Assessment of pulmonary functions among traffic police personnel in Chennai city - A comparative cross-sectional study

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ABSTRACT

Background: Air pollution due to road traffic is a solemn health hazard and vehicular emissions due to huge population in the cities are the main reason for the air quality crisis. The study was conducted to assess the degree of impairment in lung function in traffic police personnel exposed to traffic pollution compared to less-exposed healthy subjects. Materials and Methods: This comparative cross-sectional study was conducted among 250 traffic police personnel, aged 20–55 years, working in Chennai city, as compared to a matched control group, consisting of 250 less-exposed subjects. Measurement of pulmonary function testing was done with an RMS Helio 401. Statistical analysis was carried out with R statistical software. Results: The traffic police personnel had significantly ($P < 0.05$) declined FEV1 and FEV1/FVC ratio and FEF 25–75% (L/s) as compared to controls. Traffic personnel with longer duration of exposure showed significantly ($P < 0.05$) reduced lung functions than those with shorter duration. We have found a significant negative correlation with all pulmonary function parameters such as FVC, FEV1, FEV1/FVC, PEFR, and FVC 25%–75% among the traffic police personnel. Conclusion: The impairment of pulmonary function among the traffic police personnel might be due to the effect of pollution by vehicular exhausts and they should be offered personal protective or preventive measures.

Keywords: Air pollution, health hazards, pulmonary function, traffic police

Introduction

Air pollution is a continuously increasing environmental degradation due to overexploitation of natural fuel resources, industrialization, rapid urbanization an economic development. Emission from vehicular traffic is one of the biggest sources of air pollution that affect people who live or work in cities.

Vehicular traffic contributes to almost 30% of air pollution in cities. Road traffic generates volatile organic compounds, suspended particulate matter, sulfur oxides, oxides of nitrogen, and carbon monoxide which impose adverse health effects on the exposed population. Deterioration in air quality due to vehicular emissions has shown to produce significant morbidity and mortality by affecting multiple organs and systems. The respiratory system bears the direct brunt of pollutants in the inhaled air. The lungs are vulnerable due to their large surface area exposed to ventilation, thin respiratory membranes, and massive quantity of pulmonary blood flow. These pollutants cause respiratory morbidities, reduced lung function, and even cause cardiac problems and upon chronic exposure it may even cause lung cancers and COPD. Inhalation of toxic substances in the inspired air can result in injury to airways including the
terminal bronchioles, leading to acute and chronic respiratory diseases, exhibiting as a decrease in lung function.\textsuperscript{6,7} The various occupational groups exposed to air pollution include drivers, hawkers, toll booth workers, traffic police personnel, road side vendors, and street sweepers. The traffic police personnel of metropolitan cities, particularly from densely populated countries like India, who work in the traffic for hours together for many years are highly vulnerable to the respiratory morbidities.\textsuperscript{8} Hence, it is essential to understand how much would be the exposure to these pollutants to traffic police personnel who are working for a long shift on roadways as a part of their duties. There have been some studies done in different cities of the country like Hyderabad,\textsuperscript{9} Patiala,\textsuperscript{10} Jaipur,\textsuperscript{11} Paducherry,\textsuperscript{12,13} and Gujarat.\textsuperscript{14} But no studies could be traced out from the Chennai city. In spite of the high vulnerability of the traffic police personnel of the Chennai city, there are hardly any studies that have been done on them. Moreover, there is a possibility to detect pulmonary disease only by periodic retesting in the earliest stages when preventive or corrective measures are more likely to be beneficial. So, the present study was aimed at assessing the pulmonary functions among the traffic police personnel posted at various traffic junctions of the Chennai city so as to note whether prolonged exposure to vehicular exhausts had any detrimental effect on their lung functions and also by way of this study we have tried to establish a link between the duration of exposure to vehicular exhausts and decrements in various lung parameters of traffic police personnel.

