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Research Article

Effect Of Air Quality Index On Peak Expiratory Flow Rate, Spo2 And Minute Ventilation In Non-Smoker Individuals

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ABSTRACT

INTRODUCTION: This study explores the effects of ambient air quality as indicated by the air quality index (AQI) ON respiratory function in non- smoker individuals , specifically examining peak expiratory flow rate (PEFR) blood oxygen saturation (SPO2) and minute ventilation . this study involved 100 healthy non – smokers .

METHODS: This study is conducted in Delhi NCR region , a highly polluted area with varying air quality levels , to assess the effects of AQI on respiratory functions in non – smokers . A total of 100 healthy non - smokers , aged 18-50 years with no history of respiratory disease or other chronic conditions were recruited for the study . The AQI data was obtained from the official air quality monitoring stations in Delhi NCR which were installed and controlled by CPCB.

RESULTS: Respiratory health is greatly impacted by air quality , and the AIR QUALITY INDEX is a vital indicator of air pollution levels. The purpose of this study is to examine how different AQI levels affect respiratory parameters in non- smokers , particularly minute ventilation, oxygen saturation (SPO2), peak expiratory flow rate (PEFR). The study makes the assumption that elevated AQI reading , especially those in the dangerous and unhealthy ranges ,will cause a drop in PEFR, a drop in minute ventilation. This study sheds light on the immediate effects of air pollution on healthy people by carefully monitoring and measuring these indicators.

KEYWORDS: Air quality index (AQI), peak expiratory flow rate (PEFR), oxygen saturation (SPO2), minute ventilation, non-smoker

INTRODUCTION

Global ambient air pollution was predicted to be a contributing factor in 1.3million fatalities in a 2008 World Health Organization (WHO) assessment. 2012 saw a nearly threefold increase to 3.7 million. In 2008, home air pollution was a contributing factor in two million deaths. According to the most recent WHO study, which was based on data from 2012, this number also climbed and nearly doubled (to 4.3 million)[12]. Air pollution was a factor in almost two million preventable deaths annually[3]. In 2012, the combined impacts of ambient and residential air pollution were responsible for seven million fatalities worldwide.

Studies on controlled human and animal exposure have shown that respiratory tract inflammation can be caused by particles that are deposited there in large enough quantities. The dose and type of the particles affect how much inflammation occurs in the lungs[1]. Experiments on controlled human exposure have shown that exposure to a range of various particle types is associated with elevated indicators for lung inflammation[3]. For instance, combustion sources' organic carbon particles and transition metals might cause a significant inflammatory reaction.

Therefore, even if it is impossible to totally prevent exposure to particle pollution, there are easy procedures that can be taken to lessen exposure, which will lessen the intensity of unfavourable health impacts on the lungs and the systemic health of both healthy and sensitive individuals. Despite the respiratory system's amazing ability to repeatedly mobilize defence and repair systems in response to air pollution, prolonged exposure to increased particle pollution will eventually lead to impaired respiratory function, even in individuals who appear healthy. As a result, even while it is impossible to totally prevent exposure to particle pollution, there are easy ways to lessen the intensity of the negative health impacts on the lungs and the body in both healthy and sensitive individuals[3].

Air quality plays a pivotal role in influencing human health, especially the respiratory system. The AQI is a measure that evaluates air quality by quantifying pollutants such as particulate matter (PM2.5 and PM10), ground-level ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO)[1] [2]. The AQI is divided into several categories, ranging from "Good" to "Hazardous," with higher values indicating worse air quality and greater health risks.

While the impacts of air pollution on individuals with pre-existing respiratory conditions such as asthma or COPD are well-documented, less is known about its acute effects on

healthy, non-smoking individuals. This study investigates how different AQI levels affect pulmonary function as measured by Peak Expiratory Flow Rate (PEFR), oxygen saturation (SpO2), and minute ventilation, all of which are vital indicators of respiratory health. **PEFR**: A measure of the maximum flow rate during forced expiration, commonly used in assessing airway patency and lung function. **SpO2**: The percentage of oxygen saturation in the blood, providing an indication of the efficiency of oxygen transfer to tissues. **Minute Ventilation (VE)**: The total volume of air exhaled in one minute, reflecting respiratory rate and tidal volume, which can vary in response to external factors like air pollution. The objective of this study is to determine how increasing AQI levels affect these parameters in non-smoker individuals, as air pollution is known to cause acute respiratory changes even in healthy individuals.

