Indian Journal of Basic and Applied Medical Research; December 2018: Vol.-8, Issue- 1, P. 49 - 56

**Original article**

# A study of pulmonary functions in female students living in air conditioned and non-air conditioned environment

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## Abstract:

**Background:** Air conditioners are being used extensively nowadays across the globe. Air conditioners (AC's) have become indispensable at public places and in homes as well.

**Material and methods:** The present study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences & Research, Mullana (Ambala).

**Results:** Group 1B (Post-Exposure AC users) had statistically significant reduction in FEV1 and FVC with p values 0.004 and 0.003 respectively as compared to Group 1A (Pre-Exposure Ac users)

However, there is no significant change seen in FEV1/FVC ratio with p value 0.148.

**Conclusion:** To conclude, there was a significant decrease found in the Pulmonary Function Parameters i.e. FVC and $FEV_1$ after usage of air conditioners. However there was no significant change seen in $FEV_1$/FVC%. This shows a predisposition of AC users towards pulmonary dysfunction.

## BACKGROUND:

Air conditioners are being used extensively nowadays across the globe. Air conditioners (AC's) have become indispensable at public places and in homes as well. Till recent times, air conditioned environment was thought to be pleasant and harmless but many researchers have concluded that persons working and living in air conditioned environment are firmly related with increase in prevalance of work related headaches, fatigue and upper respiratory symptoms. Hence, air conditioning may affect human health since it has a profound effect on our environment, than just lowering the temperature.[1]

## MATERIAL AND METHODS:

The present study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences & Research, Mullana (Ambala).



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**STUDY GROUPS:** 100 female subjects were selected from MMU hostels. The selected subjects were categorized into 2 major groups: GROUP 1(Study group) consisted of 50 healthy female students living in AC hostels. It was further divided into Pre-exposure (Group 1A) and Post-exposure group (Group 1B).

GROUP 2 (Control group) consisted of randomly selected 50 healthy female students living in Non AC hostels. Both the groups were demographically comparable in terms of Age, Weight and Height. All the subjects were Females between the age group of 18-28 yrs. Pulmonary function testing was done twice in a time span of 6 months. First reading was taken in the month of April 2015 before the usage of air conditioners and second reading after exposure of Ac's in October 2015.

All the subjects were staying in the same hostel and usage of AC was for minimum of 6 hrs/day and atleast 5 days a week from the past 6 months.

The AC temperature was between 18-22 degree centigrade as the Ac's present in the hostels are Central AC's i.e all have a similar temperature.

Those students who stayed in Non-Ac hostels were taken as controls.

The equipment used was computerised spirometer, **Spiro-Excel (Medicaid Systems Chandigarh).**

The following **Lung volumes and capacities** were recorded:

- Forced Expiratory Volume in One Second ($FEV_1$)
- Forced Vital Capacity (FVC)
- $FEV_1$/FVC

The subjects were made to sit comfortably and were told to take a deep breath in and out to familiarize with the equipment. The subject was then asked to inhale to his maximum capacity and forcefully blow into the sensor (nose clipped) as hard as possible for as long as possible. This procedure was repeated three times and the best

of three readings were considered for analysis[2]. Data was tabulated and statistically analysed.

**DATA ANALYSIS:**

All the observations of the study were recorded as per proforma attached and the data collected was entered in Microsoft Office Excel version 2007. It was then analyzed by SPSS computer program for windows version 20. Mean ± SD (Standard Deviation) was calculated and "Independent sample T test" was used to obtain statistical significance (p value) between the Post-Exposure, Pre-Exposure and Non-Ac group groups.

However, the Pre and Post Exposure of Ac were analysed by paired 'T' test. Statistical significance was determined from p value with a p value of $< 0.05$ considered as significant and p value $\leq 0.001$ considered as highly significant.



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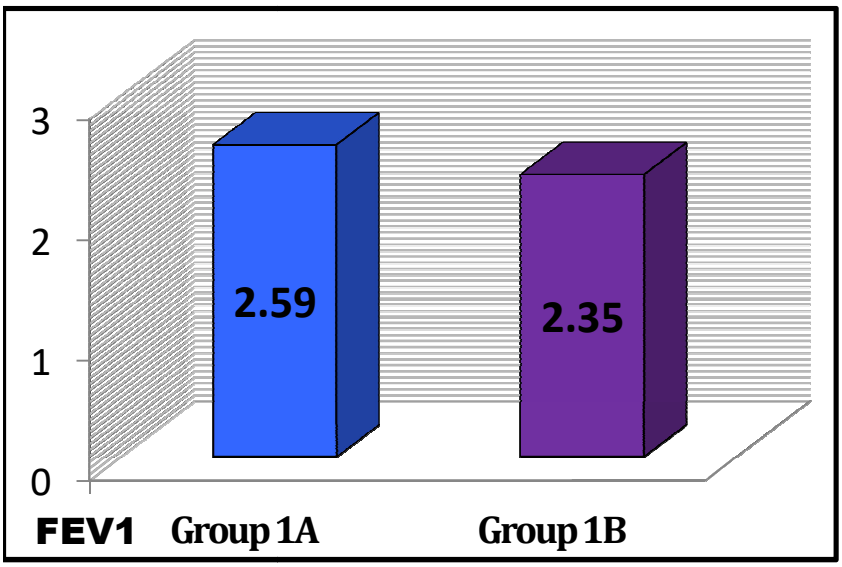