\section*{Methodology}

This comparative cross-sectional study was conducted in Chennai city West zone which includes Porur, Poonamallli, Ambattur, Mathuravayil, and Thiruverkadu. Totally, 500 subjects were included; among them, 250 subjects were traffic police personnel (exposure group) and 250 subjects were control (less exposure) group. Clearance from the Institutional Ethical Committee was obtained prior to the conduct of the study. Permission from the Deputy Commissioner of Police, Chennai city was obtained after explaining the protocol and benefits to them. Healthy nonsmoker traffic police personnel in the age group of 20–55 years who are working in traffic junctions for >1 year are included in the study. Healthy non-smoker control population of the same age group residing >2 years were selected in the study. Subjects with the history of smoking, known case of COPD/Asthma/TB and those who have recent had abdominal/thoracic surgery were excluded from the current study. Information about demographic details, socioeconomic status, and history of respiratory illnesses were obtained by using a standard questionnaire. General examination followed with detailed respiratory system examination was performed and clinical examination findings were noted. Pulmonary function test was conducted as per the ATS criteria\textsuperscript{15} and the parameters such as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), forced expiratory flow rate 25–75\% (FEF25–75\%) and peak expiratory flow rate (PEFRR) were measured using a portable spirometer (RMS Helios 401).

\section*{Results}

There was no significant difference with regard to the anthropometric parameters between the control group and exposed group [Table 1].

Out of five traffic police stations, 33\% (n-80) were from Ambattur, 20\% (n-47) in Porur, 18\% (n-43) in Mathuravoyal, 16\% (n-39) Poonamallie, and 13\% (n-31) [Figure 1] in Thiruverkadu station.

The pulmonary function parameters of the exposed traffic policemen have significantly (p<0.001) lower FEV1 (2.79±0.51), FEV1/FVC (78.40±7.67), and FEV 25-75\% (2.66±0.83) than the control groups with less exposure [Table 2]. There was no significant change with regard to the other parameters such as FVC (L) and PEFRR (L).

As shown in Table 3, we found that as the years of experience increase all the pulmonary function parameters decrease significantly in traffic police personnel. Traffic policemen having more than 20 years of experience suffer a significant decline in pulmonary function parameters.

As shown in Table 4, the Pearson correlation test between the duration of exposure and pulmonary function shows that there was a significant negative correlation between the pulmonary function parameters such as FVC, FEV1, FEV1/FVC, PEFRR and FVC 25%–75% among the traffic police personnel. This would clearly explain that as the year of exposure increases the pulmonary function declines significantly in traffic police personnel.

\section*{Discussion}

This comparative cross-sectional study was designed to look for differences in the respiratory function between traffic police personnel and less exposed group.

| VARIABLE | Less Exposed (control) | Exposed (Traffic police) |
|----------|------------------------|---------------------------|
| Age (yrs) | 38.03±10.95 | 39.43±13.87 |
| Height (cm) | 171.14±6.96 | 173.34±4.33 |
| Weight (kg) | 76.18±8.56 | 78.40±7.67 |
| BMI (kg/m\(^2\)) | 25.91±4.48 | 26.40±4.90 |

\section*{Table 2: Lung function parameters of exposed (traffic police personnel) group and less-exposed (control) group}

| Variables | Less Exposed (control) n=250 | Exposed (Traffic police) n=250 | p |
|-----------|-------------------------------|-------------------------------|---|
| FVC (L) | 3.61±0.76 | 3.55±0.58 | 0.41 |
| FEV1 (L) | 2.98±0.62 | 2.79±0.51 | 0.002 |
| FEV1/FVC (%) | 82.80±5.53 | 78.40±7.67 | <0.001 |
| PEFRR (L) | 8.01±1.2 | 8.16±1.5 | 0.27 |
| FEF25-75\% (L/s) | 3.22±0.94 | 2.66±0.83 | <0.001 |

Values were expressed as Mean(±SD). Unpaired T test was done to compare between the groups. \(P<0.05\) set as significant. FVC-Forced vital capacity, FEV1-Forced expiratory volume in one second, PEFRR-Peak expiratory flow rate, FEF25-75 ‑Forced expiratory flow rate 25–75
Table 3: Spirometric parameters among the traffic police personnel according to years of exposure

| Variables          | <5 yrs. (n=39) | 5-10 yrs. (n=79) | 10-20 yrs. (n=89) | >20 yrs. (41) | P  |
|--------------------|----------------|------------------|-------------------|---------------|----|
| FVC (L)            | 3.99±0.68      | 3.63±0.52        | 3.51±0.55         | 3.30±0.53     | 0.001 |
| FEV1 (L)           | 3.84±0.66      | 3.57±0.47        | 3.56±0.51         | 3.35±0.58     | 0.01 |
| FEV1/FVC (%)       | 80.99±6.98     | 79.06±4.95       | 78.42±7.41        | 75.80±11.04   | 0.001 |
| PEF (L/sec)        | 8.41±1.20      | 8.23±1.23        | 8.40±1.62         | 7.52±1.68     | 0.05 |
| FVC25-75% (L)      | 3.45±0.89      | 2.69±0.61        | 2.65±0.85         | 2.22±0.73     | 0.001 |

Values were expressed Mean±SD. One way Anova was done followed by Tukey HSD post hoc test. P<0.05 set as significant.

