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RESEARCH ARTICLE

A STUDY OF EFFECT OF DURATION OF AC EXPOSURE ON SPIROMETRIC PARAMETERS

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ABSTRACT

Life without machines is impossible nowadays, may it be Air conditioners (AC),vehicles or mobiles.ACs are being commonly used in homes and offices. AC causes air to become cold and dry. This can adversely affect the health of the AC users, particularly respiratory system. The present study was done to compare the spirometric parameters of AC users with non users and to study the effect of duration of AC exposure on spirometric parameters.100 healthy, non smokers of age 25 – 50 yrs exposed to AC were selected as study group. Controls were age and sex matched healthy, non smoker 100 adults, not exposed to AC. Exclusion criteria were smoking, respiratory disorders, sportsmen & those doing pranayam. Spirometry parameters recorded were FVC, FEV_1, FEV_1/FVC, $FEF_{25-75\%}$, $FEF_{25-75\%}$/FVC and PEFR. Statistical analysis was done by applying students unpaired t test, Mann Whitney test , Pearson's co relation and One way Annova tests.The PFT parameters, FEV_1, $FEF_{25-75\%}$ and $FEF_{25-75\%}$/FVC in AC users were significantly less than non AC users. There was no significant co relation between duration of AC exposure and spirometric parameters. The cool and dehumidified air of AC can cause increased airway resistance and changes in pulmonary function tests of AC users. AC users should be advised regular spirometry to prevent any complications.

INTRODUCTION

Machines are one of the biggest inventions of man. The electronic revolution has made life easier. ACs are not an exception to this. The cool and pleasant environment provided by ACs makes life comfortable and increase work efficiency at working places. ACs make the air cool and dry (Malcolm, 1997). This cool and dry air can affect health, particularly respiratory system as is being demonstrated by different animal and human studies. Research studies have shown that cold dry air inhalation causes protective nasopulmonary reflex. This causes broncho constriction and increases airway resistance (Caire, 1989 and Fontanari, 1996). Increased airway resistance hampers the air movement through the respiratory passages and affects respiration which is reflected as decreased spirometric parameters (especially FEV_1, PEFR, $FEF_{25-75\%}$). Long term use of ACs can lead to obstructive disease like pattern (Hulke, 2013). Until recent years ACs were only considered a boon of urbanization but as we are becoming familiar with their drawbacks and adverse effects on health, it has become necessary to study these. By research work we can find out the details of causation, factors affecting and ways of prevention of health hazards. In addition to this, asymptomatic cases can also be diagnosed. Hence the present study was undertaken in order to study the effect of duration of AC exposure on respiratory system.

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Aim and Objectives

- To compare spirometric parameters of AC users with non AC users
- To study the effect of duration of AC exposure on spirometric parameters
- To study and compare daily changes in peak expiratory flow rate (PEFR) in AC users and Non users.

MATERIAL AND METHODS

The study was approved by institutional ethics committee. 100 subjects, both male and female were selected, who were exposed to air conditioner for at least 6 hrs a day for minimum 1 year and 100 age, sex, BMI matched controls not exposed to AC.

Exclusion criteria were

- Age<25 and >50 years
- Smoking
- Sportsmen
- Obesity (BMI >29.9,waist circumference males>90 cm and females >85cm[5]),
- Respiratory disorders
- Those doing pranayam
- Persons with H/o major surgery

Informed consent was taken and a questionnaire was filled regarding the personal habits, past history, medications if any, duration of exposure to AC etc of the subjects. The spirometric parameters were measured using a computerized portable NDD Easyware spirometer which is automated and has a flow sensor and Wright's Peak flow meter. The tests were conducted according to the American Thoracic Society/ European Respiratory Society (ATS/ERS) task force guidelines.[6] The subjects were explained and demonstrated about the manoeuvres. For doing the tests they were comfortably seated and nose clip was applied. Tests were done before meals.The best of 3 readings was taken.

Following spirometric parameters were recorded

- Forced vital capacity (FVC) in litres.
- Force expiratory volume in one second (FEV_1) in litres.
- FEV_1/FVC in %.
- Forced expiratory fraction $_{25\text{-}75\%}$ in litre per second
- Peak expiratory flow rate (PEFR) in litre per second and

$FEF_{25\text{-}75\%}$/FVC ratio was also calculated. Statistical analysis was done using BMDS 2 (Boi medical data system) software. For the comparison of spirometric parameters between AC users and Non users, independent samples 't' test and Non-parametric test namely Mann-Whitney 'U' tests were done. For studying the effect of duration of AC exposure on pulmonary function tests the simple linear regression test was applied and Pearson's co-relation coefficient and p value was calculated. The acute effects of exposure to AC were studied by recording daily changes in PEFR by Wrights Peak flowmeter. The first reading was recorded one hour after arrival in AC then 2nd and 3rd readings after 3 and 6 hours respectively. Daily changes in PEFR were recorded in control group also. The daily changes in PEFR of both the groups were analysed by using One way Annova test and p value was found.

