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Effect of Air Conditioner on Pulmonary Function Tests of Healthy Males in India

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Abstract

Aim of our present study was to evaluate the effect of AC on pulmonary functions in healthy persons who routinely use AC, like bank employees and compare them with normal healthy volunteers who do not use AC. A comparative study covering a total of 100 subjects divided into two groups (Group-A and Group-B). Group-A (Cases) consisted of 50 healthy male subjects exposed to air conditioner in their work place namely Bank offices for a period of 7to 8 hr for 5 days a week over a period of two consecutive years. Group-B (Controls) consisted of male subjects working in the Higher Education Department who were not exposed to air conditioner during their work for last two years. In the present study, there is a significant difference between Group A and Group B with respect to FVC as p= 0.0001. Also, there is significant difference between Group A and Group B with respect to FEV_1 as p= 0.001. A significant difference was seen between Group A and Group B with respect to $FEF_{25-75\%}$ as p=0.0001. Exposure to air conditioner in bank employs leads to significant decrease in pulmonary functions as compared to non-air conditioner users. The inhalation of dry cold air causes both small and large airways obstructive lung disease, as is reflected by the decreased parameters like FVC, FEV_1, FEV_1/FVC ratio, $FEF_{25-75\%}$, PEFR and MVV.

Key words: Pulmonary function tests, FEV, FEF, FVC, MVV, PEFR.

INTRODUCTION

Air-Conditioners (AC's) are ubiquitous feature of today's urban homes and offices. They have become synonymous to comfort and luxury. These devices/systems are used to maintain indoor temperature at a comfortable level.[1] Although the prime purpose of air conditioning is to provide comfort during either hot or cold weather, it can have harmful effects on health besides being destructive to the environment.[2] Lungs function as a ventilator unit. Inhalation of cold dry air may affect the pulmonary functions.[3]

Pulmonary Function Tests (PFTs) are a valuable tool for evaluating the functional status of lungs. They include a battery of non-invasive tests, easily performed, require little time and can be readily set up in the field. These require little time and can be readily setup in the field. These tests provide objective, quantifiable data related to pulmonary function.[4]

Of the entire pulmonary function test measurements, FVC and FEV_1 are considered primary measurements of pulmonary functions and are used most commonly to determine the pattern of lung function abnormality and based on the findings, the pattern of pulmonary function in a subject can be one of the following patterns:

A normal result is indicated by: FVC value more than 80% and FEV_1/FVC >75% of predicted value. In case of restrictive respiratory disorder, FVC is less than 80% and FEV1/FVC ratio is greater than >75% of predicted value. An obstructive disorder is indicated by FVC >80% and FEV1/FVC <75% of predicted.[4,5]

The present study is conceived in Jammu city to evaluate the effect of AC on pulmonary functions in healthy persons who routinely use AC, like bank employees and compare them with normal healthy volunteers who do not use AC.

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MATERIALS AND METHODS

The present study was undertaken in Postgraduate Department of Physiology Government Medical College Jammu over a period of ten days to assess the effect of use of air conditioner on the bank employees and to compare them with the clerical staff of Higher Education Department of Jammu city. It was a comparative study covering a total of 100 subjects divided into two groups (Group-A and Group-B).

Group-A (Cases) consisted of 50 healthy male subjects exposed to air conditioner in their work place namely Bank offices for a period of 7 to 8 hr for 5 days a week over a period of two consecutive years.

Group-B (Controls) consisted of male subjects working in the Higher Education Department who were not exposed to air conditioner during their work for last two years. They too were selected by following the same approach as for group A. Their age, weight, and height was matched with cases of group A.

A preliminary survey was conducted and a list of Bank employees working in various Bank branches in the vicinity of Government Medical College Jammu was prepared. After seeking permission from the concerned authorities and detailing the purpose and methodology of the project, the eligible subjects were elected. A detailed history was taken and thorough examination was carried out. The subjects who fulfilled the eligible criteria were requested for participation and those who obliged were enrolled for the study.

Inclusion Criteria

1. Healthy subjects.
2. Willingness to participate.
3. Non-Smokers
4. History of Exposure for six months during last two consecutive years

Exclusion Criteria

1. Subjects who had history of acute or chronic respiratory illness such as running nose, watering of eyes cough bronchial asthma tuberculosis etc.
2. Any cardiac disease.
3. Subjects who had past history of neuro muscular diseases, with gross clinical abnormalities.
4. Any major defect in thoracic cage or vertebral column such as rib fracture Potts spine, and scoliosis.
5. History of smoking.
6. Non-Cooperative subjects

On a particular day 10-15 subjects were catered and anthropometric and pulmonary function tests were performed on both cases and control groups.

Data Collection

Anthropometric and other physical measurements

The physical parameters noted for each subject

Age (years), Weight (kg), Height, Body surface area (BSA), Respiratory Rate, Pulse rate and Blood Pressure (Table 1).