MATERIALS AND METHODS

This study was a cross-sectional design, with data collected from 100 healthy non-smoker volunteers (aged 18-50 years), residing in a region with varying AQI levels in the region of Delhi NCR .Participants were excluded if they had a history of respiratory disease, smoking, or any other conditions that might confound the results. The study was conducted over a period of 1year, with data collection sessions scheduled in accordance with real-time AQI data. The respiratory parameters of the participants were tracked using the different AQI categories: **Good** (0-50)**Moderate** (51-100)**Unhealthy for Sensitive Groups** (101-150)**Unhealthy** (151-200)**Very Unhealthy** (201-300) **Hazardous** (301+). In this study three respiratory parameters are monitored at different levels of AQI at different locations.

- **PEFR**(Peak expiratory flow rate) was measured using a peak flow meter in three trials, and the highest value was recorded. Participant is asked to exhale in peak flow meter.
- **SP02**was measured using a fingertip pulse oximeter, ensuring that the participant was at rest for at least 5 minutes before measurement.
- **Minute ventilation**was assessed by using the formula for minute ventilation(VE=VT(tidal volume)*F(respiratory rate) and the participants were asked to breathe normally while their ventilation was measured in litres per minute.Each participant was tested under different AQI category

PROCDEDURE

RECRUITMENT OF PARTICIPANTS

- Non - smoker individuals are recruited
- Participants are recruited according to the inclusion and exclusion criteria
- Voluntary participation and informed consent

BASELINE MEASUREMENTS:

INITIAL HEALTH ASSESSMENT: Record basic demo9graphic information(age, gender, BMI etc.) and health history. BASELINE RESPIRATORY MEASUREMENTS: Measure baseline PEFR,Spo2 and minute ventilation and respiratory rate.

MONITORING AIR QUALITY INDEX (AQI)

AQI data collection : For air quality index we've used the SAMEER A pp by CPCB as they have air quality monitoring stations at different locations or sensors for monitoring air quality . AQI Categories : AQI is generally classified into certain categories such as good , moderate, and unhealthy based on international standards such as WHO.

TESTING AND DATA COLLECTION

TIME OF MEASUREMENT : Measure PEFR , SPO2 and minute ventilation at fixed time when AQI is recorded .

ENVIRONMENTAL CONTROL : Ensured that all measurements are taken under similar conditions (same time of day, controlled indoor environment , avoiding physical exertion during testing)

RESPIRATORY MEASUREMENTS

PEFR : Measurement of peak expiratory flow meter is done by peak flow meter (PFM) in L/min. SPO2 : used a pulse oximeter to measure oxygen saturation . MINUTE VENTILATION : minute ventilation is calculated by respiratory rate and tidal volume

RESULTS

Table 1: Descriptive statistics of different pollution parameters for non-smoking population N=100

Parameters	Minimum	Maximum	Mean	Std. Deviation
Age	21	44	31.46	5.59
PEFR (Litre / minute)	280	560	419.40	73.28
SPo2 (%)	94	99	97.12	1.21
AQI	162	652	348.29	95.84
Minute Ventilation (Litre / minute)	4.82	9.63	7.24	1.04

Above table shows that mean age of non-smoker population was 31.46 years. Mean peak flow rate was 419.40 litre/minute and comes under normal range. Mean SPO2 was 97.12% and comes under normal range. Mean AQI was 348.29 and it is very poor air quality index. Mean minute ventilator was 7.24 litre/minute and comes under normal range.

Table 2: Frequency and percentage of Peak flow rate (PEFR) for non-smoker population N=100

PEFR (Litre / minute)	Frequency	Percent
Low peak flow	48	48.0
Normal peak flow	52	52.0

Above table shows that majority of 52% non-smoker population had normal peak flow rate and 48% non-smoker population had low peak flow rate litre/minutes.

