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PULMONARY FUNCTION TEST IN TRAFFIC POLICE PERSONNEL IN PONDICHERRY

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Abstract : Traffic policemen working in the busy traffic signal areas get exposed to the vehicular emissions for years together. The fumes, chemicals and particles present in the emission are reported to be damaging to the lung functions of these individuals. Since there were no data available on the PFT parameters of traffic police personnel of Pondicherry, this study was taken up to assess the effect of traffic air pollution on their pulmonary functions. PFT parameters were recorded in age- and BMI-matched 30 traffic police personnel (study group) and 30 general police personnel (control group) of male gender. As chronic smoking is known to be a critical factor in altering lung function, PFT parameters were compared between the smokers as well as nonsmokers of both the groups. In nonsmokers, there was significant decrease in VC ($P<0.05$), FEV_1 ($P<0.01$), FEF-25 ($P<0.05$) and PIF ($P<0.05$) in study group compared to the control group. In smokers, there was significant decrease in VC ($P<0.05$), FEV_1 ($P<0.0001$), PEF ($P<0.0001$), MVV ($P<0.0001$), FEF-25 ($P<0.0001$), and PIF ($P<0.01$) in study group compared to the control group. These changes indicate restriction to the lung expansion, obstruction and narrowing of the airways in traffic police personnel compared to the general police personnel. This may be due to exposure to vehicular pollution for several hours in a day for many years causing decreased functional capacity of the lungs and chronic smoking worsens the condition.

Key words : pulmonary function traffic police

INTRODUCTION

Environmental factors are believed to play a significant role in the development of allergic respiratory diseases, such as asthma and rhinitis. The presence of various particles and gases from vehicular emission like carbon dioxide, carbon monoxide, sulphur, benzene, lead, nitrogen dioxide, nitric oxide and black smoke etc. may play a role in the pathogenesis respiratory diseases. The toxic chemicals and gases

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released from vehicular emission produce irritation and allergy in the lungs and air passage of individuals who are exposed to them for a long time. Traffic policemen who work in the busy traffic signal areas for years together are exposed to the risk of air traffic pollution. In the long run, the pollutants may produce disease like asthma and bronchitis in the exposed individuals with changes in normal lung functions. Pulmonary function tests using a computerized spirometer assess all the parameters of the respiratory functions and give a fair idea about the respiratory health of an individual. Therefore, these changes can be observed even before the disease becomes symptomatic by a detailed assessment of pulmonary function tests. Pondicherry is a small city with a large number of vehicles. This study aimed at evaluating the pulmonary function test parameters in traffic policemen of Pondicherry to measure the changes and compare the findings with general police personnel to assess the effect of exposure to long term vehicular pollution.

Various studies have been conducted to assess the respiratory health status of individuals exposed to pollutions by recording different PFT parameters (1–3). Evans RG et al investigated the effects of emission from the internal combustion engine on pulmonary function and respiratory symptoms in men collecting tolls and directing traffic in areas with high levels of air pollution, known as bridge and tunnel officers. They found that the tunnel workers had significantly lower FEV_1s (forced expiratory volume at one second) and lower FVCs (forced vital capacity), respiratory symptoms and higher carboxyhemoglobin levels than the bridge workers (4). Ogunsola J et al performed PFT on Nigerian traffic wardens and found a significant difference in peak expiratory flow rate (PEFR), FEV_1 and FVC between traffic wardens and control subjects (5). Saenghirunvattana S et al measured PFT in traffic policemen of Bangkok by vitalograph. They observed abnormal pulmonary functions in 25% of subjects. The abnormalities included restrictive lung function, small airways obstruction and large airways obstruction (6). In another study carried out on traffic policemen of Bangkok, Karita et al found that there was no consistent trend of decreased pulmonary function (7). However, when age, height and smoking indices were matched with general police, who were the control subjects, the mean levels of FEV_1 and maximal expiratory flow rate in 25% of vital capacity (V 25) were significantly lower (7).

De Toni A et al studied respiratory diseases in a group of traffic police officers with a five year follow-up. They observed that there were upper respiratory symptoms in 28% traffic policemen assigned to traffic control and 11% of the administrative workers (8). Proietti L et al studied the prevalence of respiratory symptoms and allergic sensitization in a group of traffic police officers exposed to urban pollution in Catania. They found that the subjects exposed to urban pollution showed a greater prevalence of symptoms (cough, wheeze and dyspnoea), and positive reaction to skin allergy tests compared with the non-exposed group; this was not statistically significant. Also, alterations in respiratory function tests were more frequent in the non-exposed compared to the exposed group. The highest prevalence of cough, dyspnoea and wheezing was detected in smokers compared to non-smokers within each group (9). Volpino P et al evaluated the effects of urban pollutants on respiratory and cardiovascular functions in exposed traffic policemen of Rome. They observed no significant differences in the mean values of resting ventilatory capacity, the forced spirometric test, or in blood gas parameters between the groups. Their findings suggested that chronic occupational exposure to urban pollutants reduces resistance to physical effort and increases the risk of cardiovascular and respiratory changes including slight hypoxemia (10). Sekine K et al investigated the long term effects of exposure to automobile exhaust on the pulmonary functions of female adults in Tokyo, Japan. They observed high prevalence rate of respiratory symptoms and a larger decrease of FEV_1 in the group exposed to maximal level of air pollution compared with those living in areas with low levels of air pollution. Also, a significant difference in persistent phlegm and breathlessness was found.