**Figure 1(a): Bar graph showing comparison of Mean $FEV_1$of subjects in Group 1A(Pre-Exposure AC users) and Group 1B (Post-Exposure AC users).**

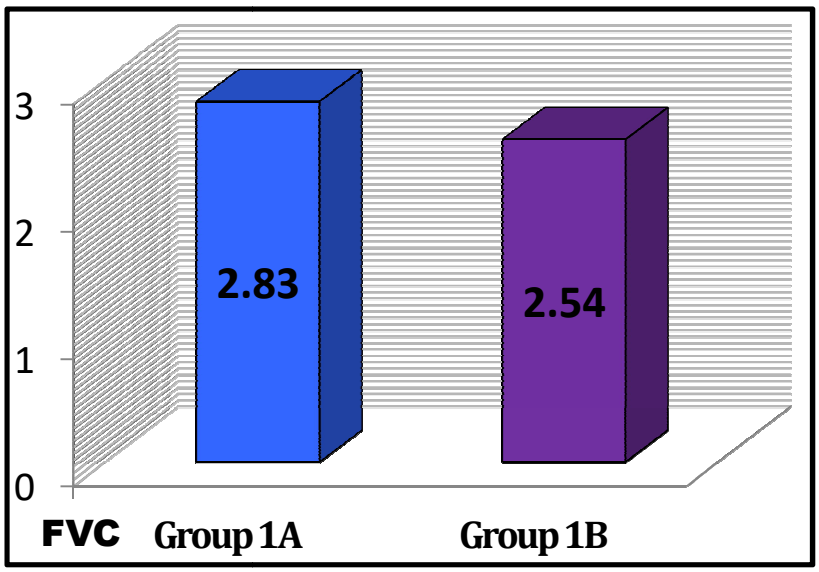


**Figure 1(b): Bar graph showing comparison of Mean FVCof subjects in Group 1A(Pre-Exposure AC users) and Group 1B (Post-Exposure AC users).**



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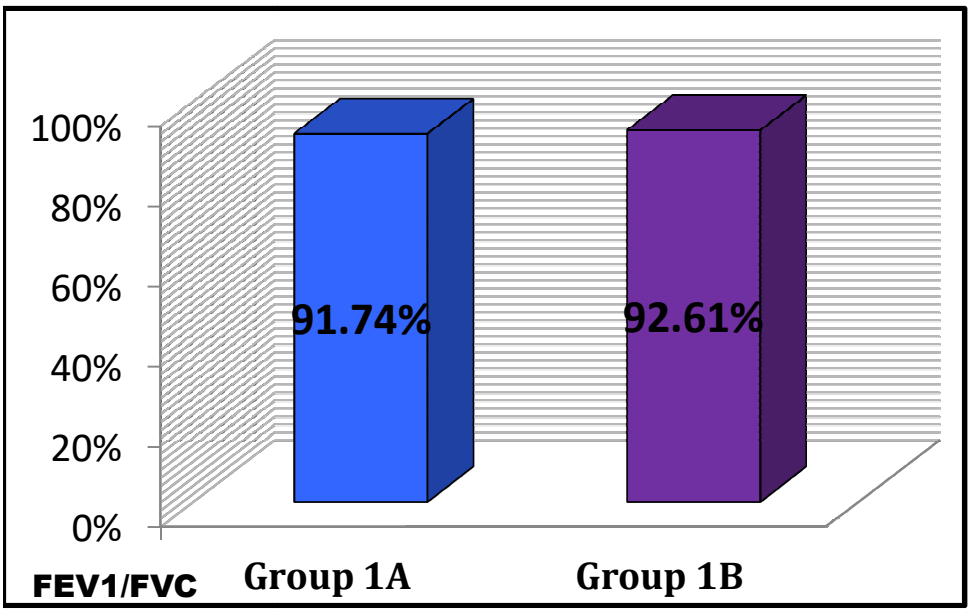


**Figure 1(c): Bar graph showing comparison of Mean $FEV_1/FVC$of subjects in Group 1A (Pre-Exposure AC users) and Group 1B (Post-Exposure AC users).**

