(RESEARCH ARTICLE)

Air conditioner users are more prone to airway obstruction: A cross sectional study done in Dhaka city, Bangladesh

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Abstract

Air conditioner (AC) has become very popular specially in the urban areas as a result of increasing environmental temperature. Exposure to cold, dry air of air conditioner may lead to various alternations in lung functions of the individuals who are regularly exposed to it which can lead to development of lung diseases in future. This cross-sectional study was conducted to observe the effects of air conditioner use on lung functions of apparently healthy adult male and female living in Dhaka city, Bangladesh. The study group consisted of 48 apparently healthy adult male and female who were exposed to air conditioner for at least 6 hours per day for minimum 5 days per week for the past 2 to 4 years and where temperature of the AC was constantly regulated in between 18° to 25°Celsius. The control group consisted of similar number of age, gender, BMI and socioeconomically matched subjects who did not use air conditioner nearly at all. Forced Vital Capacity (FVC) Forced Expiratory Volume in 1st second (FEV_1), Forced Expiratory ratio (FEV_1/FVC ratio) were estimated in both the study and control group using Minato Autospiro AS-507. Statistical analysis was done by unpaired Student's 't' test. In this study mean actual, percentage (%) of predicted value of FVC, FEV_1 and mean actual value of FEV_1/FVC ratio were significantly lower in the study group in comparison to the control group. Results of this study is suggestive of predisposition of AC users towards obstructive type of respiratory disorders.

Keywords: Air conditioner; FVC; FEV_1; FEV_1/FVC ratio

1. Introduction

Global warming has become a worldwide problem now a days as a consequence of increased industrialization and excessive pollution. Dhaka, the capital city of Bangladesh is also experiencing this problem of increasing environmental temperature because of increased infrastructural, commercial development and population overgrowth [1]. This trend of increasing temperature has made air conditioner (AC) very popular in urban areas like Dhaka city specially during warmer months of the year as the device can provide cool air by reducing its humidity and condensing the water vapour [2]. When people who work in air-conditioned environment for a long period of time go outside, they experience a sudden change in their surrounding environmental temperature which may have a direct impact on their body's adaptation system in long term [3].

Exposure to cold, dry air of AC on a regular basis, may lead to various alternations in lung functions of the AC users as a result of bronchoconstriction caused by activation of nasal cold or osmoreceptors and parasympathetic nerve, release of various inflammatory mediators from mast cell [4,5]. Use of AC may be also associated with exposure to various microorganisms, allergens and increase the chance of atopic sensitization [5].

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Significant alternation in some lung function parameters (FEV_1, FVC, FEV_1/FVC ratio) were found in air conditioner users when compared to non-users in studies done by some researchers [6,7] while other studies showed no significant change [5,8]. Some researchers showed that these alternations were more suggestive of predisposition of AC users towards developing obstructive lung disorders while others found it to be restrictive [6,8]. So because of these conflicting results, the effects of air conditioner use on lung functions still remain questionable.

Besides, gender wise comparison of lung function parameters was not done between the AC users and non-users in most of these studies and with best of our knowledge no such study has yet been done on Bangladeshi people.

So this present study was conducted to observe the effects of air conditioner use on lung functions in apparently healthy adult Bangladeshi male and female living in Dhaka city, Bangladesh. This study can help in increasing public awareness on this issue, detecting any alternation in lung functions of AC users at an early stage and taking timely intervention so that, development of future pulmonary diseases can be prevented.

2. Material and methods

This cross-sectional study was carried out after obtaining ethical clearance from research review committee and ethical review committee of Dhaka medical college, Dhaka. It was conducted in department of Physiology, Dhaka medical college from a period of July 2018 to June 2019. For this study 48 apparently health adult individuals (including 24 male and 24 female) who were exposed to air conditioned environment for minimum 6 hours per day for at least 5 days per week for the past 2 to 4 years and where temperature of the AC was constantly regulated at a range between 18 to 25 degree Celsius were taken as study group (group A). Similar number of age, gender, BMI and socioeconomically matched subjects who did not use AC nearly at all were taken as control group (group B). 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. After selection of the subjects, nature, purpose and benefits of the study were explained to the them and informed written consent was taken. After that procedure of spirometry was explained to them, they were allowed to perform some demonstrations to understand 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 [9] 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 FVC, FEV_1 and FEV_1/FVC ratio were selected. All the data were collected and recorded by the principal researcher in a prefixed data collection form. 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.

3. Results

In this study mean actual, % of predicted value of FVC, FEV_1, and mean actual value of FEV_1/FVC ratio were found to be significantly lower in the AC users in comparison to non-users in case of both male and female, predicted value showed no significant difference (table 3,4). Baseline characteristics such as age, BMI, systolic and diastolic blood pressure showed no significant difference in male and female subjects of both groups (table 1 and table 2).

