



## **Assessment of Lung Function Test on Street Vendors of Chennai Region, India**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Introduction:** Street vendors are the most dominant occupation in urban and rural areas. Street vendors are exposed to several environmental pollution. They inhale toxic compounds such as carbon monoxide, carbon dioxide, ozone, nitrogen dioxide and other volatile organic chemicals. This is due to emission from vehicles and traffic. The aim of the study is to assess lung function on street vendors of the Chennai region.

**Materials and Methods:** The study is done among street vendors in Chennai region. The study included 50 people where 25 people are from the exposed group and 25 people are from the normal group. It was conducted by using a computerised spirometer. The total air capacity of the lung. The data was collected and entered in SPSS software. The results were obtained by doing an independent sample T test.

**Result and Discussion:** Parameters like FVC, FEV1, PEF, FEV1/FVC were used to assess the lung function. It was observed that there is a decline in pulmonary functions parameters of the street vendors and it was not statistically significant.

**Conclusion:** Thus the effect of pollution by the vehicles may be responsible for the pulmonary function impairment on street vendors affecting their lungs and other organs. This can be prevented by using face masks, lifestyle modification etc.

**Keywords:** Street vendors; spirometer; toxic compounds; parameters; innovative technique.

## 1. INTRODUCTION

In all the developing countries and rural areas, street vendors are the most dominant occupation. Street vendors are found everywhere and exposed to pollutants for their daily survival [1]. Most of the street vendors are found on commercial streets where there is a high effect of pollution. Due to the development in the industries there is a high increase in environmental pollution and vehicular traffic. The vendors are exposed to pollutants like carbon monoxide, carbon dioxide, nitrogen dioxide, ozone and other volatile organic chemicals leading to severe respiratory disorders [2]. Most of the pollution in urban areas is due to emission from diesel powered vehicles and traffic. The vendors are exposed to pollution which causes a major impact on the organs and system of the body [3]. It causes major lung disease, cardiovascular disease, ischemic heart disease and also bronchitis, asthma, headache, sore eyes etc [4].

Street vendors intake high amounts of toxic compounds which affect their lung capacity. The different parameters which are being used are forced vital capacity (FVC), forced expiratory volume (FEV), Peak expiratory flow rate (PEF) and FEV1/FVC [5]. The decrease in the air quality due to vehicular emission leads to significant mortality and morbidity by affecting multiple organs and the human system [6]. The lungs are vulnerable to such pollutants as there are large surface areas, thin respiratory areas and large quantities of pulmonary blood flow. The pollutants cause reduced lung function, cardiac problems, lung cancer and COPD [7]. Inhalation of toxic compounds can result in the injury to the airways and bronchitis which leads to acute and chronic respiratory diseases resulting in decreased lung function [8].

In India, the street vendors act was enacted in 2014 which said protection of livelihood and regulation of street vendors. Any health related perspective was not covered under this act for the vendor. Lung function tests vary differently which results in suggesting and is governed by genetic, environmental and nutritional factors which can help physicians to decide and diagnose the treatment of lung disease [9]. Outdoor air quality is an important determinant of a healthy individual. It is estimated that outdoor air pollution caused an increase of 3.7 million deaths.

The main aim of the study is to evaluate the lung function between the exposed group (street

vendors) and control group in the Chennai region. This study will also be aware of the exposure of the vendors that they are being exposed to as there is a rapid increase in the pollution level. Our team has extensive knowledge and research experience that has translated into high quality publications [10-29]. The study aims to evaluate the extent of impairment in lung function in street vendors compared to the general population.

## 2. MATERIALS AND METHODS

This study was conducted in the Chennai region. The study population included 50 people of age group 20-50 yrs, of which 25 people are from the exposed group and other 25 people are from the control group.

**Participants:** Street vendors of Chennai region, control group - normal healthy individuals.

**Inclusion criteria:**

The street vendors who have minimum work experience for 5 years.

The street vendors who work minimum for 5 hours per day.