OBSERVATIONS AND RESULTS

Table 1. Comparison of demographic parameters between AC users and Non users

Parameter	AC users Male n=60 Mean±SD	Non AC users Male n=59 Mean±SD	p value	AC Female n=40 Mean±S.D	Non AC Female n=41 Mean±SD	p value	AC M+F n=100 Mean±SD	Non AC M+F n=100 Mean±SD	p value
Age(years)	33.5±5.33	33.61±7.95	>0.05	33.74±5.46	33.88±7.71	>0.05	33.59±5.35	33.56±7.78	>0.05
Sex	60	59	>0.05	40	41	>0.05	-	-	-
Height(cm)	168.7±7.16	168.7±7.29	>0.05	162.82±9.49	160.92±5.6	>0.05	165.38±8.61	165.53±7.68	>0.05
Weight(kg)	68.83±10.47	67.69±8.47	>0.05	64.94±10.15	63.41±7.39	>0.05	67.30±10.47	65.94±8.28	>0.05
BMI(kg/m^2)	24.02±3.06	24.15±2.59	>0.05	24.43±2.76	24.49±2.43	>0.05	24.18±2.94	24.92±2.52	>0.05
Waist(cm)	81.63±5.91	81.66±3.76	>0.05	79.55±4.43	80.07±3.27	>0.05	80.81±5.45	81.05±3.63	>0.05

p >0.05 is non significant, The above table shows that both the groups are age, sex, ht, wt and BMI matched.

Table 2. Comparison of pulmonary function test parameters between AC users and non users

Parameter	AC user	Non user	p value
	Mean±S.D.	Mean±S.D.	
FVC(L)	3.30±0.82	3.32±0.81	>0.05
FEV_1(L)	2.79±0.70	2.85±0.76	<0.05*
FEV_1/FVC%	84.69±8.23	85.98±7.1	>0.05
$FEF_{25\text{-}75\%}$ (L/sec)	2.81±0.9	3.23±0.93	<0.05*
$FEF_{25\text{-}75\%}$/FVC (L/sec)	0.89±0.36	1.02±0.32	<0.001**
PEFR(L/sec)	6.51±2.27	6.92±1.73	>0.05

p<0.05* is significant and p<0.001** is highly significant. The above table shows that FEV_1 (L),$FEF_{25\text{-}75\%}$(L/sec) and $FEF_{25\text{-}75\%}$/FVC (L/sec) of AC users is significantly less than that of non AC users.

Table 3. Co relation of duration of AC exposure with spirometric parameters in AC user

Parameter	Pearson-r Coefficient	p value
FVC(L)	0.10	>0.05
FEV1(L)	0.03	>0.05
FEV1/FVC(%)	0.20	>0.05
FEF25-75% (L/sec)	0.10	>0.05
FEF25-75%/FVC (L/sec)	0.18	>0.05
PEFR(L/sec)	0.08	>0.05
PEFR(L/min)	0.17	>0.05

p<0.05* is significant and p<0.001* is highly significant. The above table shows that there is no significant correlation between duration of AC exposure and spirometric parameters of AC users.

Table 4. Study of daily changes in PEFR (L/min) of AC users and non AC users

Parameter	AC users Mean±S.D.	Parameter	Non AC users Mean±S.D.
PEFR (1 hr after arriving in AC)	359±55.26	PEFR (1 hr after arriving in office)	396±94.7
PEFR (3 hr after arriving in AC)	355±55.22	PEFR (3 hr after arriving in office)	394±84.48
PEFR (6 hr after arriving in AC)	337±47.6	PEFR (6 hr after arriving in office)	389±85.56
p value	>0.05	p value	>0.05

p<0.05* is significant and p<0.001* is highly significant, The above table shows that daily changes in PEFR (L/min) of AC users and non AC users are non significant.

