

COMPARATIVE EVALUATION OF LUNG FUNCTIONS BETWEEN AC AND NON AC USERS AMONG STUDENT POPULATION

ABSTRACT

BACKGROUND : Usage of air conditioners (AC) has been highly increased in this modern era. In addition to the cooling of the environment, it has a major impact on human health. Rapid influx of cold dry air increases the risk of bronchoconstriction in asthma patients due to the dehydration of the air pathway. So the present study planned to comparatively evaluate the lung functional status in air conditioner and non air conditioner users.

MATERIALS AND METHOD: The pulmonary functional capacity was assessed using FVC, FEV1 and FEV1/FVC ratio, Peak expiratory flow rate (PEFR) and FEF 25-75% in a Helios 702 spirometer .

RESULTS : The lung functional capacities among the AC users showed a statistically significant decline in PEFR and FEF25-75% indicating the risk of airway obstruction.

CONCLUSION : The study concluded an innovative finding that AC users are developing ventilatory dysfunction and are at more risk of respiratory dysfunction. The coldness of the aerosol of the AC unit or other factors responsible may be allergens, infections and humidity level. Thus technical and hygienic features of air intake must be ensured to maintain a good indoor air quality.

Keywords: Air conditioners, innovative, Lung functions, Peak expiratory flow rate, Forced vital capacity.

Running title: Changes in lung functions in AC users.

INTRODUCTION

In this modern and fast evolving world the demand and usage of air-conditioners is highly increased. Almost every workplace, school and home uses air-conditioners(1). Air-conditioners are used for lowering the temperature it is achieved so by the condition condensation of water vapour thereby reducing the humidity. The hyperventilation of cold air is one of the main reasons for broncho constriction in asthma patients. (2) Air conditioners are destructive to the environment and are responsible for global warming by directly affecting the ozone formation leading to the depletion of ozone layer. It is the major factor for aggravating the chronic obstructive pulmonary disease (COPD) and it also paves the way for many severe acute respiratory syndrome and many other airborne infectious agents(3). Contamination of air conditioner is the major cause for hyperventilation pneumonitis.(4) Which causes many on the allergic reaction as it also increases the indoor air pollutants which leads to elevation of serum IgE which cause mucous membrane irritation and neurological symptoms such as headaches.(5)(6)

Usage of air conditioners decrease the efficiency of the lungs which leads to the decreased pulmonary function capacity. Increase inhalation of cold dry air alters the functional capacity of the lungs which may induce rhinitis.(7) Freon which are used in the cooling systems of the AC are highly toxic. Inhalation of freons in large amount increases the risk of atopic sensation which may lead to repetitive dehydration of small airway when large volumes of cold air is inhaled (8). It is also responsible for the increase indoor air pollutants, house dust, mites leading to high eosinophil activity (9).

Now this study is being conducted to compare the lung function of the people who are constantly exposed to an air conditioning work environment and people who are in a non-air-conditioned workplace using a pulmonary function test.

MATERIALS AND METHOD

The study was conducted among 20 students of a Saveetha dental college between the age group of 17 to 20 years of both genders with similar anthropometric measurements. The subjects who were under medications and with any cardiological or respiratory disorders were excluded from this study. The subjects were divided into 2 groups (10 subjects each)

Group 1:AC users

Group 2 :Non AC users

Their medical history and demographic details were collected along with physical examination. The lung functional capacities (i.e)Forced vital capacity(FVC), Forced expiratory volume in one second (FEV1), Peak expiratory flow rate(PEFR), FEV1/FVC ratio and the maximal mid expiratory flow rate [FEF(25-75%)] were compared between the two groups using pulmonary function tests. RMS Helios 702 spirometer was used to assess the pulmonary functional capacity of each individual.

Before the subjects were asked to perform the actual procedure , the procedure was demonstrated before the study participants. The procedure was based on the single breath technique where the participants were asked to forcefully inhale, followed by forceful exhalation into the tube and forceful inhalation from the tube. The results were analysed statistically using the SPSS software version 23 . The standard deviation and the mean values of all the subjects were calculated. The results were statistically analysed using independent t- test in SPSS version 23.

RESULTS

When values of the lung functional capacities were compared , there was a slight decrease in the Forced vital capacity(FVC), Forced expiratory volume in one second (FEV1), FEV1/FVC ratio in AC users compared to non AC users and was not statistically significant ($p < 0.05$). The study reported a statistically significant decreased in maximal mid expiratory flow rate [FEF(25-75%)] and PEFR in AC users compared to non AC users ($p < 0.05$)

Comment [GV1]: Sample size is too small

Comment [GV2]: Were smoker's included in the study?