**Exclusion Criteria:** smoker, alcoholic and tobacco were excluded.

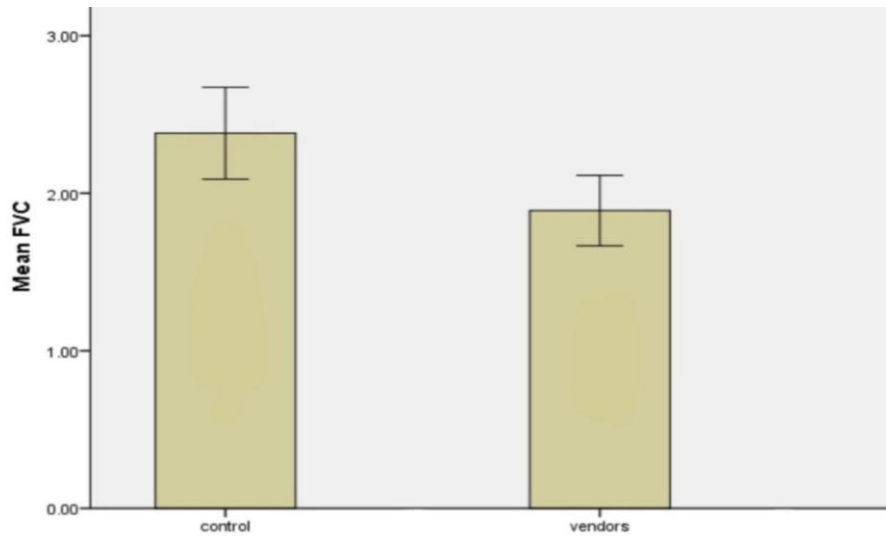
**Statistical Analysis:** the data was collected and entered in SPSS software and t test was done along with bar graphs.

## 3. RESULTS

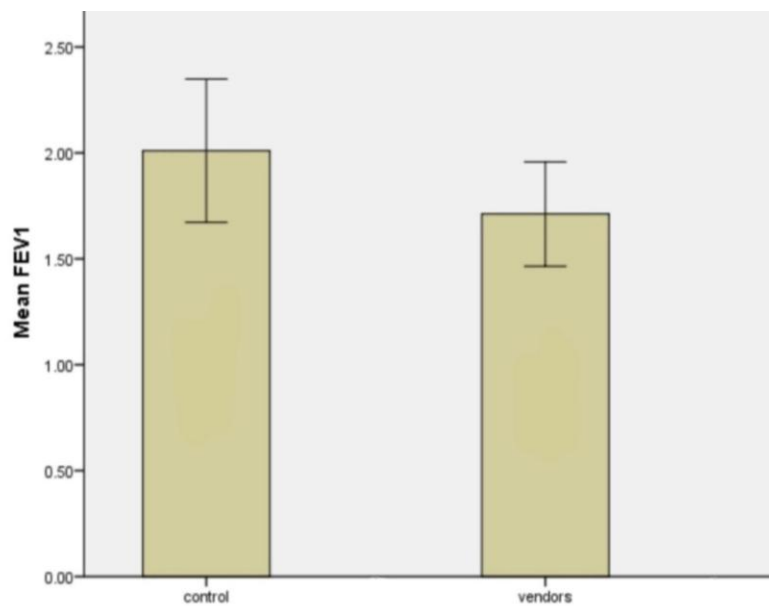
The parameters used for determining the lung function for street vendors are FVC, FEV1, PEF and FEV1/FVC for the analysis for both control group and exposed group. In (Fig. 1) the mean value for FVC for the controlled group is 2.38 and for the exposed group it is 1.88. As the street vendors are exposed to high pollution, it leads to the decline in FVC. Even Though the mean value of the exposed group was low, it was statistically not significant ( $P > 0.05$ ). In (Fig. 2) the mean value for FEV1 for the controlled group is 2.01 and for the exposed group it is 1.71. The mean value for the exposed group is less than the controlled group. So, there was a decrease in lung function of the exposed people ( $p > 0.05$ ). It was statistically not significant. In (Fig. 3) the mean value for PEF for the exposed group is 2.82 and for the controlled group it is 3.37 which

is low. The PEF for the exposed group is lower than the controlled group ( $P>0.05$ ). So it is statistically not significant. In (Fig. 4) the mean value for FEV1/FVC for the exposed group is 86.97 and for the controlled group it is 87.23. The mean value for exposed people is decreased