Table 4: Correlation between the pulmonary function and duration of exposure among traffic police personnel

| Correlation coefficient (r) | P      |
|-----------------------------|--------|
| FVC (L)                     | -0.38  | <0.001 |
| FEV1 (L)                    | -0.34  | <0.001 |
| FEV1/FVC (%)                | -0.2   | 0.001  |
| PEF (L/s)                   | -0.12  | 0.04   |
| FVC 25%-75% (L)             | -0.34  | <0.001 |

A similar recent study by Amit et al., 2015 on Gujarat traffic police personnel also documents decreased pulmonary function and correlates the decline in the same to the effect of pollution by vehicular exhausts. The comparison of PFT parameters among traffic police personnel with the duration of exposure has revealed a negative correlation. The magnitude of decline in many PFT parameters has been shown to be directly proportional to the duration of traffic duty. This suggests that increase in the duration of traffic duty (in years) has an increasingly harmful effect on the lung function of traffic police personnel. This decline in lung function parameters may be due to a large number of pollutants such as sulfur dioxide, carbon monoxide, nitric oxide, particulate matter, and ozone influence on the body. These pollutants put a burden on the lungs and the resulting oxidative stress is thought to contribute to the genesis of fibrotic lung diseases, chronic bronchitis, emphysema, and lung cancer. Toxic chemicals and gases of vehicular emission produce irritation and allergy in the lungs and airways of subjects who are exposed to them for a long time. Traffic police are particularly prone to this occupational hazard. Vehicular exhaust, particularly, organic extracts of diesel exhaust induce reactive oxygen species in macrophages and bronchial epithelial cells which are the key cell types targeted by the particulate matter in the lung. Reactive oxygen species in turn activate the promoters of cytokines and chemokines leading to allergic inflammation through activator protein 1 and nuclear factor kappa B signaling pathways. Organic diesel exhaust particles, via a mitochondrial pathway, induce apoptosis and necrosis in bronchial epithelial cells.
exhaust particles thought to be made up of carbon core are surrounded by trace metals, such as nickel and salts which adsorb organic hydrocarbons and a number of these components do have inflammatory lung effects seen in laboratory animals. Inhalation of hydrocarbons also leads to lung inflammation. These observations indicate that diesel particles themselves can induce airway inflammation. We observed that the actual value of forced expiratory volume in 1 second (FEV1) and FEV1/FVC were reduced in traffic police personnel as compared to predicted values. This shows some degree of obstruction being present in the respiratory tract of traffic police personnel. The changes might be in the tissue of the lungs due to the chronic irritation by vehicular pollutants.

