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Research Article

Analysis of dynamic pulmonary functions in air conditioned work environment

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ABSTRACT

Background: Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment. Maintaining thermal comfort is the prime aim of heating, ventilation and air conditioning (HVAC) design engineers. Thus air conditioning has become a necessary luxury. Work environment is made comfortable to increase productivity by using air conditioners (ACs), but literature shows that long term exposure to ACs has deleterious effects.
Methods: After obtaining institutional ethical clearance, the participants for this descriptive study are recruited from the staff of the hospital, based on inclusion and exclusion criteria. 40 subjects in the age group of 25-45 years using ACs for at least last 6 months for a minimum duration of 6 hours per day are included in the study. The pulmonary functions of the subjects are assessed using computerized spirometer (micro Quark) in the afternoon hours. The dynamic lung volumes obtained are compared to the predicted values according to age and sex of the individual.
Results: The dynamic pulmonary function parameters such as FEV1, FVC, FEV1/FVC and PEFR were assessed. FEV1, FVC and PEFR were found to be decreased in subjects when compared to their predicted values. Marked deterioration in dynamic pulmonary functions was noted in 40-50 years age group. As the duration of exposure increases, the dynamic pulmonary functions have decreased to a statistically significant level. Pulmonary parameters are markedly decreased in subjects with BMI>23.5.
Conclusions: The results of the study indicate that the subjects working in AC environment for a long duration are prone to develop restrictive lung diseases. Hence, study concludes that periodic pulmonary function assessment should be made mandatory. Further, regular maintenance of ACs is also recommended.

Keywords: Thermal comfort, Air conditioners, Spirometer, Pulmonary functions

INTRODUCTION

Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment. Maintaining thermal comfort is the prime aim of heating, ventilation and air conditioning (HVAC) design engineers. Satisfaction with the thermal environment is important as it influences the productivity of work and health. The concept of thermal comfort is closely related to thermal stress. Researchers have found that the thermal stress decreases the performance of people by 11% in comparison to those exposed to normal thermal environment.[1]

Aiming at increasing productivity at work, many work environments like IT firms, hospitals, colleges, offices etc. are fixed with air conditioning systems which help to maintain thermal comfort. This artificially maintained thermal environment is found to influence the productivity of work, but long term use of this system could have deleterious effects. Research has proved that inhalation of cold dry air leads to hyper responsiveness of

the bronchial musculature leading on to respiratory problems.[2] The AC system also cools and dries the air which on inhalation can cause the same effects. Hypersensitivity pneumonitis is also reported in air conditioner users due to bacteria, fungi ,virus or moulds in air conditioners.[3] Atopic sensitization and alterations in eosinophil activity is also reported in people with intensive use of air conditioners.[4,5]

The aim of the present study was to analyze the dynamic pulmonary function of staff working in hospitals in an air conditioned environment and to establish the variations in pulmonary functions with age, duration of AC exposure and BMI.

METHODS

The present study was carried out in the Department of Physiology of Jubilee Mission Medical College and Research Institute. After obtaining the institutional ethical clearance, subjects were selected based on inclusion and exclusion criteria.

Forty subjects working in the hospital ICU in an AC environment were selected for the study. Based on the inclusion criteria, subjects in the age group of 25-45 years of both sexes with more than six months of AC exposure which included daily exposure of more than six hours were selected for the study.

Subjects with respiratory diseases, smokers, irregular AC users and those practicing yoga or any regular exercise were excluded from the study. Baseline data was collected using a proforma followed by physical examination of the subjects. Anthropometric assessment was done to obtain the predicted values of pulmonary functions according to age, weight and height. The pulmonary functions were assessed using micro-Quark, a PC based spirometer.

The subject was first familiarized with the instrument and procedure of pulmonary function assessment was explained to the subject. Test was done for all subjects seated comfortably in an upright position. Subject was connected to the mouth piece and nose clip was applied. The manoeuvre was repeated thrice and the best of the three readings were recorded. Basic parameters assessed were functional vital capacity (FVC), forced expiratory volume in first second (FEV1), (FEV1/FCV) and peak expiratory flow rate (PEFR).

The outcome of the test was expressed as mean±standard deviation for each of the parameter. The test results were compared with the predicted values for each subject according to the age, sex, height and weight of the individuals. They were analyzed using unpaired students t test and p value of <0.05 was considered to be statistically significant while p value of <0.001 was highly significant.

