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Effects of variation in air conditioner temperature on lung functions of air conditioner users

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Abstract

Background: As a result of increasing environmental temperature, use of air conditioner (AC) has become very popular specially in the urban areas mostly during hot months of the year. Regular exposure to cold, dry air of AC can cause various alterations in lung functions of AC users which can lead to many lung diseases in future. These alterations in lung functions can be influenced by AC temperature fixation. **Objective:** This study aimed to observe the effect of variation of AC temperature on lung function in apparently healthy adult subjects living in Dhaka city, Bangladesh. **Method**: This cross sectional study was conducted on 48 apparently healthy adult male and female subjects who were exposed to cold air discharged by air conditioner for at least 6 hours per day for minimum 5 days per week for the past 2 to 4 years. They were then divided into two groups based on setting temperature at which AC was regulated. Group A was consisted of 24 subjects (12 male and 12 female) who were exposed to AC temperature constantly regulated in between 18° C to 22°C. Group B consisted of 24 subjects (12 male and 12 female) who were exposed to AC temperature constantly regulated in between 23°C to 25°C. Forced vital capacity (FVC),forced expiratory volume in first second (FEV_1), and ratio of FEV_1/FVC were estimated in all subjects to assess lung functions using Minato Autospiro AS-507. Percentage (%) of predicted value of all parameter was used in data analysis. Statistical analysis was done by independent sample 't' test. **Results**: In this study mean percentage (%) of predicted value of FVC_1, FEV, and FEV_1/FVC were significantly lower in group A in comparison to group B. **Conclusion:** Regulation of AC at a lower temperature can lead to more reduction of lung function in AC users.

Key words: Air conditioner, AC temperature, FVC, FEV_1, FEV_1/FVC

Introduction

As modernization and industrialization goes hand by hand, more and more infrastructural and commercial development is taking place in urban areas. This leads to population migration to these areas. Population overgrowth results in environmental pollution and ultimately all these factors together contribute to a rise in environmental temperature.[1] These trends of increasing environmental temperature has made air conditioner very popular in the urban areas specially in the warmer months of the year as this device can cool the air by reducing it's humidity.[2]

People who work in AC regulated environment are regularly exposed to this cold, dry air discharged by air conditioner are at risk of deteriorated lung function. These altered functions may result from chronic bronchoconstriction caused by activation of nasal cold or osmoreceptors and parasympathetic nerve, release of inflammatory mediators from mast cell.[3-4] When they go outside, they have to face a sudden change in their surrounding environmental temperature. There are possible harmful consequences on respiratory system when air temperature drops quickly without any gradual adaptation even for changes as low as 2 to 3°C specially for changes greater than 5°C. Besides it takes 60% more energy to cool a space to 72% than to cool it to 78%.[2,5-6]

Many previous studies have shown significant alteration of some lung function parameters like FVC, FEV_1,FEV_1/FVC ratio in AC users which are crucial in detecting presence, absence or severity of lung diseases.[2,4] But it is almost impossible to completely stop use of AC in this twenty first century where environmental temperature is increasing day by day. A probable solution for the problem may be gathering knowledge about the range upto which AC temperature can be lowered without having any harmful consequence on lung functions. But with best of our knowledge, we have not found any study till the date reported on this issue. So, this study has been designed to evaluate the comparative effects of low and moderately low AC temperature on FEV_1, FVC,FEV_1/FVC of AC users. We hope this study will shade a new light on the issue of using AC and will create a public awareness in near future.

Methods

Study design and setting

This cross-sectional study was carried out in the department of Physiology, Dhaka medical college from a period of July 2018 to June 2019.

Study participants

For this study 48 apparently health adult individuals (including 24 male and 24 female) aged 18-44 years who were exposed to air conditioned environment for minimum 6 hours per day for at least 5 days per weeks for the past 2 to 4 years were selected.

Sampling

All subjects were enrolled by purposive sampling to this study. They were divided into two groups based on temperature at which AC was regulated. Group A consisted of 24 subjects (12 male and 12 female) who were exposed to AC temperature constantly regulated in between 18° C to 22°C. Group B consisted of 24 subjects (12 male and 12 female) who were exposed to AC temperature constantly regulated in between 23°C to 25°C. For group A subjects were selected from employees working in intensive care unit of a specialized hospital where AC temperature was constantly regulated in between 18°C to 22°C and for group B subjects were selected from employees working in pharmaceutical laboratory of Pharmacy department of a private university where AC temperature was constantly regulated in between 23 to 25°C.