**Conclusion**

The findings of this study show that the FEV and FVC of the traffic police personnel have decreased over the years, thus confirming the significant adverse health impacts of automobile pollution. The prolonged exposure to vehicular pollution might cause airway obstruction by inducing chronic airway irritation and increased mucus production leading to obstructive kind of lung diseases. Thus, we strongly vouch for the adoption of various strategies for the protection/preventive measure of traffic police personnel from vehicular pollution.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. 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;170:520-6.
2. Chattopadhyay B, Alam J, Roychowdhury A. Pulmonary function abnormalities associated with exposure to automobile exhaust in a diesel bus garage and roads. Lung 2003;181:291-302.
3. Lodovici M, Bigagli E. Oxidative stress and air pollution exposure. J Toxicol 2011;2011:487074. doi: 10.1155/2011/487074.
4. Katsouyanni K, Touloumi G, Samoli E, Gryparis A, Le Terr A, Monopolis Y, et al. Confounding and effect modification in the short-term effects of ambient particles on total mortality: Results from 29 European cities within the APHEA2 project. Epidemiology 2001;12:521-31.
5. Silverman EK, Speizer FE. Risk factors for the development of chronic obstructive pulmonary disease. Med Clin North Am 1996;80:501-22.
6. Hodgkin JE, Abbey DE, Euler GL, Magie AR. COPD prevalence in nonsmokers in high and low photochemical air pollution areas. Chest 1984;86:830-8.
7. Nitta H, Sato T, Nakai S, Maeda K, Aoki S, Ono M. Respiratory health associated with exposure to automobile exhaust. I.
8. Results of cross-sectional studies in 1979, 1982, and 1983. Arch Environ Health 1993;48:53-8.
9. Devi VS, Rao VD, Har Gopal V, Prasad BS, Devi GS, Jothy A, et al. Cytogenetic evaluation of traffic policemen occupationally exposed to vehicular exhaust. Indian J Med Res 2009;130:520-5.
10. Gupta S, Mittal S, Kumar A, Singh KD. Respiratory effects of air pollutants among nonsmoking traffic policemen of Patiala, India. Lung India 2011;28:253-7.
11. Singh V, Sharma BB, Yadav R, Meena P. Respiratory morbidity attributed to auto-exhaust pollution in traffic policemen of Jaipur, India. J Asthma 2009;46:118-21.
12. Ranganadin P, Chinnakali P, Vasudevan K, Rajaram M. Respiratory health status of traffic policemen in Puducherry, South India. Int J Curr Res Rev 2013;5:87.
13. Dutta T, Pal G. Pulmonary function test in traffic police personnel in Pondicherry. Indian J Physiol Pharmacol 2010;54:329-36.
14. Makwana AH, Solanki JD, Gokhale PA, Mehta HB, Shah CJ, Gadavali BP. Study of computerized spirometric parameters of traffic police personnel of Saurashtra region, Gujarat, India. Lung India 2015;32:457-61.
15. Miller A, Enright PL. PFT interpretive strategies: American Thoracic Society/European Respiratory Society 2005 guideline gaps. Respiratory Care 2012;57:127-35.
16. Taylor DR, Fergusson DM, Milne BJ, Horwood LJ, Moffitt TE, Sears MR, et al. A longitudinal study of the effects of tobacco and cannabis exposure on lung function in young adults. Addiction 2002;97:1055-61.
17. Celi BR, Cote CG, Lareau SC, Meek PM. Predictors of Survival in COPD: More than just the FEV1. Respir Med 2008;102:S27-35.
18. Wedzicha JA, Miravitlles M, Hurst JR, Calverley PM, Albert RK, Anzueto A, et al. Management of COPD exacerbations: A European respiratory society/American thoracic society guideline. Eur Respir J 2017;49:1600791. doi: 10.1183/13993003.00791-2016.
19. Karita K, Yano E, Jinsart W, Boudoung D, Tamura K. Respiratory symptoms and pulmonary function among traffic police in Bangkok, Thailand. Arch Environ Health 2001;56:467-70.
20. Gronenberg-Kloft B, Kraus T, Van Mark A, Wagner U, Fischer A. Analyzing the causes of chronic cough: Relation to diesel exhaust, ozone, nitrogen oxides, sulphur oxides and other environmental factors. J Occup Med Toxicol 2006;1:6.
21. 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. Respir Med 2001;95:606-11.
22. Pramila T, Girija B. Study of pulmonary function tests in traffic policemen exposed to automobile pollution in Bangalore City. Risk 2013;11:13.
23. Dickson RP, Schwartz DA. Acute and chronic responses to toxic inhalations. Fishmans Pulm Disord 2008;4:995-1002.
24. Nel AE, Diaz-Sanchez D, Li N. The role of particulate pollutants in pulmonary inflammation and asthma: Evidence for the involvement of organic chemicals and oxidative stress. Curr Opin Pulm Med 2001;7:20-6.
25. Inoue K-i, Takano H, Yanagisawa R, Ichinose T, Shimada A, Yoshikawa T. Pulmonary exposure to diesel exhaust particles induces airway inflammation and cytokine expression in NC/Nga mice. Arch Toxicol 2005;79:595-9.

26. Nightingale JA, Maggs R, Cullinan P, Donnelly LE, Rogers DF, Kinnersley R, et al. Airway inflammation after controlled exposure to diesel exhaust particulates. Am J Respir Crit Care Med 2000;162:161-6.