

Respiratory effects of air pollutants among nonsmoking traffic policemen of Patiala, India

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ABSTRACT

Background: Air pollution due to road traffic is a serious health hazard and thus the persons who are continuously exposed, may be at an increased risk. Although several studies have confirmed the ill effects of air pollutants on the lung function of traffic policemen, only a few have investigated the relationship between respiratory health and duration of exposure in this category of occupationally exposed persons. **Aim:** The study was carried out with the aim of evaluating the extent of impairment in lung function in traffic policemen in respect to an unexposed control group having the same age group. **Materials and Methods:** A cross-sectional study was conducted in which the spirometric parameters of a group of 100 nonsmoking traffic policemen, aged 20-55 years, working in and around Patiala city, were compared with those obtained in an age-matched control group, consisting of 100 healthy males, serving in the Punjab Police, who have never done traffic duty and are thus not exposed to traffic pollution. Lung function was done with MEDSPIROR. The data on the overall health status of the subjects was collected using the standard Respirator Medical Evaluation Questionnaire. The statistical analysis was carried out with SPSS PC software version 13. **Results:** Traffic policemen recorded a significant decline in various parameters, such as forced vital capacity (FVC), forced expiratory volume in one second (FEV₁), and peak expiratory flow rate (PEFR) when compared with controls, and is probably due to exposure to vehicular pollution. It was also observed that in traffic policemen with >8 years of exposure, the values of FVC (2.7 L), FEV₁ (1.8 L), and PEFR (7.5 L/s) were significantly lower than those obtained in traffic policemen with <8 years of exposure, in whom the values were 2.9 L, 2.3 L, and 7.7 L/s for FVC, FEV₁, and PEFR, respectively. **Conclusion:** The effect of pollution by vehicular exhausts may be responsible for these pulmonary function impairments.

KEY WORDS: Spirometry, traffic policemen, vehicular exhaust

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INTRODUCTION

Air quality crisis in cities is mainly due to vehicular emissions.^[1] Owing to the expanding economic base, Indian cities are growing rapidly. This has led to an increase in the ownership and use of motor vehicles with a subsequent rise in the levels of air pollution. Exposure to air pollutants is known to be harmful to health, in general, and to the lungs, in particular. In this respect, traffic policemen are at a risk, since they are continuously exposed to emissions

from vehicles, due to the nature of their job.^[2] Automobile exhaust consists of oxides of nitrogen, carbon monoxide, particulate matter, and others, which cause injury to the terminal bronchioles and a decrease in the pulmonary compliance and vital capacity.^[3]

Among the motor vehicle-generated air pollutants, diesel exhaust particles account for a highly significant percentage of the particles emitted in many towns and cities. Acute effects of diesel exhaust exposure include irritation of eyes and nose, lung function changes, headache, fatigue, and nausea. Chronic exposure is associated with cough, sputum production, and lung function decrements.^[4]

The present study was aimed at assessing the pulmonary function status in traffic policemen stationed at various traffic junctions in and around Patiala city, so as to note whether prolonged exposure to vehicular exhausts had

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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 policemen.

MATERIALS AND METHODS

The study was conducted during March-April 2009 at Govt. Dispensary, Police Lines, Patiala. During the study period, an idea regarding the approximate number of vehicles of different types in Patiala district was taken [Table 1]. It was observed during this study that the vehicular density in and around Patiala city had become quite high during the past few years.

Study population

The study comprised 100 nonsmoking traffic policemen, aged 20-55 years, working in and around Patiala city. A group of 100 healthy males from similar age group, who were serving in the Punjab Police and were not exposed to traffic pollution, served as controls. The constables who are serving in the Punjab Police and traffic police departments are mostly Sikhs and as per the tenets of Sikhism, smoking and tobacco chewing is prohibited, thus all the subjects were neversmokers. For both the groups, that is, cases and controls, only the healthy persons were selected while those with wheezing, history of smoking/tobacco chewing, visible chest wall bony, and muscular deformities, history of cardiac and respiratory disease (eg, overt asthma), history of medications, such as antiasthmatics and others, were excluded from the study.