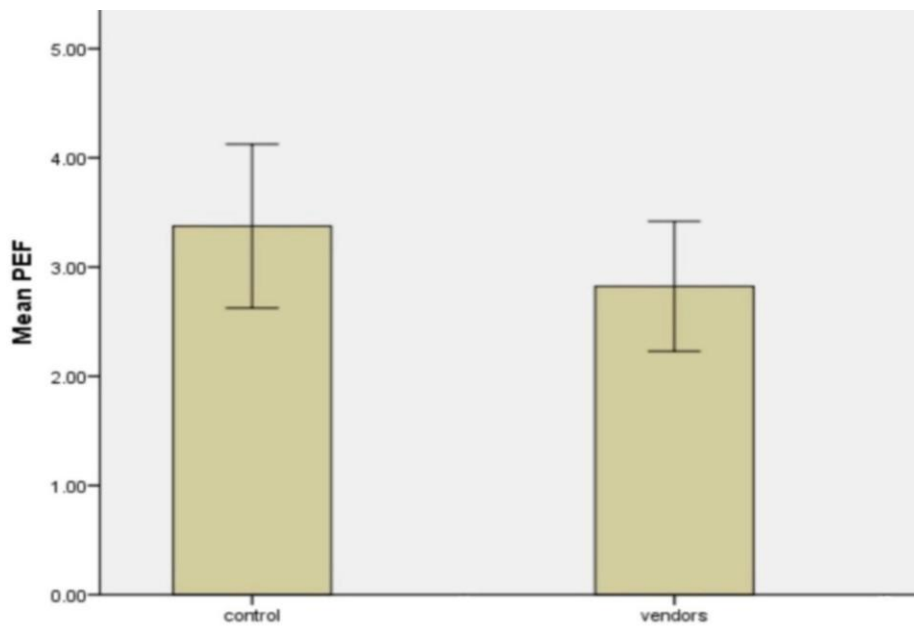
when compared to normal people ( $P>0.05$ ). It is not statistically significant. The (Table 1) shows the significance between the exposed group and normal group. It is not statistically significant in any case.



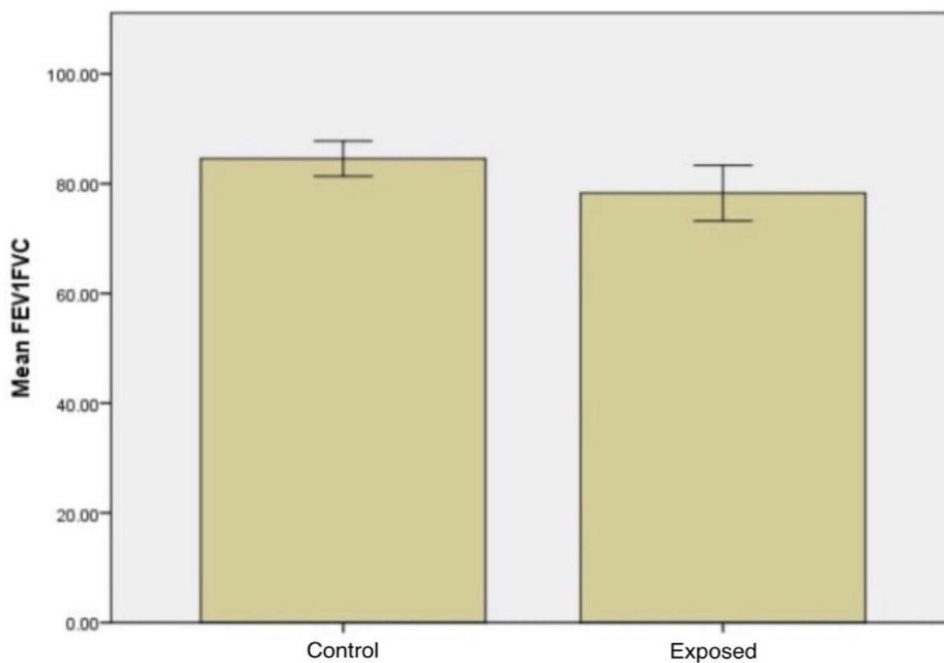
**Fig. 1. Shows the forced vital capacity (FVC) of control and exposed group. The X axis represents the controlled and the exposed group and the Y axis represents the mean FVC value. The Exposed group has lesser FVC value compared to the control group. An independent T test was done and the p value was found to be 0.108 ( $P>0.05$ ) which is statistically not significant**