DISCUSSION

There are evidences that inhalation of cold and dry air has detrimental effects on respiratory system. There is a need to study the effects of exposure to AC on respiratory system of the person exposed to it. So, the present study was undertaken to compare the spirometric parameters of AC users with non AC users and study the effect of duration of AC exposure on spirometric parameters. FEV1 is the volume of air which can be forcibly exhaled from the lungs at the end of first second of a forced expiratory manoeuver. It measures about 80 % of FVC in normal healthy subjects. In our study, it was observed that in AC users FEV_1 was significantly less than Non AC users but within normal limits.These results point towards development of obstructive pattern (Official statement of American Thoracic Society by board of directors, 1991), in AC users. $FEF_{25-75\%}$ is the mean forced expiratory flow between 25% and 75% or middle half of the FVC ($FEF_{25–75\%}$) has also been known as the maximum mid-expiratory flow. This index is taken from the blow with the largest sum of FEV_1 and FVC. Normally it is ≥60%. Decrease in $FEF_{25-75\%}$ indicates early smaller airway obstruction.It is regarded more sensitive but variable measure of narrowing of smaller airways than provided by FEV_1 (Marseglia, 2007; Marzieh Tavakol, 2013; De Meo, 2004). In our study, it was observed that in AC users $FEF_{25-75\%}$ was significantly less than Non AC users. These results suggest that exposure to cold and dry air leads to small airway obstruction though to a subclinical extent. $FEF_{25-75\%}$/FVC is the ratio between airway calibre and lung size (airway size relative to lung size). In our study it was observed that in AC users $FEF_{25-75\%}$/FVC was significantly less than Non AC users. Decrease in $FEF_{25-75\%}$/FVC points towards development of obstructive pattern in AC users (Augusto, 1999).

PEFR is maximum flow rate achieved by the patient during the forced vital capacity maneuver. It measures about 5-6 L/sec. It denotes the size of larger bronchi and bronchioles.In our study, it was observed that in AC users PEFR was less than Non AC users but it was non significant. FVC is the volume of air which can be forcibly and maximally exhaled out of the lungs after the patient has taken in the deepest possible breath (Mendell, 2004). The mean value of FVC in AC users though was significantly less than the control group, was still within normal limits. Also all our subjects were asymptomatic. This may be the beginning of development of restrictive pattern in AC users which may be due the hypersensitivity pneumonitis which causes interstitial disease like changes (Baur, 1992; Beasley, 1989). In our study we tried to find out if the duration of AC exposure has any effect on the pulmonary function tests.For this we applied linear regression test and found the coefficient of correlation. The parameters did not show any significant correlation with the duration of exposure to AC. The explanation for this can be that few of our subjects were exposed to AC for many years (>10 years) but their PFT parameters showed less decrease. Whereas some others who were exposed to AC for lesser duration (<5years) showed comparatively more decrease in the same PFT parameters. This might have nullified the effect of duration on PFT parameters. These different responses may be attributed to individual susceptibility. Also, it might happen that whatever changes in the PFT parameters are occurring, occur in the earlier years of exposure and further exposure for longer period does not enhance the changes.

To the best of our knowledge,there are no other studies correlating duration of exposure with spirometric parameters. For this further studies with larger sample size and with longer duration of exposure to AC are required. We also studied the daily changes in PEFR of AC users and non AC users using peak flow meter. No significant findings were observed in either group. In our study we found significant difference in $FEF_{25-75\%}$ between AC users and non users. $FEF_{25-75\%}$ is a measure of smaller airways and decrease in this parameter in AC users might be due to early stage of obstructive disease. Whereas PEFR is a measure of larger airways which might be affected later in the course. This may be the reason why there was no significant finding in daily changes in PEFR. The etiopathogenesis of development of changes in the pulmonary function test parameters is postulated by different mechanisms. Due to cold air inhalation, airway becomes hyperesponsive (Benson, 1987; Fontanari, 1996). Bronchoconstriction occurs and it increases resistance of airways. This makes person susceptible to COPD (Koskela, 2007). The mechanism causing bronchoconsriction is vagal mediated nervous reflex (Koskela, 2007). The other factor behind it is increase in the number of mast cells. They release histamine which is a known bronchoconstrictor (Heikki, 2007; Cruz, 2008; Clark, 1987). Cold air also causes epithelial desquamation and loss of epithelial derived relaxation factor which leads to bronchoconstriction (Iravani, 1989). Repeated cooling and dessication also causes airway remodeling same as that of asthma (Merre, 2003; Davis, 2003). Other effects of cold and dry air are: Increased mucosal blood flow (Merre, 2003), and congestion of nasal mucosa, sneezing and rhinorrhoea (Heikki, 2007). It also removes the protective mucosal barrier which exposes underlying submucosa (Iravani, 1989). This leads to inflammatory changes and increase in the number of eosinophils (Kuwahara, 2001).

In summary, our results are suggestive of mixed type of respiratory pattern but at a subclinical level. From our study it appears that exposure to cold dry air is detrimental to pulmonary function tests as seen by development of early obstructive and to some extent restrictive pathology. Even though our subjects showed altered values for PFT, they were within normal limits and were asymptomatic. It shows that exposure for less duration may not induce frank lung pathology but prolonged exposure may cause clinically evident pulmonary disorder. Hence it is necessary to take following preventive measures to avoid harmful effects of cold dry air on pulmonary functions,

- Here, we would like to mention that though AC provides cool and pleasant environment, one should try to cut down its use as far as possible so that its harmful effects can be minimised.
- AC users should practise breathing exercises like pranayam to improve their pulmonary function tests.
- They should also undergo pulmonary function tests regularly to detect any changes at an earlier stage.

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