Comment [GV3]: The duration of use of AC's not mentioned

Comment [GV4]: How many reading's were taken?

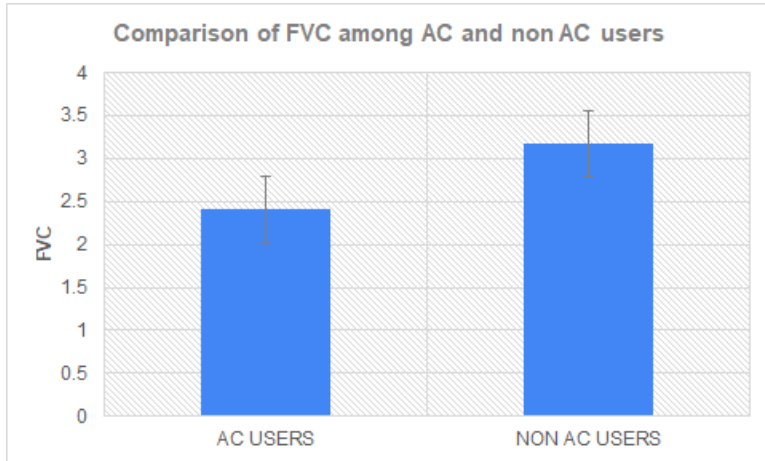


Figure 1: Represents the bar graph of comparison of FVC among AC and Non AC users. There was statistical insignificant decrease in the value of FVC in the AC users compared to the Non AC users ($p < 0.05$)

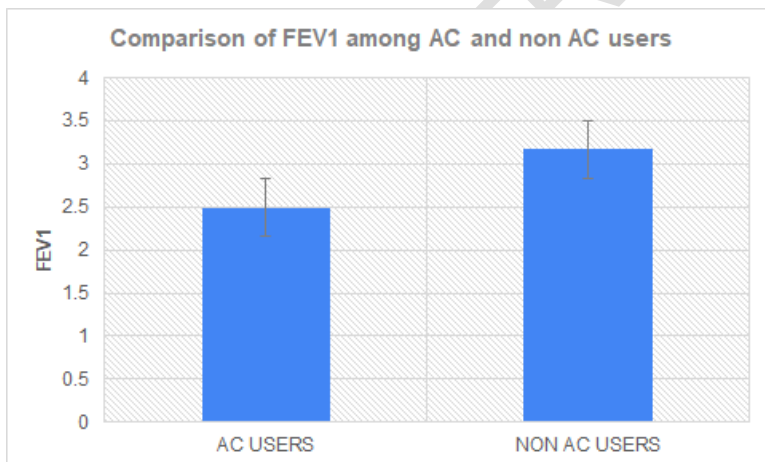


Figure 2 : Represents the bar graph of comparison of FEV1 among AC and Non AC users. There was statistical insignificant decrease in the value of FEV1 in the AC users compared to the Non AC users ($p < 0.05$)

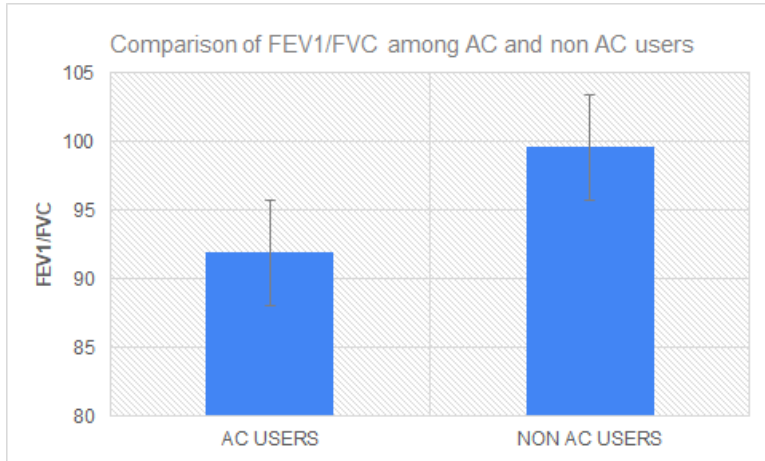


Figure 3: Represents the bar graph of comparison of FEV1/FVC among AC and Non AC users. There was statistical insignificant decrease in the value of FEV1 /FVC in the AC users compared to the Non AC users ($p < 0.05$)