**Fig. 2. Shows the forced expiratory volume of control and exposed group. The X axis represents the controlled and the exposed group and the Y axis represents the mean FEV1 value. The Exposed group has lesser FVC value compared to the control group. An independent T test was done and the p value was found to be 0.119 ( $P>0.05$ ) which is statistically not significant**



**Fig. 3.** This graph shows the peak expiratory flow rate (PEF) of the control and exposed group. The X axis represents the controlled and the exposed group and the Y axis represents the mean PEF value. The Exposed group has lesser FVC value compared to the control group. An independent T test was done and the p value was found to be 0.288 ( $P>0.05$ ) which is statistically not significant



**Fig. 4.** This graph shows the FEV1/FVC value of control and exposed group. The X axis represents the controlled and the exposed group and the Y axis represents the mean FEV1/FVC value. The Exposed group has lesser FEV1/FVC value compared to the control group. An independent T test was done and the p value was found to be 3.09 which is statistically not significant

**Table 1. Shows the significance in the exposed group and control group. It is not statistically significant in any case**

Parameters	Control group	Exposed group	P value
FVC	2.38±0.706	1.88±0.54	0.108
PEF	3.37±1.81	2.82±1.44	0.288
FEV1	2.01±0.82	1.71±0.59	0.119
FEV1/FVC	87.23±18.46	86.97±15.45	3.09

#### 4. DISCUSSION

The present study is designed to look for the differences in the respiratory function between the street vendors and the normal people. The street vendors are taken as an exposed group with long term exposure to air pollution.

From the study, it has been found that the street vendors are exposed to environmental pollutants and though it is not statistically significant, the lung function is lowered in the exposed group when compared to normal people. The chronic irritation caused by pollutants induce inflammatory responses associated with reduced lung function [30]. The street vendors are exposed to exhaust from motor vehicles along with other pollutants existing on the road. Exposure to pollutants has been associated with an increase in respiratory symptoms and decrease in lung function. The source of air pollution in urban areas is due to power plants, automobiles and industries [31].

Forced Vital Capacity(FVC) is the amount of air which is forcibly exhaled from the lungs after the deepest inhalation. From our study it was found that the mean value of FVC for the controlled group is higher than the exposed group. There is a decline in FVC for the street vendors. In a study conducted by [32] it was stated that the mean FVC value for exposed groups is lesser than the controlled group. In another study done by [33] the mean FVC was found to be the lesser for exposed groups. In our study the mean FVC value was less when compared to above studies. There is a decline in FVC value as street vendors are exposed to high intake of pollution which decreases their lung capacity [21].

Forced Expiratory volume in 1st second (FEV1) is the amount of air exhaled in the first second of the total expiratory time [34]. From our study it was found that FEV1 value for exposed groups is less than control groups. In a study conducted by [32] it was observed that FEV1 value for exposed groups is less than control group land. In the other study done by [33] it was found that the

FEV1 was less for exposed groups. In our study it was found that the FEV1 value is less when compared to other studies [35]. The decrease in FEV1 value is due to industrial pollution, vehicular emission which play a vital role in the decline of FEV1 [36].

Peak Expiratory Flow rate (PEF) is the maximal speed during forced expiration. When compared to other studies done by [32] the mean PEF value for the exposed group was less when compared to the control group. In our study the PEF value was less when compared to other studies. There is an abnormal PEF value in our study [15]. Age, height and weight can be the main factors which lead to a decline in PEF [28].

FEV1/FVC ratio is the measurement of the amount of air forcefully exhaled from the lungs. From our study it was found that the mean value of FEV1/FVC for exposed groups is less than the control group [18]. It is clearly understood that the significant value was decreased in the exposed group compared with the control group [37].

A similar study done in the Telangana region also documents the decrease in pulmonary function of the street vendors and the effect of pollution by vehicular emissions [38]. There is a negative correlation when compared to the pulmonary function test parameters among the street vendors with the duration of their exposure [26]. The decline in the lung function parameters may be due to the large number of pollutants like carbon monoxide, sulphur dioxide, ozone and other volatile organic compounds [39]. These pollutants affect the lungs resulting in oxidative stress which can contribute to fibrotic lung diseases, chronic bronchitis, emphysema and lung cancer [40]. As the street vendors are exposed to pollution for a long time the toxic chemicals and gases of vehicular emission produce irritation and allergies in the lungs and the airways [41]. The street vendors are particularly prone to occupational hazards [42]. The vehicular exhaust particularly from diesel exhaust induces reactive oxygen species in

macrophages and bronchial epithelial cells which is targeted by the particulate matter in the lung [43].