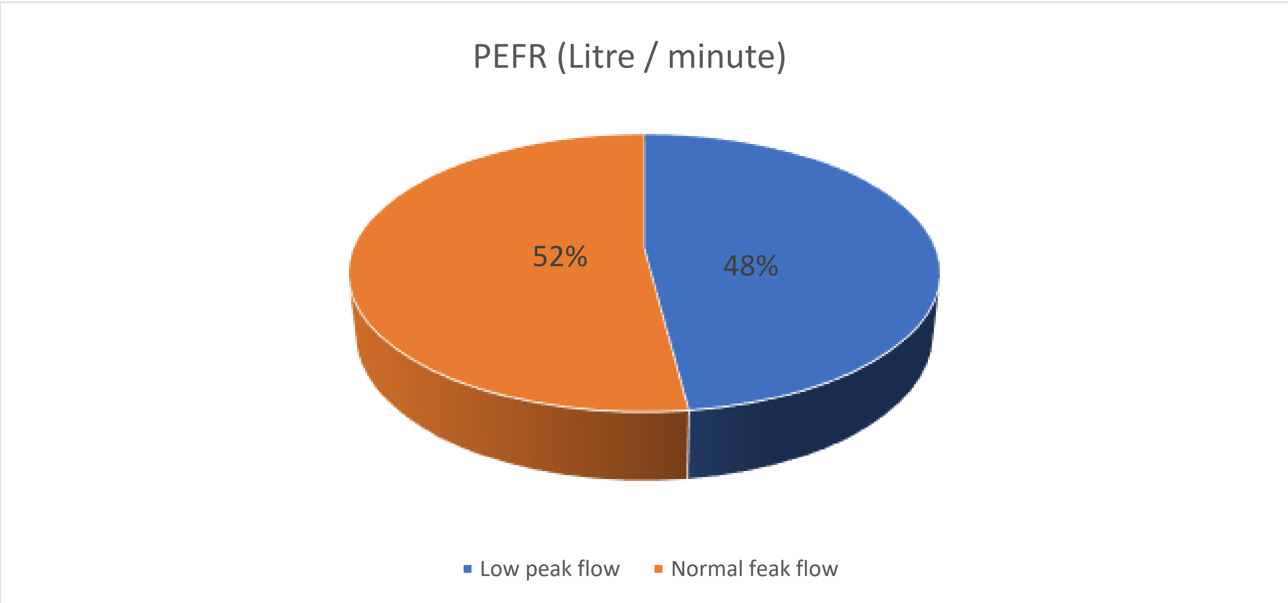

Table 3: Frequency and percentage of Air Quality Index (AQI) for non-smoker population N=100

AQI scale	Frequency	Percent
Very poor	49	49.0
Poor	26	26.0
Moderately polluted	3	3.0
Severe	22	22.0

Above table shows that majority of 49% non-smoker population had very poor air quality, 26% non-smoker population had poor air quality, 22% non-smoker population had severe air quality and 03% non-smoker population had moderately polluted air quality.