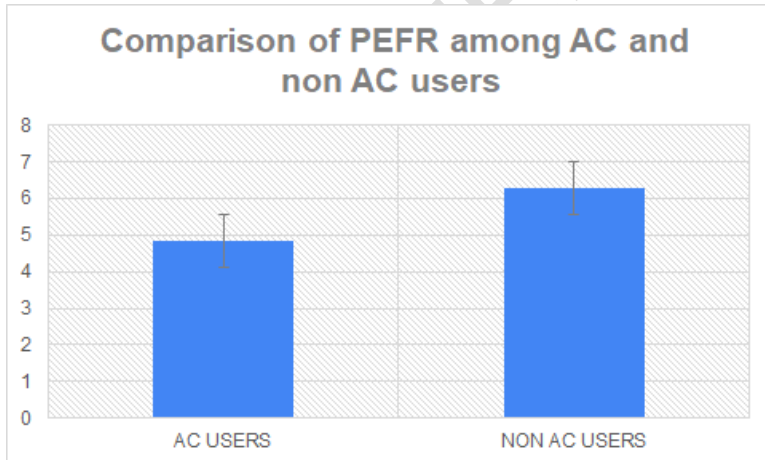


Figure 4: Represents the bar graph of comparison of PEFR among AC and Non AC users. There was statistical significant decrease in the value of PEFR in the AC users compared to the Non AC users ($p < 0.05$)

Comment [GV5]: What does the x-axis represent in the diagram?

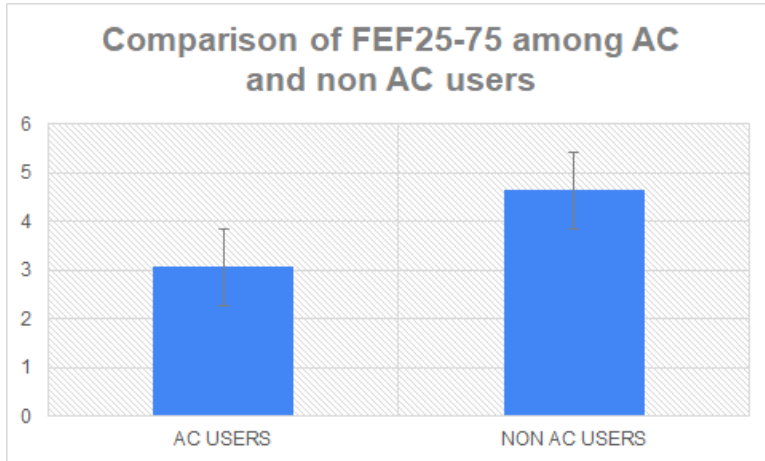


Figure 5: Represents the bar graph of comparison of FEF (25 - 75) among AC and Non AC users. There was statistical significant decrease in the value of FEF (25 - 75) in the AC users compared to the Non AC users ($p < 0.05$)

Comment [GV6]: What are the units for FEF25-75 and what does the x-axis depict in the diagram?

DISCUSSION

The respiratory dysfunction observed in AC users is more like an obstructive pattern. In the present study we found statistical decreases in maximum mid expiratory flow are (i.e) FEF 25-75%. It's a sensitive indicator of small airway disease where most chronic obstructive pulmonary disease starts. A similar study stated that medical students exposed to AC for 6 months increased respiratory symptoms and were more prone for broncho constriction (2,10,11). Nasal breathing of cold air increases engorgement of venous sinus in the sub mucosa leading to nasal congestion, sneezing and rhinitis. (12)(12,13)

The results of the study showed that peak expiratory flow rate is significantly decreased in the subject exposed to the air condition work environment .PEFR is mainly the calibre of bronchi and bronchioles which are exposed to reflex bronchoconstriction.(14,15)(16)(14,15) The main reason for bronco constriction in asthma patients is due to hyperventilation of cold air.(17,18)(3) It was also found that when the duration of ventilation is increased there is significant fall in FEV1 .It was found that the level of ventilation plays a major role in bronco constriction than the dryness of cold dry air.(19,20)(21,22)

Remodelling of airways like that of asthma patients can be seen in people exposed to repeated cooling of the air leading to desiccation of the airway. (23–25)

It was identified that in children who were exposed to AC had mean lower than the other children who are forced and heating and air-conditioning in the study other domestic factors such as heating devices , gas stoves, etc were considered. The inhalation of cold dry air leads to removal of protective mucosal barriers(26–28). The study sample is small and the AC users are not exposed to air conditioners throughout the entire day. Study samples can be increased for more accurate results. Other parameters can also be included such as diet and exercise.