We observed that the value of FVC, FEV1, PEF, FEV1/FVC were reduced in street vendors as compared to the normal group. The street vendors are at high risk of obstructive and restrictive lung disease [44]. Some preventive measures should be taken for the street vendors as they are exposed to high pollution [45]. This study was done within a small population which is the limitation of the study and the future scope of the study is to be conducted in other regions.

## 5. CONCLUSION

Within the limitations of the study it was found that there is a decline in pulmonary function parameters in street vendors. Early detection, education awareness programs, wearing face masks, lifestyle modification and regular lung function tests can help them to avoid developing lung diseases.

## CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Amegah AK, Jaakkola JJK. Work as a street vendor, associated traffic-related air pollution exposures and risk of adverse pregnancy outcomes in Accra, Ghana [Internet]. Vol. 217, International Journal of Hygiene and Environmental Health. 2014;354–62. Available:<http://dx.doi.org/10.1016/j.ijheh.2013.07.010>
2. 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.
3. Gold DR, Samet JM. Air pollution, climate, and heart disease. *Circulation*. 2013 Nov 19;128(21):e411–4.
4. Hassing C, Twickler M, Brunekreef B, Cassee F, Doevendans P, Kastelein J, et al. Particulate air pollution, coronary heart disease and individual risk assessment: A general overview. *Eur J Cardiovasc Prev Rehabil*. 2009 Feb;16(1):10–5.
5. Evans SE, Scanlon PD. Current practice in pulmonary function testing. *Mayo Clin Proc*. 2003 Jun;78(6):758–63; quiz 763.
6. Lodovici M, Bigagli E. Oxidative stress and air pollution exposure. *J Toxicol*. 2011 Aug 13;2011:487074.
7. Silverman EK, Speizer FE. Risk factors for the development of chronic obstructive pulmonary disease. *Med Clin North Am*. 1996 May;80(3):501–22.
8. Nitta H, Sato T, Nakai S, Maeda K, Aoki S, Ono M. Respiratory health associated with exposure to automobile exhaust. I. Results of cross-sectional studies in 1979, 1982, and 1983. *Arch Environ Health*. 1993 Jan;48(1):53–8.
9. Makwana AH, Solanki JD, Gokhale PA, Mehta HB, Shah CJ, Gadhavi BP. Study of computerized spirometric parameters of traffic police personnel of Saurashtra region, Gujarat, India. *Lung India*. 2015 Sep;32(5):457–61.
10. Saraswathi I, Saikarthik J, Senthil Kumar K, Madhan Srinivasan K, 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. *PeerJ*. 2020 Oct 16;8:e10164.
11. 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 $\gamma$  Mediated Pathways. *Ind J Pharm Educ*. 2021 Mar 19;55(1s):s265–74.
12. 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.

13. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity. *Drug Dev Ind Pharm.* 2020 Aug;46(8):1219–29.
14. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global. 2019;237.
15. Prakash AKS, Devaraj E. Cytotoxic potentials of *S. cumini* methanolic seed kernel extract in human hepatoma HepG2 cells [Internet]. Vol. 34, *Environmental Toxicology.* 2019;1313–9. Available: <http://dx.doi.org/10.1002/tox.22832>
16. 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. *Cell Biol Int.* 2021 Jul;45(7):1498–509.
17. 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.
18. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Raj DDRD, Sivasubramanian M, et al. Emerging Therapeutic Approaches to Combat COVID-19: Present Status and Future Perspectives [Internet]. Vol. 8, *Frontiers in Molecular Biosciences.* 2021. Available: <http://dx.doi.org/10.3389/fmolb.2021.604447>
19. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. *Hepatobiliary Pancreat Dis Int.* 2020 Oct;19(5):429–34.
20. 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.
21. 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;101992. Available:<http://dx.doi.org/10.1016/j.jddst.2020.101992>
22. 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 [Internet]. Vol. 129, *Inorganic Chemistry Communications.* 2021;108647. Available:<http://dx.doi.org/10.1016/j.inoche.2021.108647>
23. 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;130229. Available:<http://dx.doi.org/10.1016/j.molstruc.2021.130229>
24. Gowhari Shabgah A, Ezzatifar F, Aravindhan S, Olegovna Zekiy A, Ahmadi M, Gheibihayat SM, et al. Shedding more light on the role of Midkine in hepatocellular carcinoma: New perspectives on diagnosis and therapy. *IUBMB Life.* 2021 Apr;73(4):659–69.
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. 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;306–12. Available:<http://dx.doi.org/10.1016/j.oooo.2020.06.021>
27. J PC, Marimuthu T, C K, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. *Clin Implant Dent Relat Res.* 2018 Aug;20(4):531–4.
28. 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.

29. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja VB. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study. *Journal of Cranio-Maxillofacial Surgery*. 2020 Jun 1;48(6):599–606.
30. Aronson D, Roterman I, Yigla M, Kerner A, Avizohar O, Sella R, et al. Inverse association between pulmonary function and C-reactive protein in apparently healthy subjects. *Am J Respir Crit Care Med*. 2006 Sep 15;174(6):626–32.
31. Tager IB, Balmes J, Lurmann F, Ngo L, Alcorn S, Künzli N. Chronic exposure to ambient ozone and lung function in young adults. *Epidemiology*. 2005Nov;16(6):751–9.
32. Pakkala A, Raghavendra T, Ganashree C. Effect of automobile pollution on pulmonary function tests of exposed hawkers [Internet]. Vol. 4, *Muller Journal of Medical Sciences and Research*. 2013;96. Available: <http://dx.doi.org/10.4103/0975-9727.118237>
33. Jones AYM, Lam PKW, Gohel MDI. Respiratory health of road-side vendors in a large industrialized city. *Environ Sci Pollut Res Int*. 2008 Mar;15(2):150–4.
34. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja V. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study [Internet]. Vol. 48, *Journal of Cranio-Maxillofacial Surgery*. 2020;599–606. Available:<http://dx.doi.org/10.1016/j.jcms.2020.04.005>
35. Meyer MW, Robinson JM. *The Nag Hammadi Scriptures: The Revised and Updated Translation of Sacred Gnostic Texts Complete in One Volume*. Harper Collins. 2010;864 .
36. 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 [Internet]. Vol. 54, *European Journal of Physical and Rehabilitation Medicine*; 2019. Available:<http://dx.doi.org/10.23736/s1973-9087.18.05005-0>
37. 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;1219–29. Available:<http://dx.doi.org/10.1080/03639045.2020.1788059>
38. 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 PPARγ Mediated Pathways [Internet]. Vol. 55, *Indian Journal of Pharmaceutical Education and Research*. 2021;s265–74. Available:<http://dx.doi.org/10.5530/ijper.55.1s.59>
39. Groneberg-Kloft B, Kraus T, van Mark A, Wagner U, Fischer A. Analysing the causes of chronic cough: relation to diesel exhaust, ozone, nitrogen oxides, sulphur oxides and other environmental factors. *J Occup Med Toxicol*. 2006 May 18;1:6.
40. Kim JJ, Smorodinsky S, Lipsett M, Singer BC, Hodgson AT, Ostro B. Traffic-related air pollution near busy roads: The East Bay Children's Respiratory Health Study. *Am J Respir Crit Care Med*. 2004 Sep 1;170(5):520–6.
41. D'amato G, Liccardi G, D'amato M, Cazzola M. The role of outdoor air pollution and climatic changes on the rising trends in respiratory allergy [Internet]. Vol. 95, *Respiratory Medicine*. 2001;606–11. Available:<http://dx.doi.org/10.1053/rmed.2001.1112>
42. 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;e10164. Available:<http://dx.doi.org/10.7717/peerj.10164>
43. Shenoy SJ, Sarasamma SV. A study of pulmonary function tests in traffic policemen in kottayam district and normal healthy adults [Internet]. Vol. 4, *Journal of Evidence Based Medicine and Healthcare*. 2017;405–9. Available:<http://dx.doi.org/10.18410/jebmh/2017/78>
44. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma [Internet]. Vol. 48, *Journal of Oral Pathology & Medicine*. 2019;299–306.



- Available:<http://dx.doi.org/10.1111/jop.12835>
45. 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;1498–509. Available:<http://dx.doi.org/10.1002/cbin.11589>

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