Workplace environment of traffic policemen

Both the subjects and the controls came to us in small batches every day. In all, 200 people were examined, of whom 100 were traffic policemen and the rest were Punjab Police personnel. These traffic policemen worked for around 9 h every day from 9 am to 6 pm at various traffic junctions in and around Patiala city. In special cases, the duty hours of traffic policemen increased. The road traffic is very dense at most of the traffic junctions either because of nonfunctional traffic lights or due to traffic snarl-ups. It was also observed that the traffic policemen never used any kind of personal protective equipment during their duty hours to protect themselves from the air pollution.

The control group comprised Punjab Police personnel, who were sedentary workers. Since they worked from 9 am

to 5 pm in offices and were never posted for traffic duty, they were not exposed to traffic-related pollution. It was observed that the workplace of Punjab Police personnel was visibly free from pollution since smoking is banned in public offices and also there was no other source of indoor pollution.

The air quality data at various places with increased traffic density, where our subjects were posted, was obtained from Punjab Pollution Control Board (PPCB), Patiala. Air quality monitoring is done on a daily basis by using a high volume sampler (HVS). The data, however, is provided on an annual basis. There are 2 fixed stations in Patiala; one is present in the heart of the city and the other is located in industrial area. The mean concentration values for Suspended Particulate Matter (SPM) during the study period was $253 \mu\text{g}/\text{m}^3$, whereas for SO_2 , it was $7 \mu\text{g}$. The mean concentration of oxides of nitrogen was $26 \mu\text{g}/\text{m}^3$. NO_x values were found to be higher than SO_2 , which may be due to low sulfur content of diesel.

Pulmonary function test

The traffic policemen and the controls were subjected to Pulmonary function test. Before the test, age, height, and weight of the subjects were entered in the spirometer (MEDSPIROR, Recorder and Medicare Systems, India). The spirometer gives two values, one is actual and the other is expected. The Medspiror software calculates the expected values for adults, using the following set of prediction equations:

$$\text{FVC (L)} (0.05 \times \text{H}) - (0.014 \times \text{A}) - (4.49) \quad (1)$$

$$\text{FEV}_1 \text{ (L)} (0.04 \times \text{H}) - (0.021 \times \text{A}) - (3.13) \quad (2)$$

$$\text{PEFR (L/s)} (0.071 \times \text{H}) - (0.035 \times \text{A}) - (1.82) \quad (3)$$

Where

H = height in cm.

A = age in years.

FVC = forced vital capacity, that is, the maximum amount of air that can be exhaled following a maximal inspiratory effort.

FEV_1 = forced expiratory volume in one second, that is, the volume of air exhaled in the first second during a forced vital capacity effort.

PEFR = peak expiratory flow rate, that is, the maximum amount of air exhaled with forced effort during FVC.

The pulmonary function test was carried out in the afternoon hours and it was ensured that the subjects were not exposed to air pollution at least 12 h before the test.

The actual values of FVC, FEV_1 , and PEFR are based on the maximal inspiration and expiration of the subjects. The tests were conducted in standing position. Regular sterilization of the mouthpieces was done before each use. The subjects were asked to do maximum inspiration followed by maximal expiration. Three such tests were performed and the best of the three performances was taken into account.^[5] Informed consent was taken from all the subjects. The procedures

Table 1: Total number of vehicles in Patiala district till March 2009

Type of vehicle	Number of vehicles
Two wheelers	6,78,273
Three wheelers	37,028
Four wheelers	1,27,647
Total	8,42,050

Source: Regional Transport Office, Patiala

followed were in accordance with the ethical standards of the institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

Statistical analysis

The data was processed for mean, standard deviation, and one-way ANOVA.^[6] It comprises FVC, FEV₁, and PEF_R. Age, height, weight, and duration of exposure were the independent variables, whereas spirometric parameters were the dependent variables. These were treated as categorical variables. The statistical analysis was carried out with SPSS PC software version 13.0.