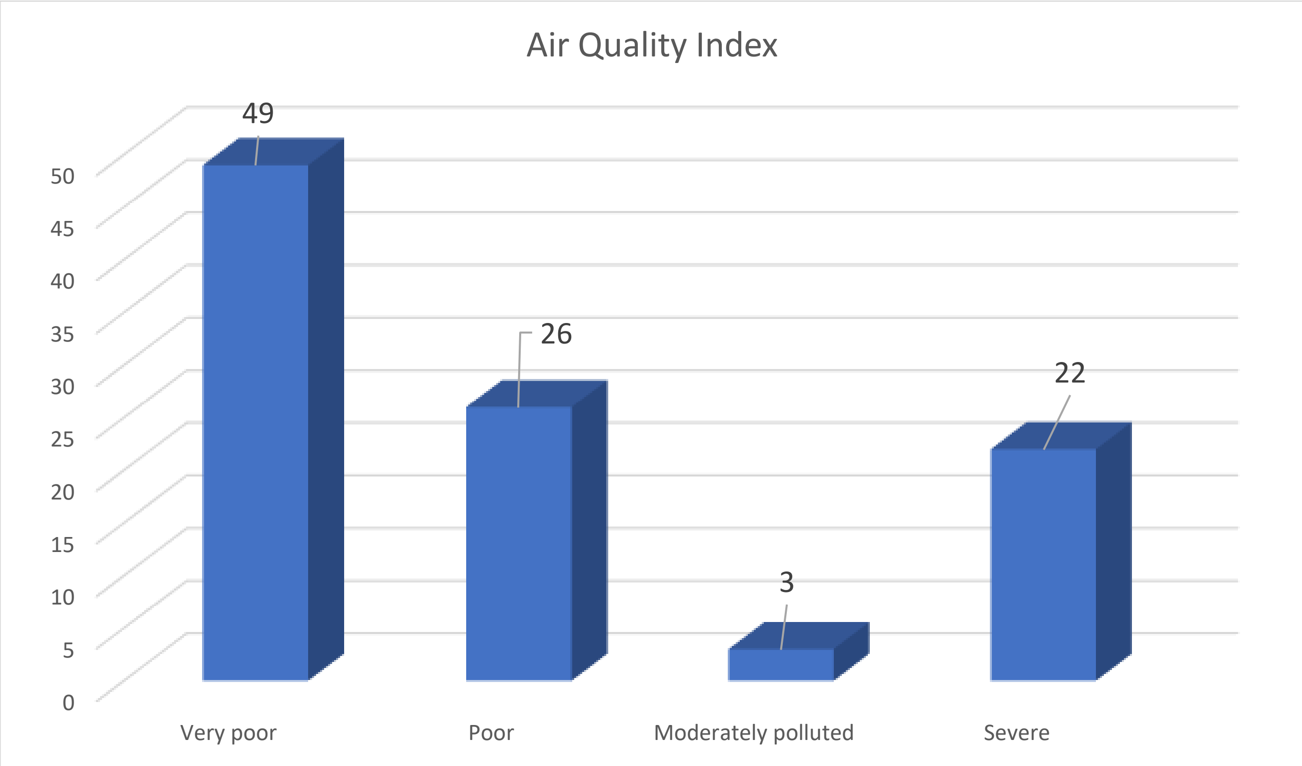

Table 4 : Correlation between Airquality index with PEFR; Spo2 and minute ventilation for non-smoker populationN=100

Parameters	Correlation Value (r)	P-value
	Air Quality Index (AQI)	
PEFR (litre/minutes)	0.100	0.320
Spo2 (%)	0.107	0.290
Minute Ventilation (litre/minutes)	-0.003	0.977

Above table shows that there was no correlation between air quality index and PEFR; Spo2 and minute ventilation with $P>0.05$.

Table 5 : Correlation between Minute ventilation with PEFR; Spo2 and Airquality index for non-smoker population N=100

Parameters	Correlation Value (r)	P-value
	Minute Ventilation (litre/minutes)	
PEFR (litre/minutes)	0.344	0.001
Spo2 (%)	0.273	0.006
Air Quality Index (AQI)	-0.003	0.977

Above table shows that there was no correlation between peak flow rate and PEFR; Spo2 with $P<0.05$. and no correlation with minute ventilation with $P>0.05$.

DISCUSSION

The findings of this study highlight the acute effects of air pollution, as reflected by AQI levels, on respiratory function in healthy non-smokers. The significant reduction in PEFR at elevated AQI levels underscores the impact of air pollution on airway obstruction and lung function, even in the absence of pre-existing respiratory conditions. This decline in PEFR may reflect inflammation, bronchoconstriction, or other airway responses induced by pollutants

Exposure to poor air quality compromises oxygenation. While non-smokers generally exhibit high baseline SpO2 levels, prolonged exposure to elevated AQI levels may impair the body's ability to transport oxygen effectively. Interestingly, the increase in minute ventilation at higher AQI levels suggests a compensatory effort by the respiratory system to maintain oxygen intake. However, the increased ventilation does not fully counteract the negative impacts on PEFR and SpO2, indicating that minute ventilation alone is insufficient to mitigate the effects of air pollution on pulmonary function. These findings are consistent with existing literature that links air pollution to respiratory health deterioration, even among individuals without chronic respiratory diseases. However, this study provides novel insights into the specific respiratory parameters—PEFR, SpO2, and minute ventilation—that are affected by varying AQI levels.

CONCLUSION

This study demonstrates that elevated AQI levels have a significant impact on respiratory function in healthy, non-smoking individuals. Increased air pollution, particularly in the"Unhealthy" to "Hazardous" categories, leads to reduced PEFR, lower SpO2, and altered minute ventilation. These findings emphasize the importance of air quality in maintaining respiratory health and suggest that even non-smokers are vulnerable to the acute effects of air pollution. Future research should explore long-term exposure and investigate potential interventions to mitigate these impacts.