Pulmonary Function Tests

Pulmonary function tests of each subject were performed at one time by the investigator with the help of portable computerised digital spirometer DT- Spiro (Maestros Medline System Ltd., Himachal Pradesh, India.) available in research laboratory of Postgraduate Department of Physiology that confirms both to European safety standards and the latest American Thoracic Society (ATS) classification. All the parameters were recorded.

A nose clip was used where needed to direct all expired air into spirometer. These tests were done in sitting position for all subjects so as to standardize the procedure. The trials were conducted with sufficient time between each test so that the subject was comfortable and has no feeling of dizziness. Three readings were taken at the same time of the day and best one was considered. The PFT readings of the subject were considered acceptable only after they met the acceptability criteria laid down by Miller *et al.,* 2005.[5]

DT-Spiro is a computerised portable spirometer designed for performing pulmonary functions. This instrument has an electromechanical pneumotach transducer as its basic component. The in-built thermal printer permits one or more printouts containing patient's information, i.e. actual, predicted and percentage values on all parameters.

A backlit LCD screen displays the same in real time standard accessories.

Only two manures i.e. FVC and MVV were required to accumulate all the necessary data. After all the tests have been performed, the computer stored and calculated all the necessary flow and volume data and plots then in graph form.

Pulmonary Function Parameters

DT-Spiro was used to calculate the following

Forced Vital Capacity (FVC), Force expiratory volume in half second ($FEV_{0.5}$), Forced expiratory volume in 1 sec (FEV_1), Forced expiratory volume in 3 sec (FEV_3), Peak Expiratory flow Rate (PEFR), Mean forced expiratory flow rate from 0.2 to 1.2 litres of volume change ($FEF_{0.2\text{-}1.2}$), Mean forced expiratory flow during the middle half of FVC ($FEF_{25\text{-}75\%}$), Forced expiratory flow 25% ($FEF_{25\%}$), Forced expiratory flow 50% ($FEF_{50\%}$), Forced expiratory flow 75% ($FEF_{75\%}$), $FEV_{0.5}$/FVC, FEV_1/FVC, FEV_3/FVC, Maximum voluntary ventilation (MVV).

Table 1: Comparison of basic parameters (Age, Weight, Height, BSA) between AC users (Group A) and non-AC users (Group B).

Parameter	Group A			Group B			*P* Value
	N	Mean	SD	N	Mean	SD	
Age(yrs)	50	41.20	9.55	50	39.02	6.44	0.19*
Weight(Kg's)	50	72.70	9.46	50	71.42	8.40	0.44*
Height (cm's)	50	171.6	6.94	50	172.2	5.69	0.61*
BSA(Sq.m^2)	50	1.85	0.14	50	1.84	0.12	0.70*

*Insignificant.

Table 2: Comparison of mean FVC between AC users (Group A) and non-AC users (Group B).

Parameter	Group A			Group B			Statistical Inference	
	N	Mean	SD	N	Mean	SD	*t* value	*P* value
FVC (litres)	50	3.38	0.64	50	4.52	0.58	9.33	0.0001***

***Highly Significant

Table 3: Comparison of mean FEV_1/FVC between AC users (Group A) and non AC users (Group B).

Parameter	Group A			Group B			Statistical Inference	
	N	Mean	SD	N	Mean	SD	*t* value	*P* value
FEV_1/FVC%	50	77.52	15.97	50	90.97	6.56	5.51	0.0001***

***Highly Significant

Table 4: Comparison of mean $FEF_{25-75\%}$ between AC users (Group A) and non-AC users (Group B).

Parameter	Group A			Group B			Statistical Inference	
	N	Mean	SD	N	Mean	SD	*t* value	*P* value
$FEF_{25-75\%}$ (lit/sec)	50	5.48	1.47	50	6.60	1.16	4.26	0.0001***

***Highly Significant

Table 5: Comparison of mean MVV between AC users (Group A) and non AC users (Group B).

Parameter	Group A			Group B			Statistical Inference	
	N	Mean	SD	N	Mean	SD	*t* value	*P* value
MVV (lit/min)	50	100.20	24.02	50	110.09	23.29	2.09	0.039**

**Significant

Table 6: Comparison of mean PEFR between AC users (Group A) and non AC users (Group B).

Parameter	Group A			Group B			Statistical Inference	
	N	Mean	SD	N	Mean	SD	*t* value	*P* value
PEFR(lit/sec)	50	7.62	2.20	50	8.68	1.90	2.57	0.012**

**Significant

RESULTS

A total of 100 subjects were chosen for the study after fulfilling the inclusion and exclusion criteria. Group A consisted of 50 bank employees working in an air conditioned environment for a minimum of two years while Group B the consisted of 50 clerical staff of Higher Education Department working in a non-air conditioned environment.

Table 2 shows that there is significant difference between Group A and Group B with respect to FVC as p= 0.0001. So non air conditioner user Group B have significantly higher FVC as compared to air conditioner user Group A.

Table 3 shows that there is significant difference between Group A and Group B with respect to FEV_1 as p= 0.001.So non-air conditioner user Group B have significantly higher FEV_1/FVC as compared to air conditioner user Group A.