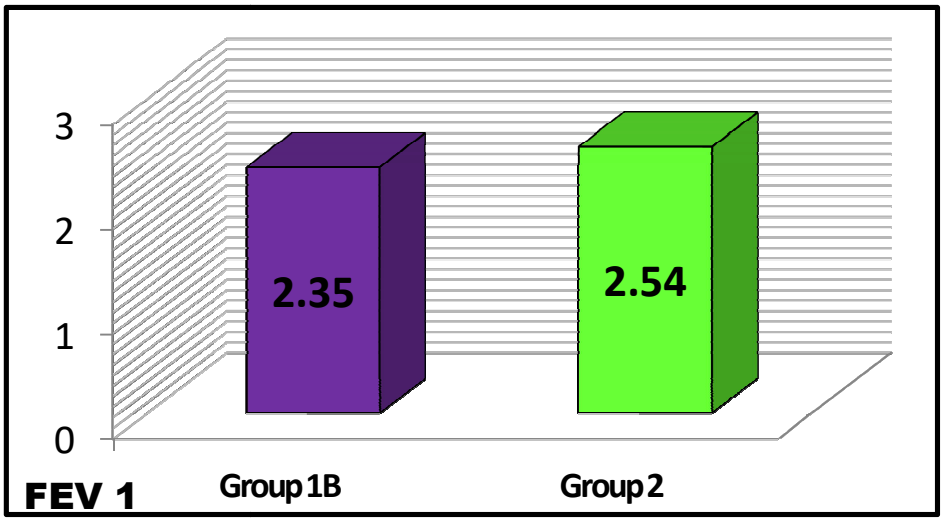


**Figure 2(a):Bar graph showing comparison of Mean $FEV_1$ of subjects in Group 1B (Post-Exposure AC users) and Group 2 (Non-AC users).**



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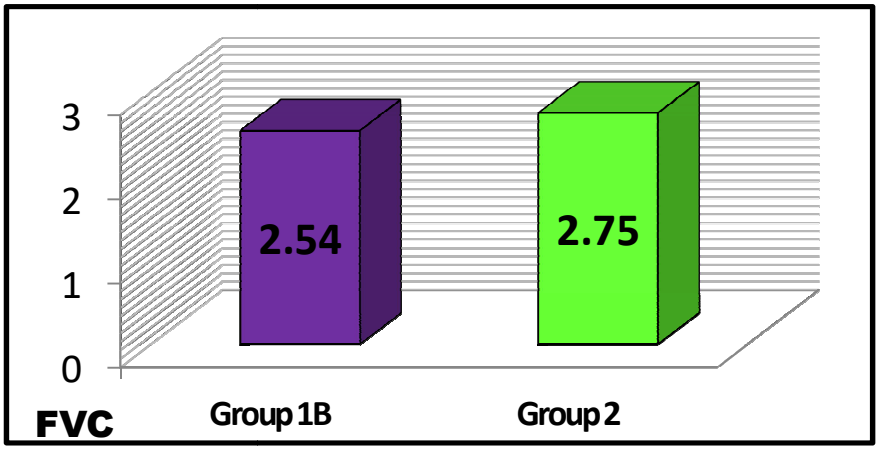


**Figure 2(b): Bar graph showing comparison of Mean FVC of subjects in Group 1B (Post-Exposure AC users) and Group 2 (Non-AC users).**

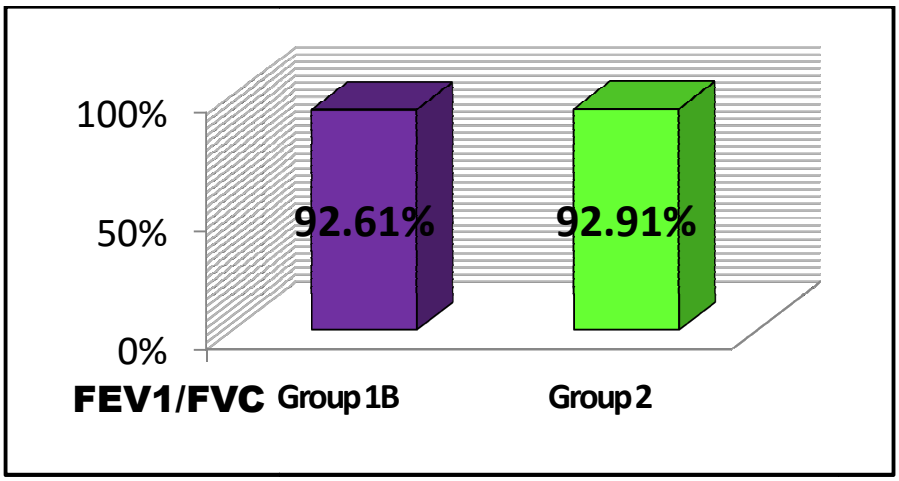


**Figure 2(c): Bar graph showing comparison of Mean $FEV_1$/FVC of subjects in Group 1B (Post-Exposure AC users) and Group 2 (Non-AC users).**

**DISCUSSION**:

The present study was undertaken in the Department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences & Research, Mullana (Ambala) to study the effect of use of air conditioners on pulmonary functions in female students living in air conditioned hostels. Various observations depending on AC usage and pulmonary function impairment were analysed.