REFERENCES

1. Stieb, D. M., Shutt, R., Kauri, L. M., Roth, G., Szyszkowicz, M., Dobbin, N. A., Chen, L., Rigden, M., Van Ryswyk, K., Kulka, R., Jovic, B., Mulholland, M., Green, M. S., Liu, L., Pelletier, G., Weichenthal, S. A., & Dales, R. E. (2018). Cardiorespiratory Effects of Air Pollution in a Panel Study of Winter Outdoor Physical Activity in Older Adults. *Journal of occupational and environmental medicine*, *60*(8), 673–682. https://doi.org/10.1097/JOM.0000000000001334
2. Kelly, F. J., &Fussell, J. C. (2011). Air pollution and airway disease. *Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology*, *41*(8), 1059–1071. https://doi.org/10.1111/j.1365-2222.2011.03776.x
3. Kurt, O. K., Zhang, J., & Pinkerton, K. E. (2016). Pulmonary health effects of air pollution. *Current opinion in pulmonary medicine*, *22*(2), 138–143. https://doi.org/10.1097/MCP.0000000000000248
4. Zhou, Y., Liu, Y., Song, Y., Xie, J., Cui, X., Zhang, B., Shi, T., Yuan, J., & Chen, W. (2016). Short-term Effects of Outdoor Air Pollution on Lung Function among Female Non-smokers in China. *Scientific reports*, *6*, 34947. https://doi.org/10.1038/srep34947
5. Wang, M., Aaron, C. P., Madrigano, J., Hoffman, E. A., Angelini, E., Yang, J., Laine, A., Vetterli, T. M., Kinney, P. L., Sampson, P. D., Sheppard, L. E., Szpiro, A. A., Adar, S. D., Kirwa, K., Smith, B., Lederer, D. J., Diez-Roux, A. V., Vedal, S., Kaufman, J. D., & Barr, R. G. (2019). Association Between Long-term Exposure to Ambient Air Pollution and Change in Quantitatively Assessed Emphysema and Lung Function. *JAMA*, *322*(6), 546–556. https://doi.org/10.1001/jama.2019.10255
6. Luttmann-Gibson, H., Suh, H. H., Coull, B. A., Dockery, D. W., Sarnat, S. E., Schwartz, J., Stone, P. H., & Gold, D. R. (2006). Short-term effects of air pollution on heart rate variability in senior adults in Steubenville, Ohio. *Journal of occupational and environmental medicine*, *48*(8), 780–788. https://doi.org/10.1097/01.jom.0000229781.27181.7d
7. Huang, F., Wang, P., Pan, X., Wang, Y., & Ren, S. (2020). Effects of short-term exposure to particulate matters on heart rate variability: A systematic review and meta-analysis based on controlled animal studies. *Environmental pollution (Barking, Essex : 1987)*, *256*, 113306. https://doi.org/10.1016/j.envpol.2019.113306
8. Yan, P., Liu, P., Lin, R., Xiao, K., Xie, S., Wang, K., Zhang, Y., He, X., Zhao, S., Zhang, X., Liu, M., &Xie, L. (2019). Effect of ambient air quality on exacerbation of COPD in patients and its potential mechanism. *International journal of chronic obstructive pulmonary disease*, *14*, 1517–1526. https://doi.org/10.2147/COPD.S190600
9. Choi, J., Oh, J. Y., Lee, Y. S., Min, K. H., Hur, G. Y., Lee, S. Y., Kang, K. H., & Shim, J. J. (2018). Harmful impact of air pollution on severe acute exacerbation of chronic obstructive pulmonary disease: particulate matter is hazardous. *International journal of chronic obstructive pulmonary disease*, *13*, 1053–1059. https://doi.org/10.2147/COPD.S156617
10. Zieliński, M., Gąsior, M., Jastrzębski, D., Desperak, A., &Ziora, D. (2018). Influence of particulate matter air pollution on exacerbation of chronic obstructive pulmonary disease depending on aerodynamic diameter and the time of exposure in the selected population with coexistent cardiovascular diseases. *Advances in respiratory medicine*, *86*(5), 227–233. https://doi.org/10.5603/ARM.2018.0036
11. Basille, D., Soriot, L., Weppe, F., Desmettres, P., Henriques, P., Benoit, N., Devaux, S., Diouf, M., Jounieaux, V., &Andrejak, C. (2024). Association between acute exacerbation of chronic obstructive pulmonary disease and short-term exposure to ambient air pollutants in France. *Environmental health : a global access science source*, *23*(1), 107. https://doi.org/10.1186/s12940-024-01146-3WORLD HEALTH ORGANISATION
12. Li, J., Sun, S., Tang, R., Qiu, H., Huang, Q., Mason, T. G., & Tian, L. (2016). Major air pollutants and risk of COPD exacerbations: a systematic review and meta-analysis. *International journal of chronic obstructive pulmonary disease*, *11*, 3079–3091. https://doi.org/10.2147/COPD.S122282

13. Su, J. G., Aslebagh, S., Shahriary, E., Barrett, M., &Balmes, J. R. (2024). Impacts from air pollution on respiratory disease outcomes: a meta-analysis. *Frontiers in public health*, *12*, 1417450. https://doi.org/10.3389/fpubh.2024.1417450
14. Brunekreef, B., Beelen, R., Hoek, G., Schouten, L., Bausch-Goldbohm, S., Fischer, P., Armstrong, B., Hughes, E., Jerrett, M., & van den Brandt, P. (2009). Effects of long-term exposure to traffic-related air pollution on respiratory and cardiovascular mortality in the Netherlands: the NLCS-AIR study. *Research report (Health Effects Institute)*, (139), 5–89.