Inclusion & exclusion criteria

All the subjects were nonsmoker, age ranging from 18 to 44 years, BMI ranging from 18.4 to

24.9 Kg/m^2. All of them were free from COPD, asthma, pneumonia, tuberculosis, pleural effusion, hypertension, DM as per history. Subjects having symptoms suggestive of any respiratory or cardiac diseases, history of taking drugs like beta blocker, diuretics, cardiac glycosides, personal history of consumption of tobacco, betel nut, regular physical exercise, pregnancy, lactation were excluded from the study.

Data collection

After selection of the subjects, nature, purpose and benefits of the study were explained to them and informed written consent was taken. Then the procedure of spirometry was explained to them and they were allowed to perform some demonstrations to assure the effective performance of the procedure. Spirometry was done between 9 am to 12 pm to avoid any possible diurnal variation using Minato Autospiro AS-507 with all the subjects comfortably seated in an upright position. It was performed following a standardized procedure adherent to American Thoracic Society (ATS) guideline[7] under direct supervision of the principal researcher and ATS acceptability and repeatability criteria were followed to accept the best results. Subjects were allowed to perform a minimum 3 and a maximum of 8 tests and the best value of FEV_1, FVC and FEV_1/FVCwas selected. All the data were collected and recorded by the principal researcher in a prefixed data collection form.

Statistical analysis

The percentage of predicted value of FVC, FEV_1, & actual value of FEV_1/FVC was expressed as mean±SD. Statistical analysis was done by unpaired Student's 't' test using computer based statistical program SPSS (Statistical Package for Social Science) version 25 and *p* value <0.05 was taken as level of significance.

Results

Baseline characteristics such as age, BMI, systolic and diastolic blood pressure showed no significant difference in male and female subjects of both groups (Table I and Table II). In this study, mean % of predicted value of FEV_1, FVC and FEV_1/FVC were found significantly lower in the group A in comparison to group B (Table III & IV) in case of both male and female.

Table I: General characteristics of male subjects in both groups

Parameters	Group A (n=12)	Group B (n=12)	P value
Age (years)	34.58±5.85	36.08±5.09	0.510
BMI (Kg/m^2)	23.24±1.00	22.72±2.00	0.424
SBP (mm/Hg)	110.42±5.82	109.17±10.19	0.716
DBP(mm/Hg)	78.33±3.89	75.42±6.56	0.199

Data shown as mean±SD. Independent sample 't' test was applied for statistical analysis. Group A- AC users who were exposed to 18 to 22°C AC temperature, Group B- AC users who were exposed to 23 to 25°C AC temperature, BMI= Body mass index, SBP= Systolic blood pressure, DBP= Diastolic blood pressure

Table II: General characteristics of female subjects in both groups

Parameters	Group A (n=12)	Group B (n=12)	P value
Age (years)	29.50±7.00	31.67±7.54	0.473
BMI (Kg/m^2)	23.19±1.89	22.33±1.79	0.265
SBP (mm/Hg)	106.25±8.56	107.50±6.22	0.686
DBP(mm/Hg)	74.58±4.98	72.92±6.20	0.476

Data shown as mean±SD. Group A- AC users who were exposed to 18 to 22°AC temperature, Group B - AC users who were exposed to 23 to 25°AC temperature, BMI= Body mass index, SBP= Systolic blood pressure, DBP= Diastolic blood pressure

Table III: FVC, FEV_1, FEV_1/FVC in male subjects of both groups(N=24)

Parameters	Group A (n=12)	Group B (n=12)	P value
FVC (% of predicted)	55.50±11.24	66.75±4.25	0.009
FEV_1(% of predicted)	52.50±7.17	66.33±9.20	0.001
FEV_1/FVC ratio	79.50±9.44	86.83±12.05	0.05

N = Total number of male subjects in both group. Data was expressed in mean±SD, For statistical analysis independent sample 't' test was used. Group A- AC users who were exposed to 18 to 22°C AC temperature, Group B- AC users who were exposed to 23 to 25°C AC temperature FVC=Forced Vital Capacity, FEV_1= Forced Expiratory Volume in 1st second