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**A) ANTHROPOMETRIC PARAMETERS:**

The mean Age is comparable in AC users (Group 1) and Non- Ac users (Group 2). There is no significant difference between the mean age of two groups (p = 0.875) as shown in table 1(a).

Height is comparable in AC users (Group 1) and Non-Ac users (Group 2). There is no significant difference found between two groups (p =0.594) as shown in table 1(b).

Weight is comparable in Ac users (Group 1) and Non-Ac users (Group 2). There is no significant difference found between two groups (p = 0.569) as shown in table 1(c).

Sabade et al reported a non significant difference in the anthropometric data such as in age, height and weight amongst AC users and Non-AC users.[3]

Borse LJ et al observed that there was no significant difference in the anthropometric parameters (age, weight, height) between Ac and Non Ac users.[4]

Our observations are in quite agreement with the observations made by Vidya G et al who also reported the anthropometric parameters to be non-significant in Ac and Non Ac users.[5]

**B) PULMONARY FUNCTION PARAMETERS:**

Pulmonary functions i.e. FVC, $FEV_1$, $FEV_1$/FVC% were determined using computerized Spirometer (Spiro-excel).

The **Forced Vital Capacity** represents the largest amount of air that can be expired after a maximal inspiratory effort, is frequently measured as an index of pulmonary function. It gives useful information about the strength of the respiratory muscles and other aspects of pulmonary function.[6]

**$FEV_1$:** It's the component of the vital capacity expired during the first second of a forced expiration.

**$FEV_1$/FVC%** is the volume of air expired in the first second, expressed as percentage of FVC. It is more sensitive indicator of airway obstruction than FVC or $FEV_1$.

The following conclusions were made

**GROUP 1B (POST-EXPOSURE AC USERS) AND GROUP 2 (NON-AC USERS):**

Group 1B had statistically significant reduction in $FEV_1$ and FVC with p values 0.031, 0.046 respectively as compared to Non-Ac users (Group 2).

However, there was no significant change seen in $FEV_1$/FVC ratio with p value 0.724.

**GROUP 1A (PRE-EXPOSURE AC USERS) AND GROUP 1B (POST-EXPOSURE AC USERS:**

Group 1B (Post-Exposure AC users) had statistically significant reduction in FEV1 and FVC with p values 0.004 and 0.003 respectively as compared to Group 1A (Pre-Exposure Ac users)

However, there is no significant change seen in FEV1/FVC ratio with p value 0.148.

Our study is in correlation with various other studies.

Hulke MS et al observed a fall in Forced Vital Capacity. They concluded that as maximum inspiratory and expiratory effort can be assessed with FVC, hence it provides information about the strength of respiratory muscles.[7]



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The study by Sabade SB et al found a significant decrease in FVC in persons using air conditioners. The study is in agreement with our study as they conducted on volunteers who were using Ac's 6 hrs /day for last 6 months.[3]

Ali Maqsood S, Ali Musab S reported that there is a significant difference in FVC values in air conditioned and Non-air conditioned bank employees.[8]

Vidya G et al observed that AC usage leads to respiratory dysfunction. It was concluded that while the interval of ventilation is increased from 2-3 minutes it causes a reduction in $FEV_1$. The main factor responsible for constriction of bronchi because of cold dry air is the level of ventilation rather than the dryness of temperature.[5]

Likewise Babitha R et al concluded a significant decrease in FEV1 in subjects working in banks using AC's.[9]

Crapo R considered a decrease in $FEV_1$as the most important test to check out generalized obstruction of airways. It is regarded as the most widely used test to detect airway responsiveness.[10]

Khaliq F, Sharma S, Tandon OP found a significant decrease in FEV1 when the duration of ventilation is increased from 2-3 minutes.[11]

Vidya G et al did a study in AC users and found a decrease in FVC and $FEV_1$. However, the ratio of $FEV_1$/FVC was found normal. This favors' the restrictive pattern of respiratory disorder. These results are in favour with our study.[5]

As observed by Dange DC et al 10 subjects in their study showed a decrease in $FEV_1$/FVC and 25 subjects showed an increase $FEV_1$/FVC. This favors' a mixed pattern of respiratory dysfunction both obstructive as well as restrictive.[12]

**CONCLUSION:**

To conclude, there was a significant decrease found in the Pulmonary Function Parameters i.e. FVC and $FEV_1$ after usage of air conditioners. However there was no significant change seen in $FEV_1$/FVC%. This shows a predisposition of AC users towards pulmonary dysfunction.

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