Table 1 General characteristics of male subjects in both groups

Parameters	Group A (n=24)	Group B(n=26)	*p* value
Age (years)	37.36±8.56	37.54±7.62	0.713[ns]
BMI (Kg/m^2)	22.98±1.57	23.06±1.33	0.834[ns]
SBP (mm/Hg)	109.79±7.56	111.35±7.56	0.487[ns]
DBP (mm/Hg)	76.87±5.48	77.31±5.52	0.782[ns]

Data shown as mean±SD. Group A= AC users, Group B= AC non users,
BMI= Body mass index, SBP= Systolic blood pressure, DBP= Diastolic blood pressure

Table 2 General characteristics of female subjects in both groups

Parameters	Group A(n=24)	Group B(n=22)	*p* value
Age(years)	31.20±8.39	32.14±7.71	0.699[ns]
BMI(Kg/m^2)	22.76±1.85	22.94±1.36	0.713[ns]
SBP (mm/Hg)	106.87±7.34	110.23±7.63	0.136[ns]
DBP (mm/Hg)	73.75±5.57	75.91±5.03	0.176[ns]

Data shown as mean±SD. Group A= AC users, Group B= AC non users, BMI= Body mass index,
SBP= Systolic blood pressure,DBP=Diastolic blood pressure,ns=not significant

Table 3 Comparison of study parameters in male subjects of study and control group(n_1=50)

Parameters	Group A n_1A=24	Group B n_1B=26	*p* value
FVC			
Actual value(L)	2.54±0.53	3.12±0.35	<0.001***
Predicted value(L)	4.14±0.45	4.33±0.43	0.133[ns]
% Of predicted value	61.13±10.19	72.04±1.48	<0.001***
FEV$_1$			
Actual value(L)	2.01±0.43	2.87±0.32	<0.001***
Predicted value(L)	3.37±0.51	3.63±0.35	0.063[ns]
% of predicted value	59.42±10.76	79.46±5.40	<0.001***
FEV$_1$/FVC ratio			
Actual value	81.67±10.88	92±6.23	<0.001***

n_1= Total number of male subjects in both groups, n_1A= male in group A, n_1B= male in group B,
FVC=Forced Vital Capacity, FEV$_1$= Forced Expiratory Volume in 1st second, **/***=Significant

Table 4 Comparison of study parameters in female subjects of study and control group(n_2=46)

Parameters	Group A n_2A=24	Group B n_2B=22	*p* value
FVC			
Actual value(L)	1.79±0.35	2.34±0.28	<0.001***
Predicted value(L)	3.13±0.36	3.25±0.36	0.265[ns]
% of predicted value	57.29±8.16	72.05±1.46	<0.001***
FEV$_1$			
Actual value(L)	1.58±0.29	2.12±0.30	<0.001***
Predicted value(L)	2.65±0.38	2.82±0.33	0.114[ns]
% of predicted value	58.38±9.21	75.55±8.13	<0.001***
FEV$_1$/FVC ratio			
Actual value	88.79±9.35	90.32±8.78	<0.001***

n_2= Total number of female subjects in both groups, n_2A= female in group A, n_2B= female in group B,
FVC=Forced Vital Capacity, FEV$_1$= Forced Expiratory Volume in 1st second, **/***=Significant

4. Discussion

In this study FVC, FEV_1 and of FEV_1/FVC ratio were found to be significantly (p value<0.001) lower in the study group in comparison to the control group in case of both male and female. These findings are consistent to that of some researchers [3,10]. This finding may be explained by loss of heat and water from the airway mucosa on contact with cold, dry air that is inhaled by the AC users. Loss of heat and water result in mucosal cooling and hyperosmolarity that can activate TRPM8 receptors (Transient receptor potential melastatin 8) and irritant receptors lining the airway mucosa. Both of these receptors can stimulate vagal parasympathetic nerve. Hyperosmolarity of airway mucosa can also activate the mast cells. Stimulation of vagus nerve and the inflammatory mediators like prostaglandin, leukotrienes, histamine released from the activated mast cells can lead to bronchoconstriction. There may be also hypersecretion of mucus, microvascular leakage, airway hypersensitivity and airway thickening as a result of activation of vagus nerve and the mediators released from the mast cells. All these factors may together contribute to the bronchoconstriction and ultimately to airway obstruction in AC users [11-17].

There may be also growth of mite allergen in AC which can cause atopic sensitization mediated by immunoglobulin E. It also enhances eosinophil activity which then release eosinophil cationic protein that is a cytotoxic molecule. It injures bronchial epithelium and bronchial mucociliary apparatus. AC can also be contaminated with various fungus and actinomycetes such as *Alternaria, Penicillium* etc. Exposure to these contaminants can be another possible explanation for reduced lung functions observed in AC users [18,19]. These factors were not evaluated in this study.

On the other hand, no significant reduction in FEV_1, FVC and FEV_1/FVC ratio were found in AC users in comparison to nonusers in some studies [5,8]. The probable reason for the difference in the results may be the difference in the exposure time to AC, as increasing duration of exposure to air conditioner is associated with increased alternation in lung functions [20]. In the present study, subjects were exposed to AC for minimum 6 hours per day for at least 5 days per week for the past 2 to 4 years while in those studies the study subjects were exposed to AC for minimum 6 hours per day for at least the last 6 months and for at least 1 hour daily for the last 6 months [5,8].

Findings of this study clearly demonstrates that use of AC on a long term, can reduce lung functions of AC users. So the people who work in air conditioned environment should include lung function tests in their regular health checkup so that any alternation in lung functions can be detected at an early stage and development of lung diseases can be prevented by taking proper interventions.

5. Conclusion

Air conditioner use can cause significant alternation of lung functions in apparently healthy adult male and female which is more likely to be obstructive in nature as evidenced by significantly lower value of FEV_1/FVC ratio in AC users in comparison to that of non-users.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

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

Statement of informed consent

Informed written consent was obtained from all individual participants involved in the study.

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