic inflammation, airway wall thickening, goblet cell hyperplasia, squamous metaplasia, [14]. Nasal cold air challenge tests have shown vagally mediated bronchoconstriction, [15].

Cold dry air increases airway resistance due to contraction of airway smooth muscles, increased mucus production, loss of ciliated epithelium, increased muco-ciliary clearance, hyper responsiveness and airway obstruction. It also causes vascular congestion, epithelial damage and vascular leakage, [10, 11, 12, 16]. All these result in reduction in pulmonary functions. Limitation of this study is the small sample size. Reversibility of the pulmonary functions with bronchodilator was not tested.

CONCLUSIONS

Present study showed, occupational daily exposure to air conditioners leads to significant decline in pulmonary function test parameters like FEV_1, FVC, FEV_1/FVC, PEFR and FEF_{25-75} compared to controls. The decrease in sGAW, which is a specific measure for bronchomotor tone, gives definite evidence of airway obstructions in individuals exposed to air conditioners. To reduce the damage created by air-conditioners, awareness should be created and remedies like providing humidifiers for individuals exposed for longer duration can be done.

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