CONCLUSION

The study concluded that AC users are developing ventilatory dysfunction and are at more risk of respiratory dysfunction. The coldness of the aerosol of the AC unit or other factors responsible may be allergens, infections and humidity levels. Thus technical and hygienic features of air intake must be ensured to maintain a good indoor air quality.

Comment [GV7]: Sample size is too small to draw any conclusion

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES

1. Kamath SM, Manjunath Kamath S, Jaison D, Rao SK, Sridhar K, Kasthuri N, et al. In vitro augmentation of chondrogenesis by Epigallocatechin gallate in primary Human chondrocytes - Sustained release model for cartilage regeneration [Internet]. Vol. 60, Journal of Drug Delivery Science and Technology. 2020. p. 101992. Available from: <http://dx.doi.org/10.1016/j.jddst.2020.101992>
2. Khaliq F, Sharma S, Tandon OP. Pulmonary functions in air conditioner users. Indian J Physiol Pharmacol. 2006 Jan;50(1):67–72.
3. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global; 2019. 237 p.
4. Hulke S, Deora K, Bhargava D. Comparison of Pulmonary Function Test in Petrol Pump Worker and Auto-rickshaw Driver [Internet]. Vol. 8, Advanced Biomedical Research. 2019. p. 44. Available from: http://dx.doi.org/10.4103/abr.abr_204_18
5. Vidya G, Kumar BA, Kalpana M, Chand K. Pulmonary function tests in air conditioner users [Internet]. International Journal of Medicine and Biomedical Research. 2014. p. 75–80. Available from: <http://dx.doi.org/10.14194/ijmbr.3.2.3>
6. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. Hepatobiliary Pancreat Dis Int. 2020 Oct;19(5):429–34.
7. Pistelli R. Reference values for pulmonary function test: suggestions for a correct use and interpretation [Internet]. Shortness of Breath. 2014. Available from: <http://dx.doi.org/10.11138/sob/2014.3.2.075>
8. Lavanya MEG, Mahalakshmi V, Srinithi V, Nivetha M. Computational analysis of pulmonary artery stenosis [Internet]. 2017 International Conference on Innovations in Green Energy and Healthcare Technologies (IGEHT). 2017. Available from: <http://dx.doi.org/10.1109/igeht.2017.8094105>
9. Takao M, Miyahara Y, Shinboku H, Nishijima K, Morimitsu T, Hara K. Noninvasive Assessment of Right Heart Function by 81mKr Equilibrium Radionuclide Ventriculography in Chronic Pulmonary Diseases [Internet]. Vol. 109, Chest. 1996. p. 67–72. Available from: <http://dx.doi.org/10.1378/chest.109.1.67>
10. Nambi G, Kamal W, Es S, Joshi S, Trivedi P. Spinal manipulation plus laser therapy versus laser therapy alone in the treatment of chronic non-specific low back pain: a randomized controlled study. Eur J Phys Rehabil Med. 2018 Dec;54(6):880–9.