Table IV: FVC, FEV_1, FEV_1/FVC in female subjects of both groups (N=24)

Parameters	Group A (n-12)	Group B (n-12)	P value
FVC(% of predicted)	55.25±7.40	62.33±5.27	0.001
FEV_1(% of predicted)	52.75±7.17	64.00±7.95	0.001
FEV_1/FVC ratio	85.08±10.64	90.80±7.77	0.046

n= Total number of female subjects in both group,, Data was expressed in mean±SD, For statistical analysis unpaired Student's independent sample 't' test was used. Group A- AC users who were exposed to 18 to 22°C AC temperature, Group B- AC users who were exposed to 23to 25°C AC temperature FVC=Forced Vital Capacity, FEV_1= Forced Expiratory Volume in 1st second.

Discussion

Increasing use of air conditioner(AC) affecting lung functions now emerged as a new public health issue because of continuous exposure of airways to cold, dry air of AC or to be more specific from sudden temperature change. People working in airconditioned environment experience, a sudden change and without gradual adaptationlung function is negatively affected and ultimately develop various lung diseases.[5,6] This fact clearly indicates that the more the difference between indoor and outdoor air temperature the more could be the chance of harmful consequence on respiratory tract. So, the temperature at which AC is regulated should be considered as an important factor in evaluating the effects of AC use on lung function.

In this study, the comparative analysis of spirometric parameters FVC, FEV_1 & FEV1/FVC demonstrated greater attenuated pulmonary function variation in AC users exposed to low temperature for the same duration. This findings agree to some researches with similar observations irrespective of male and female.[2,8.]

These findings may be explained by increased evaporation of water from the airway mucosa on contact with cold, dry air that is inhaled by the AC users. It results in mucosal cooling and hyperosmolarity that can activate TRPM8 receptors (Transient receptor potential melastatin 8) and irritant receptors that line the airway mucosa. Both of these receptors can stimulate vagal parasympathetic fiber. Hyperosmolarity of airway mucosa can also activate the mast cells. Upon activation, mast cells release various inflammatory mediators like prostaglandin, leukotrienes, histamine etc. Vagal stimulation and mediators released from activated mast all both can cause bronchoconstriction. There may be also hypersecretion of mucus, microvascular leakage, airway hypersensitivity and airway thickening. All these factors may together contribute to alternation of lung functions either in a restrictive or obstructive pattern in AC users.[6,11-18.]

From the findings of this study, it is clearly evident that air conditioner induced artificial cooling & drying of the air can reduce the lung functions of AC users. But in the perspective of rising environmental temperature due to growing industries, motor vehicles, use of fuel and gas, it has really become difficult to live without AC. A unique aspect of this study was to find out the association between AC temperature and lung functions of AC users which alert the AC users about the impending health hazards & respiratory illness. From the result it was obvious that regulation of AC at a lower temperature was associated with more reduction of FVC, FEV_1, and FEV_1/FVC ratio in AC users. This finding clearly supports the fact that, we can minimize the negative impact of constant AC use on lung functions by not regulating it at a very low level. But till the date there is no universal cut off value for cold or low temperature has been fixed. Rather it is the magnitude of downward temperature change below the mean seasonal range for a given area at which the adaptive ability of people of that area is challenged.[6] Normal mean temperature of Dhaka, Bangladesh is 28.6°C, 27.5°C and 26°C during monsoon, pre-monsoon, post monsoon respectively.[1]

So when using AC during the warmer period of the year, we should not regulate it at a very low temperature to minimize the temperature difference between indoor and outdoor environment. Lung function tests should be a part of routine health checkup for those who remain exposed to airconditioned environment specially in work place for a long period of time where there is no scope for self control. This will help to find out any alteration in their lung functions at an early stage and prevent development of future lung diseases by taking timely interventions.

Conclusion

The results of this study concluded that attenuated lung functions in AC users may be related to the lower temperature at which AC is regulated.

Conflict of interest

The authors declare no conflict of interest

Ethical approval

This study was conducted after receiving ethical approval from research review committee and ethical review committee of Dhaka medical college, Dhaka, Bangladesh.

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