Risk assessment

The data on the health status of the study group was collected using the standard Respirator Medical Evaluation Questionnaire.^[7] The questionnaire was translated in local language. Only three symptoms, that is, frequent coughing, shortness of breath, and irritation in respiratory tract were considered for odds ratio (OR) analysis, while other symptoms, such as chronic phlegm, chest tightness, and wheezing were excluded. The risk was calculated between the traffic policemen and the control group. Analysis of odds ratio was conducted by setting up a simple 2 × 2 matrix as shown in Table 2. OR is defined as the ratio of the cross product of the entries in the matrix:^[8]
OR = ad/bc.

OR value >1 suggests positive relationship between exposure and risk, while an OR value <1 indicates a negative relationship and OR value equal to 1 indicates no relationship between exposure and risk.

RESULTS

The average age, height, and weight of the traffic policemen and the control group are shown in Table 3. In this study, the service of 100 traffic policemen was also noted to know the duration of exposure, which, as seen in Table 3, shows that about 66% of the traffic policemen are in service for >8 years. Table 4 shows the prevalence of various respiratory symptoms and the calculation of OR in both traffic policemen and controls, on the basis of the analysis of the questionnaire. It was seen that among the 100 traffic policemen examined, 68% complained of frequent coughing, 22% reported having shortness of breath and 36% suffered from irritation in respiratory tract. In case of controls, the occurrence of the above symptoms was much lower, as only 25% complained of frequent cough, 12% had shortness of breath and only 15% suffered from irritation in respiratory tract. The OR values for frequent coughing, shortness of breath, and irritation in respiratory tract are above 1. The values of unadjusted OR for frequent coughing, shortness of breath, and irritation in respiratory tract are 6.37, 2.06, and 3.18, respectively. These values show a significant excess risk of respiratory morbidity in traffic policemen than the Punjab Policemen (controls). Now since a majority of these traffic policemen are in service for >8 years, thus

a long-term exposure to various air pollutants may be the reason for higher incidence of respiratory symptoms in these people.

Table 5 shows the results of the pulmonary function tests in traffic policemen and control group. One-way ANOVA was applied to the spirometric parameters of these groups and the actual values of lung function parameters in both the groups were compared.

It was observed that FVC in traffic policemen was considerably lesser (3.1 L) as compared to that in controls (3.9 L). FEV₁ was also significantly lower in traffic policemen (2.7 L) as against the controls (3.2 L). PEF_R is a good indicator of expiratory effort and it was also worse in traffic policemen (8.0 L/s) as compared to controls (8.5 L/s). Since the differences in all the lung

Table 2: Risk assessment of exposure (2 × 2 matrix)

	Prevalence of symptoms	
	Yes	No
Exposed	a	b
Not exposed	c	d

Table 3: Anthropometric data of traffic policemen and controls

Parameter	Traffic policemen	Controls
Age (years)	39.8 ± 5.80	39.1 ± 8.98
Height (cm)	174.1 ± 5.95	174.6 ± 6.13
Weight (kg)	80.6 ± 9.59	78.5 ± 10.25
Duration of exposure (years)		
<8	34%	NA
>8	66%	

NA: Not applicable

Table 4: Comparison of risk of respiratory symptoms among the traffic policemen (exposed) and control (nonexposed) groups (n=100)

Symptoms	Study population	Presence of symptoms		Odds ratio
		Yes	No	
Frequent coughing	Traffic policemen	68	32	6.37*
	Controls	25	75	
Shortness of breath	Traffic policemen	22	78	2.06*
	Controls	12	88	
Irritation in respiratory tract	Traffic policemen	36	64	3.18*
	Controls	15	85	

*All values are statistically significant

Table 5: Comparison of spirometric parameters among the traffic policemen (exposed) and control (nonexposed) groups (n=100)

Parameters	Traffic policemen	Controls	P value
FVC (L)	3.1 ± 0.36	3.9 ± 0.25	<0.0015
FEV ₁ (L)	2.7 ± 0.35	3.2 ± 0.37	<0.0001
PEFR (L/s)	8 ± 1.93	8.5 ± 1.71	<0.0001

Overall difference is based on one-way ANOVA, $P < 0.0001$ and $P < 0.0015$. Test was performed for comparison of actual values of different parameters between traffic policemen and control group, where F values in ANOVA are significant. n = no. of subjects

function parameters between exposed and unexposed are statistically significant, it clearly supports that our assumption is correct, that is, the traffic policemen have decreased lung function with respect to controls.