11. Wadhwa R, Paudel KR, Chin LH, Hon CM, Madheswaran T, Gupta G, et al. Anti-inflammatory and anticancer activities of Naringenin-loaded liquid crystalline nanoparticles in vitro. *J Food Biochem*. 2021 Jan;45(1):e13572.
12. Website [Internet]. Available from: Saraswathi I, Saikarthik J, Senthil Kumar K, Srinivasan KM, Ardhanaari M, Gunapriya R. Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: a prospective longitudinal study [Internet]. Vol. 8, *PeerJ*. 2020. p. e10164. Available from: <http://dx.doi.org/10.7717/peerj.10164>
13. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity [Internet]. Vol. 46, *Drug Development and Industrial Pharmacy*. 2020. p. 1219–29. Available from: <http://dx.doi.org/10.1080/03639045.2020.1788059>
14. Gruenwald P. Normal and abnormal expansion of the lungs of newborn infants obtained at autopsy. I. Expansion of lungs by liquid media [Internet]. Vol. 139, *The Anatomical Record*. 1961. p. 471–81. Available from: <http://dx.doi.org/10.1002/ar.1091390404>
15. Website [Internet]. Available from: Santhakumar P, Roy A, Mohanraj KG, Jayaraman S, Durairaj R. Ethanolic Extract of Capparis decidua Fruit Ameliorates Methotrexate-Induced Hepatotoxicity by Activating Nrf2/HO-1 and PPAR γ Mediated Pathways [Internet]. Vol. 55, *Indian Journal of Pharmaceutical Education and Research*. 2021. p. s265–74. Available from: <http://dx.doi.org/10.5530/ijper.55.1s.59>
16. Egbuna C, Mishra AP, Goyal MR. Preparation of Phytopharmaceuticals for the Management of Disorders: The Development of Nutraceuticals and Traditional Medicine. Academic Press; 2020. 574 p.
17. Desjardins A, de Luca S, Cartier A, L'Archevêque J, Ghezso H, Malo J-L. 321 Non-specific bronchial hyperresponsiveness to inhaled histamine and hyperventilation of cold dry air in individuals with respiratory symptoms of unknown etiology [Internet]. Vol. 81, *Journal of Allergy and Clinical Immunology*. 1988. p. 248. Available from: [http://dx.doi.org/10.1016/0091-6749\(88\)90555-6](http://dx.doi.org/10.1016/0091-6749(88)90555-6)
18. Prakash AKS, Devaraj E. Cytotoxic potentials of *S. cumini* methanolic seed kernel extract in human hepatoma HepG2 cells [Internet]. Vol. 34, *Environmental Toxicology*. 2019. p. 1313–9. Available from: <http://dx.doi.org/10.1002/tox.22832>
19. Resnick AD, Deal EC Jr, Ingram RH Jr, McFadden ER Jr. A critical assessment of the mechanism by which hyperoxia attenuates exercise-induced asthma. *J Clin Invest*. 1979 Aug;64(2):541–9.
20. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Daniel Raj Daniel Paul Raj D, Sivasubramanian M, et al. Emerging Therapeutic Approaches to Combat COVID-19: Present Status and Future Perspectives. *Front Mol Biosci*. 2021 Mar 8;8:604447.
21. Barabadi H, Mojab F, Vahidi H, Marashi B, Talank N, Hosseini O, et al. Green synthesis,

characterization, antibacterial and biofilm inhibitory activity of silver nanoparticles compared to commercial silver nanoparticles. *Inorg Chem Commun.* 2021 Jul;129(108647):108647.

22. Wahab PUA, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, Abhinav RP. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. *J Oral Maxillofac Surg.* 2018 Jun;76(6):1160–4.
23. Tahmasebi S, Qasim MT, Krivenkova MV, Zekiy AO, Thangavelu L, Aravindhan S, et al. The effects of oxygen–ozone therapy on regulatory T- cell responses in multiple sclerosis patients [Internet]. Vol. 45, *Cell Biology International.* 2021. p. 1498–509. Available from: <http://dx.doi.org/10.1002/cbin.11589>
24. Bharath B, Perinbam K, Devanesan S, AlSalhi MS, Saravanan M. Evaluation of the anticancer potential of Hexadecanoic acid from brown algae *Turbinaria ornata* on HT–29 colon cancer cells [Internet]. Vol. 1235, *Journal of Molecular Structure.* 2021. p. 130229. Available from: <http://dx.doi.org/10.1016/j.molstruc.2021.130229>
25. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. *J Oral Pathol Med.* 2019 Apr;48(4):299–306.
26. Iravani J, Norris Melville G. Mucociliary function in the respiratory tract as influenced by physicochemical factors [Internet]. Vol. 2, *Pharmacology & Therapeutics. Part B: General and Systematic Pharmacology.* 1976. p. 471–92. Available from: [http://dx.doi.org/10.1016/0306-039x\(76\)90003-9](http://dx.doi.org/10.1016/0306-039x(76)90003-9)
27. Shabgah AG, Ezzatifar F, Aravindhan S, Zekiy AO, Ahmadi M, Gheibihayat SM, et al. Shedding more light on the role of Midkine in hepatocellular carcinoma: New perspectives on diagnosis and therapy [Internet]. Vol. 73, *IUBMB Life.* 2021. p. 659–69. Available from: <http://dx.doi.org/10.1002/iub.2458>
28. R H, Hannah R, Ramani P, Ramanathan A, Jancy MR, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene [Internet]. Vol. 130, *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology.* 2020. p. 306–12. Available from: <http://dx.doi.org/10.1016/j.oooo.2020.06.021>