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Original Article

Pulmonary function tests in air conditioner users

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ABSTRACT

Background: Modernization has been implicated in the pathogenesis of allergic airway diseases. House dust, mites, and indoor air pollutants have been reported to cause elevation of serum IgE levels and/or enhancement of eosinophil activity. A component of modern lifestyle is the intense use of air-conditioners (AC) that has increased the risk of atopic sensitization. **Aim:** To assess the effect of air conditioners on pulmonary function tests in healthy non-smokers. M**ethods:** The study included 100 subjects using AC and 100 subjects who were not using AC. After ethical committee approval, pulmonary function tests were done for both study groups by using Medspiror. The data obtained was tabulated and analyzed. **Results:** The lung functions particularly Forced vital capacity (FVC), and Forced expiratory volume in 1 second ($FEV_{1)}$, were affected more in AC users. FVC and FEV_1 were found to be significantly reduced and FEV_1/FVC was found to be normal. **Conclusion:** As FVC and FEVFEV_1 were found to be significantly reduced and FEV1/FVC was found to be normal, this is suggestive of predisposition of AC users towards restrictive type of respiratory disorders.

Key words: Air-conditioner, pulmonary function tests, smokers, allergy, Med-spiror

INTRODUCTION

Air-conditioners (AC) are devices/systems that are used indoors to cool air by reducing the humidity of the air following condensation of the water vapour. It is observed that hyperventilation of cold dry air causes bronchoconstriction in asthmatic patients.[1,2] Modern styles of living in urban areas are considered potentially responsible for the development of airway allergic diseases due to proliferation of house dust, mites, and increasing concentration of indoor air pollutants which lead to elevation of serum IgE levels or the enhancement ofoesinophilactivity.[3,4] One

of the components in modern lifestyle is intense use of air-conditioners (AC) which has increased the risk of atopic sensitization.[5,6] Increased prevalence of IgG induced sensitisation and hypersensitivity pneumonitis are reported in persons exposed to aerosols of contaminated AC.[7] Common complaints among ACusers include mucous membrane irritation, breathing difficulties, irritated skin and constitutional/neurological symptoms such as headache and fatigue.[8]

The present study was sought to evaluate the effect of AC exposure on pulmonary function tests in healthy non-smokers.

METHODOLOGY

The study included 100 subjects who were using AC (temperature was maintained constantly between 18 and 22^0C for at least 6-8 hours daily for the past 2 years, selected from the ICFAI Business School, Punjagutta, Hyderabad and Sagacia Soft Technologies, Somajiguda, Hyderabad, and 100 subjects who were not using AC. Subjects were between 18 and 45years. The study was approved by Ethical Committee of the institution, and informed consent was obtained from each subject.

Exclusion criteria included presence of any respiratory disorders, systemic illness that affects the respiratory system directly or indirectly, smoking, and the use of AC on an irregular basis.

Forced vital capacity (FVC), Forced expiratory volume in 1 second($FEV_{1)}$, andFEV_1/FVC were studied in the subjects using Medspiror.

Statistical analysis

Values are presented as mean ± SD for each of the parameter. Both groups were compared by using unpaired T- test. The *P*-value of less than 0.05 was considered significant. The data obtained were analyzed partly manually and partly computerized by using statistical software, Microsoft Excel and SPSS10 for windows to arrange the data statistically.

RESULTS

Study group contained 100 subjects (65 males and 35 females) using AC for at least 6 to 8 hours daily for the past 2 years between the age group of 18-45 years and control group contained 100 subjects (65 males and 35 females) who were not using AC at all between the same age groups were selected for the study. The pulmonary function tests (FVC, FEV_1, and FEV1/FVC) were conducted on the study and control groups.

Forced Vital Capacity (FVC)
The mean values for FVC in male subjects in study group were 2.73 and 3.41 in the control group. This was statistically significant (<0.001). The mean values for FVC in female subjects were 2.2 and 2.11 in controls. This was not statistically significant (>0.005).

Forced Expiratory Volume (FEV_1)
The mean values for FEV1 in male subjects were 2.49 and 2.71 in controls. This was statistically significant (<0.01). The mean values for FEV1 in female subjects were 1.99 and 1.86 in controls. This was not statistically significant (>0.05).

FEV1/FVC
The mean values for FEV1/FVC in male subjects were 90.8 and 85.7 in controls. This was not statistically significant (>0.05). The mean values for FEV1/FVC in female subjects were 87.5 and 87.5 in controls. This was not statistically significant (>0.05).

As FVC and FEV_1 were found to be significantly reduced and FEV_1/FVC was found to be normal, this is suggestive of restrictive type of respiratory disorders in AC users.

DISCUSSION

The results of the present study showed that AC users are predisposed to respiratory dysfunction. It was revealed that increasing the duration of ventilation from 2-3 minutes causes a significant fall in FEV_1.[8-10]The level of ventilation more than the dryness of temperature of the inspired air is reported to be the principal determinant of the magnitude of bronchoconstriction induced by cold dry air.[8]

A significantly lower FEV1 value is consistent with the previous studies done on children who lived in homes with hot water heating systems with no AC had mean FEV1 lower than their counter parts who lived in homes with air heating and air conditioning systems.[9] In their study, many

domestic factors were considered in addition to AC like use of gas stoves, heating devices, crowded homes, and smokers.[9]The frequency of observations of pairs of exposure variables showed that those with AC also had more electric stoves and lived in crowded homes.[9] These results must be biased due to these combinations of factors. In this study, only two factors were considered, the use of AC and smokers and no subjects was in the low socio-economic status. In the present study, FEV1/FVC values were not statistically significant. PEFR is also significantly reduced in subjects using AC. This finding is consistent with previous studies done by Khaliq *et al*.[10] in subjects using car AC.