The data comparison in Table 6 clearly shows a decline in all the spirometric parameters in traffic policemen as the duration of exposure to various pollutants increased. The traffic policemen with >8 years of exposure showed a significant decline in FVC (2.7 L), FEV₁ (1.8 L), and PEFR (7.5 L/s), when compared with those with <8 years of exposure, in whom the values of FVC, FEV₁, and PEFR were 2.9, 2.3, and 7.7 L/s, respectively.

DISCUSSION

The results of this study very clearly show a reduction in respiratory functions of traffic policemen. Similar observations have been made in traffic policemen by several studies conducted by different authors in India and around the world.^[9-16] Wongsurakiat *et al.*^[17] observed a significant lowering of mean values of FEV₁ and FVC of traffic policemen in Thornburi, Thailand, as compared to normal Thai population (3.29 ± 0.5 L vs 3.43 ± 0.5 L, *P*=0.01 for FEV₁ and 3.86 ± 0.5 L vs 3.98 ± 0.6 L, *P*=0.047 for FVC). It was also observed that among the traffic policemen, the values were much lower in those policemen who did not use protective masks as compared to those using the masks. The results of a study carried out by Zhou *et al.*^[18] showed a significantly higher prevalence of respiratory symptoms and chronic respiratory disorders in the exposed group (comprising bus drivers, conductors, and taxi drivers) than in the unexposed controls, since the OR values obtained for throat pain, phlegm, chronic rhinitis, and chronic pharyngitis were 1.95, 3.90, 1.96, and 4.19, respectively. Singh *et al.*^[19] reported a significant difference in FEV₁ data of nonsmoking subjects exposed to traffic-generated pollution and those not exposed. The FEV₁ value in exposed subjects was 87.8% ± 9.5% of the expected value, whereas in nonexposed subjects, FEV₁ was 95.3% ± 13.6% of the expected value. Our study corroborates their findings. Both the restrictive and obstructive patterns of respiratory impairment have been observed in our study. The significant reduction in PEFR values indicates the warning symptoms of asthma among traffic policemen. A large number of studies have shown that long-term exposure to particulates and vehicular exhausts is associated with adverse effects on health.^[20-24]

CONCLUSION

The findings of this study show that the adverse health impacts of automobile pollution can be significant. The observed result is probably due to the prolonged exposure to vehicular pollution, which causes airway obstruction by inducing chronic airway irritation and increased mucus

Table 6: Spirometric parameters among the traffic policemen according to duration of exposure

Parameters	Duration of exposure		P value
	<8 years (n=66)	>8 years (n=34)	
FVC (L)	2.9 ± 0.41	2.7 ± 0.23	<0.0001
FEV ₁ (L)	2.3 ± 0.22	1.8 ± 0.32	<0.0001
PEFR (L/s)	7.7 ± 1.21	7.5 ± 0.11	<0.0001

All values are significant when compared between the two groups.
n=no. of subjects

production. Thus we strongly vouch for the adoption of various strategies for the protection of traffic policemen from vehicular pollution. Some measures that can be adopted are as follows:

1. Compulsory use of protective equipment (eg, nose mask) by traffic policemen during duty hours.
2. Imparting health education and conducting regular medical checkups for protection of traffic policemen working at heavy traffic junctions.
3. Intensive promotion of electrical vehicles by Govt. agencies.
4. Promotion of “Car-pool” concept, that is, use of a single vehicle by 3-4 people who work in the same office.

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