RESULTS

87% of the subjects included in the study belonged to 20-30 years age group and only 5% was above 40 years.

The measured value of FVC in 20 -30 years age group was 1.88±0.4 while the predicted value was 3.25± 0.26 and this was found to be statistically significant. Values for FEV1 and PEFR were also found to be statistically significant. The subjects in the other two age groups also showed significant differences in all the parameters but the subjects in 40-50 years showed highly significant difference in all the parameters. Of the 40 subjects 58% had normal BMI and 35% were with BMI more than 23.5.

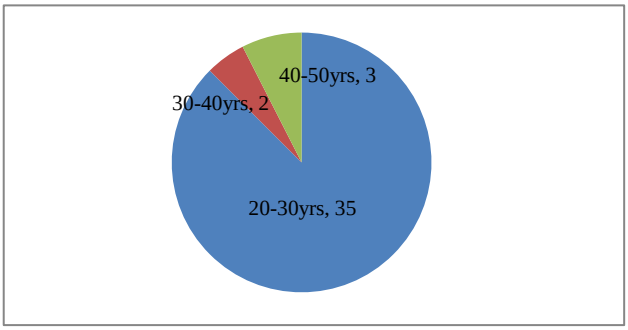

Figure 1: Distribution showing different age groups.

Table 1: The dynamic pulmonary parameters of different age groups.

		FVC	FEV1	FEV1/FVC	PEFR
		(L)	(L)	(%)	(L/min)
20-30 years	Predicted	3.25±0.36	2.82±0.3	87.40±1.86	409.51±44.86
	Measured	1.88*±0.4	1.61*±0.57	84.79±19.96	222.51*±86.34
30-40 years	Predicted	2.96±0.03	2.54±0.04	86.00±0.14	392.50±0.71
	Measured	1.58*±0.09	1.44**±0.01	91.15±5.02	183.00**±5.94
40-50 years	Predicted	2.81±0.12	2.34±0.09	83.16±0.15	386.00±30.12
	Measured	1.46**±0.19	1.27**±0.22	87.43±14.36	176.00**±60.06

* p value<0.05, significant, **p value<0.001, Highly significant.

Table 2: The dynamic pulmonary functions in subjects with different BMI.

		FVC	FEV1	FEV1/FVC	PEFR
		(L)	(L)	(%)	(L/min)
<18	Predicted	2.97±0.40	2.61±0.34	88.03±1.17	380.00±30.26
	Measured	1.77*±0.10	1.22±0.37	69.80±24.89	146.20±125.47
18-23.5	Predicted	3.13±0.33	2.70±0.29	86.50±1.84	399.96±22.46
	Measured	1.80*±0.35	1.56*±0.51	85.73±19.44	222.00*±68.19
>23.5	Predicted	3.36±0.37	2.92±0.31	87.62±2.45	424.07±63.17
	Measured	1.91**±0.51	1.68**±0.61	87.93±16.87	224.00**±95.68

* p value < 0.05, significant, **p value <0.001, highly significant.

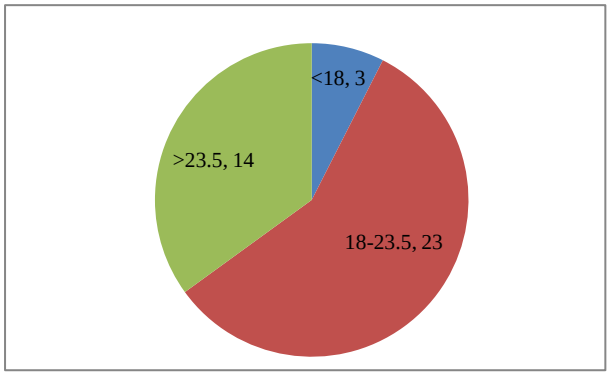

Figure 2: Distribution showing varying BMI.

It was found that all subjects had statistically significant difference in pulmonary functions with respect to their predicted values but the group with BMI >23 had highly significant difference.

65% of the subjects were exposed to AC use for 1-5 years, 27% for <1years and 8% for >5 years.