Table 4 shows that there is significant difference between Group A and Group B with respect to $FEF_{25-75\%}$ as p=0.0001.So non air conditioner user Group B have significantly higher $FEF_{25-75\%}$ as compared to air conditioner user Group A.

Table 5 shows that there is significant difference between Group A and Group B with respect to MVV as p=0.039.So non-air conditioner user Group B have significantly higher FVC as compared to air conditioner user Group A.

Table 6 shows that there is significant difference between Group A and Group B with respect to PEFR as p= 0.012.So non air conditioner user Group B have significantly higher PEFR as compared to air conditioner user Group A.

DISCUSSION

Present study was undertaken with an aim to evaluate the effect of air conditioned environment on lung functioning by using spirometric tests.

It was carried out in the research lab of the Postgraduate Department of Physiology Government Medical College Jammu and the protocol consisted of bank employees working in air conditioned environment and clerical staff of Higher Education Department working in non-air conditioned environment in Jammu city.

In routine pulmonary function testing, it is important to minimize the variation caused by technical factors and to take biological variation into account, so that variation caused by disease can be properly interpreted (American Thoracic Society, 1970).[6]

In the present study, there was a significant decrease in the mean values of FVC in group A as compared to FVC of group B and the difference was statistically highly significant (p value =0.0001).

Vidya G *et al.* (2014) reported that FVC was significantly reduced in AC users as compared to non AC users; this was believed to be due to house dust, mites, and indoor air pollutants, elevation of serum IgE levels and/or enhancement of eosinophil activity.[7]

In the present study mean FEV_1/FVC of Group A was 77.52 ± 15.97and among Group B was 90.97 ± 5.56 and significant difference between Group A and Group B (p= 0.0001). So non air conditioner user Group B have significantly higher FEV_1/FVC as compared to air conditioner Group A.

Our results were in accordance with the observations of Lavanya M (2017) who reported a study on 66 subjects which were divided into two Groups viz Group A using AC and Group B not using AC. After performing their pulmonary function tests, it was reported that FEV_1/FVC was higher in non AC users as compared to AC users. In conclusion it was seen that non AC users have higher pulmonary function as compared AC users.[8]

However Sabade SB (2013) reported insignificant change in FEV_1/FVC in AC users. This finding could be attributed to the difference in the age of the subjects and the equipment used.[9]

In our study mean $FEF_{25-75\%}$ among Group A was 5.48 ± 1.47 litres/sec in comparison of Group B with mean $FEF_{25-75\%}$ 6.60 ± 1.16 litres/sec and there was significant difference between Group A and Group B (p=0.0001).

Our results are in agreement with Borse LJ *et al.* (2012) who suggested that exposure to air conditioned work environment is a risk factor for development of respiratory dysfunction and allergic disorders in future.[10]

However Vidya G (2014) did not find significant result of $FEF_{25-75\%}$ among AC users. This finding could be attributed to difference in age and gender of the subjects selected for the study.[7]

In the present study, mean MVV among Group A was 100.20 ± 24.02 litres/min and Group B was 110.09 ± 23.29 lit/min with significant difference (p=0.039).

Our findings are in agreement with those reported by Sabade SB *et al.* (2013). They observed that in AC users Maximum Voluntary Ventilation (MW) was significantly reduced (p< 0.05); while in the control group there was no such decrease in the pulmonary ventilation. The results of experimental group showed early small airway obstruction.[9]

Results of the current study and forgoing discussion has brought the outcome in unambiguous terms that air conditioner users have impaired pulmonary functions as compared to non-air conditioner users. This suggests that AC environment should be avoided and minimal exposure be allowed.

The extent of AC exposure to cause pulmonary function impairment was not within the preview of the current study. However, the current study does confirm that minimal 7-8 hr AC exposure daily for 5 days a week over two years lead to impairment of pulmonary functions.

In the present study mean PEFR among Group A was 7.62 ± 2.20 litres/sec and Group B was 8.68 ± 1.90 litres/sec, and the difference was statistically significant (p=0.012).

Our observations are in agreement with those of Goerge SO *et al.* (2012) who reported that there was a significant decrease in peak expiratory flow rate (PEFR) and a significant increase in the respiratory rate of those subjects working in AC environment as compared to subjects working in non AC environment.[11]

Farah K *et al.* (2016) reported that PEFR was significantly reduced in subjects using car AC's as compared to those not using AC. The result was suggestive of predisposition of car AC users towards respiratory disorders in the form of mild respiratory outflow restriction.[12]

SUMMARY AND CONCLUSION

Exposure to air conditioner in bank employs leads to significant decrease in pulmonary functions as compared to non-air conditioner users. The inhalation of dry cold air causes both small and large airways obstructive lung disease, as is reflected by the decreased parameters like FVC, FEV_1, FEV_1/FVC ratio, $FEF_{25-75\%}$, PEFR and MVV.

However, the decrease in FVC and MVV also indicates that the exposure to air conditioner may lead to restrictive pattern of lung disease. The airway patency and lung parenchyma affected due to prolonged exposure to air conditioner is responsible for alteration in the pulmonary function tests among air conditioner users.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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