Table 1: FVC in subjects and controls in both males and females

FVC					
AC users			Non-AC users		
	MEAN	SD	MEAN	SD	*P*-Value
MALES	2.73	0.46	3.41	0.46	Significant
FEMALES	2.2	0.51	2.11	0.28	Not significant

Table 2: FEV_1 in subjects and controls in both males and females

FEV_1					
AC users			Non-AC users		
	MEAN	SD	MEAN	SD	*P*-value
MALES	2.49	0.46	2.71	0.41	Significant
FEMALES	1.99	0.49	1.86	0.29	Not significant

Table3: FEV_1/FVC in subjects and controls in both males and females

FEV_1/FVC					
AC users			Non- AC users		
	MEAN	SD	MEAN	SD	*P*-value
MALES	90.8	4.2	85.7	5.57	Not Significant
FEMALES	87.5	6.89	87.5	6.96	Not significant

Table 4: Variable comparison the male subjects and controls

MALES				
	SE	T	*P*	RESULT
AGE	1.036	0.6	> 0.05	Not Significant
HEIGHT	1.2	0.95	> 0.05	Not Significant
WEIGHT	1.44	0.63	> 0.05	Not Significant
FVC	0.08	5.75	<0.001	Significant
FEV1	0.08	2.75	< 0.01	Significant
FEV1/FVC	0.9	0.66	> 0.05	Not Significant

Table 5: Variable comparison the female subjects and controls

FEMALES				
	SE	T	*P*	RESULT
AGE	1.04	1.2	> 0.05	Not Significant
HEIGHT	1.24	0.56	> 0.05	Not Significant
WEIGHT	1.34	1.71	>0.05	Not Significant
FVC	0.098	1	>0.05	Not Significant
FEV1	0.09	1.3	>0.05	Not Significant
FEV1/FVC	1.65	0	>0.05	Not Significant

Air conditioners in cars also have their problems, micro organisms have been formed with in the units that may cause breathing problems.[10,21] In order to study the effect of AC on pulmonary functions, only people working in software offices were selected as these people work constantly using AC for a minimum of 6-8hours in their offices. Also all the subjects were non smokers and none were suffering from upper respiratory tract infections; hence the results of this study cannot be related to these factors which influence the bronchial responsiveness. Repeated cooling and desiccation of peripheral airways can cause airway remodeling similar to that seen in asthma.[11]

Naturally ventilated building have fewer asymptomatic occupants than those from air conditioned offices despite measurements of air quality being better in air conditioned buildings.[12] The major factors controlled by air conditioning can have both positive and negative effects, the balance often been decided by post-design factors, particularly plant and system maintenance.[13] The main factors which have been studied include fresh air ventilation rates, temperature, humidity, dust and microbial content of the air.[13,14] There are studies showing relationship between ventilation rate and symptoms.[14] With air conditioned buildings, it is likely that low ventilation rates of less than 10, liters per second per person are associated with increased symptoms.[14]

Within a group of air conditioned buildings, there is a positive correlation between the number of fungal colony forming units and building sickness. Pickering *et al.* studied a building with a clean room, the room being positively pressurized and supplied with air from high grade filters.[15] The microbial load in the clean room was 125cfu/m^3 compared with 400cfu/m^3 for the area supplied by the standard air conditioning systems.[15] The total dust levels were also halved in the clean room.[15]

Studies of the relationship between ventilation types, sick building syndromes and sickness absence have been made in groups of workers employed by the same government department.[16] One group of workers moved from naturally ventilated offices to an air conditioned buildings, the other group moved in opposite direction.[16] Sickness absence was collected prospectively. The differences in sickness absence were small with 6 days per 100 workers per month. Less sickness absence in those working in naturally ventilated buildings.[16]

Sickness absence due to the sick building syndrome was also studied in the Dutch multi-building cross-sectional study.[17] In addition to this; many people have been made sick by extreme variances between outside and inside temperatures.[17] For example, going from an outside temperature of over 100^0F to an inside one of less than 78^0F is bound to play havoc with one's health.[17]

It takes 60% more energy to cool a home to 72% than it does to 78%.[18] In fact, as an energy saving measure, the United States government issued a directive in 1980 making it illegal to cool public buildings below 78%.[18] A study in the USA suggested that mite allergens detected in the dust samples are reduced by the use of air conditioners in summer because of their water drainage effects.[18] On the other hand, a Japanese study found that specific mite populations were significantly higher in homes with air conditioning.[19]

Post-operative fungal infections may be caused by discharge of spores from contaminated air conditioning units.[20] The filters of such units may act as a nidus for the growth of fungi according to the study done in 25 operating theatres in India over 2 years.[20] The overall rate of fungal colonization of the AC filters was 26%.[20] In addition window mounted AC units had higher fungal counts than wall mounted AC units.[20]

Thus AC does more to our environment than just lowering the temperature. It has a profound effect on the quality of air we breathe and on our respiratory system than just lowering the temperature. However, a long term project in a larger cross section of subjects using AC for varying duration, and evaluating parameters like height, weight, BMI, ambient temperature, air flow velocity of the air conditioned room, space to which the subjects are exposed during air conditioning, history of allergy, and correlating with the extent of impairment in pulmonary functions can be done.

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