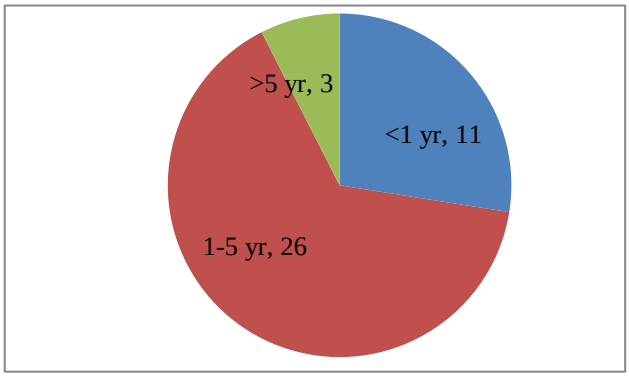

Figure 3: Distribution showing different durations of exposure.

Table 3: Compares the pulmonary functions according to the duration of exposure.

		FVC	FEV1	FEV1/FVC	PEFR
		(L)	(L)	(%)	(L/min)
<1 years	Predicted	3.51±0.37	2.76±0.32	87.83±0.83	395.09±22.93
	Measured	1.95*±0.54	1.67*±0.65	85.54±20.67	218.67*±84.55
1-5 years	Predicted	3.20±0.38	2.76±0.33	86.32±1.68	411.58±50.85
	Measured	1.83**±0.33	1.60**±0.48	86.91±17.52	222.55**±84.64
>5 years	Predicted	3.35±0.18	2.93±0.17	89.93±4.82	409.67±9.29
	Measured	1.46**±0.19	1.05**±0.49	70.46±26.46	163.40**±67.24

* p value <0.05, significant, **p value<0.001, highly significant.

DISCUSSION

The present study included 40 subjects who were exposed to air conditioned environment for >6 hours daily for >6 months. It was found that prolonged exposure causes decrement in pulmonary functions. The parameters taken into account to assess the dynamic pulmonary functions were FVC, FEV1, FEV1 /FVC and PEFR. The pulmonary functions were assessed using computerized spirometer. FVC and FEV1 were found to be decreased in subjects working in air conditioned environment. The decrease in FEV1 suggested the presence of restrictive lung disease. PEFR is the maximum velocity with which air is forced out of the lungs. It gives an assessment of the calibre of the bronchioles.

In the present study PEFR was decreased which suggests that the upper airways are affected for subjects working in air conditioned environment. This finding is similar to the findings by borse et al.[6] Hyperventilation of cold dry air results in reflex bronchoconstriction as is noted in

asthmatics. Cold air stimulates the activity of mast cells which results in release of histamine resulting in bronchoconstriction, increased airway resistance and decreased dynamic compliance.[7]

The decrease in dynamic pulmonary functions was associated with the age of the subject, BMI and duration of exposure to the air conditioned environment. From the present study it was noted that as the duration of exposure increases, the dynamic pulmonary functions deteriorated to a highly significant level. Subjects with BMI more than 23 had more deterioration of pulmonary functions when compared with those with normal BMI.

As the age advances, the tolerance of subjects to the air conditioned environment decreases as was noted by the highly significant changes in dynamic pulmonary functions of subjects in the age group 40-50 years. Prolonged use of AC leads onto atopic sensitization and decreased eosinophil activity. Cold air ventilation further results in repeated dehydration of the airways, bronchoconstriction and exacerbation of COPD. Dampness created by AC environment can result in growth of bacteria, virus moulds which can cause IgE Induced sensitization, hypersensitivity pneumonitis and fungal infections.[8,9]

The findings of the present study suggest increased incidence of restrictive lung diseases in subjects working in air conditioned environment. Hence the concept that thermal comfort attained by using AC, will result in increased productivity of work and better health is to be probed into.

Prolonged exposure along with no proper maintenance of AC can result in deleterious effects on the respiratory system. Proper maintenance of AC along with use of humidifiers is recommended to decrease the impact of cold air. Periodic analysis of dynamic pulmonary functions of subjects working in air conditioned environment is also recommended.

CONCLUSION

From the present study it has been observed that the dynamic pulmonary functions have decreased in subjects working in air conditioned environment. The pulmonary parameters suggest the presence of restrictive lung disease in subjects with prolonged exposure to the air conditioned environment. It is recommended that subjects who are working in this environment should have their pulmonary functions periodically assessed.

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