Since the traffic density is larger in areas with high air pollution, the differences among the groups may reflect the effect of air pollution attributable to particulate matter found in automobile exhaust (11). Burr ML et al of Cardiff, UK, studied the prevalence of respiratory symptoms in residents of congested streets exposed to air pollution from vehicle exhaust and compared the results with residents of uncongested streets. They also followed up after construction of a by-pass road to reduce the vehicular congestion. They found no clear or consistent differences between the residents of the two areas initially in terms of symptoms or peak flow variability. After one year of the bypass, the improvement in chest symptoms was greater in the uncongested streets, but not statistically significant. Rhinitis and rhinoconjunctivitis tended to improve to a greater extent in the congested streets; the difference between the areas was significant for the degree to which rhinitis interfered with daily activities. Peak flow variability tended to improve in the uncongested areas. Thus, reduced pollutant levels probably alleviated rhinitis and rhinoconjunctivitis, but had little effect on lower respiratory symptoms (12).

Steerenberg et al studied the traffic-related air pollution effects on peak expiratory flow, exhaled nitric oxide, and inflammatory nasal markers. The urban school children, who were exposed to high levels of nitric oxide, nitrogen dioxide, carbon monoxide and black smoke compared to the suburban children, had higher mean levels of peak expiratory flow, exhaled nitric oxide and more interleukin-8, urea, uric acid, albumin and nitric oxide metabolites in nasal lavage than did suburban children. Peak expiratory flow, exhaled nitric oxide levels and nasal markers were associated with levels of particulate matter with diameters less than or equal to 10 microm, black smoke, nitrogen dioxide and nitric oxide. Thus, urban children had increased levels of inflammatory nasal markers and their responses were more pronounced than were the suburban children’s response to the same increment in air pollution (13). Nakai S et al in a cross-sectional study in Hodogaya, Japan, between different levels of exposure to automobile exhaust followed by repeated Pulmonary function tests for 4 years, suggested that exposure to road traffic pollutants may be associated with respiratory symptoms. They found that repeated pulmonary function testing did not reveal any consistent differences (14). Lubinski W et al studied the influence of air pollution on pulmonary function in healthy young men from different regions of Poland. They found significant airflow limitation in the central and peripheral bronchi in all subjects. In the central bronchi there was FEV_1 /FVC < 70% and FEV_1 < 80% of the predicted value. In the peripheral bronchi, there was FEV_1 /FVC > 70% and FEF (50) < 70% of the predicted value. The persons exposed to high air pollution levels had higher percentage of airflow limitation in central as well as peripheral bronchi (15).

Ingle et al studied the effects of exposure to vehicular pollution and respiratory impairment of traffic policemen in Jalgaon city, India. The PEFR, FEV_1 and FVC were significantly affected in traffic policemen as against the control group of population (16). Rao NM et al have studied the pulmonary function status of shopkeepers of Ahmedabad exposed to auto exhaust pollutants and found significant impairment in FEV_1% and FEF 25–75% in high polluted area shopkeepers (17). Kumar KS et al studied the respiratory symptoms and spirometric observations in relation to atmospheric air pollutants in a sample of urban population in Hyderabad, India. They observed higher respiratory and ventilatory abnormalities in the commercial areas, which are associated with higher mean and peak levels of SO_2 and NOx (18). Sharma M et al studied the effects of air pollution on the respiratory health of subjects who lived in three areas of Kanpur, India. They observed that subjects who resided at clean area performed at predicted values more often than did subjects who lived at more polluted area. Subjects who were more exposed to air pollution demonstrated a substantial average deficit in baseline FVC and FEV_1. The authors used a statistical model to estimate that an increase of 100 microg/m^3 of the pollutant PM10 could reduce the mean peak expiratory flow rate of an individual by approximately 3.2 l/min (19). Chhabara SK et al have studied the effect of air pollution on the residents of Delhi and found that lung function of asymptomatic non-smokers was consistently and significantly better among both male and female residents of the lower pollution zone (20). Recently, Zhang et al have reported that automobile tyre colloidal particles induced allergic damage of respiratory system in traffic policemen in China (21).

Thus, many studies have been conducted across the world on air pollution and its effect on exposed individuals. But, there are limited studies in India regarding pulmonary function parameters in traffic policemen. Especially, no systemic study has been conducted in traffic policemen in Tamilnadu, Pondicherry region of India. Therefore, this study was conducted to assess the effect of air pollution on traffic policemen of Pondicherry.

MATERIALS AND METHODS

This study was carried out in 30 traffic police personnel and 30 general police personnel of Pondicherry. The approval of JIPMER research council and human ethics committee were obtained and subjects were properly explained about the aim, objectives, methodology, expected outcome and implications prior to the commencement of the study. Written informed consents were obtained from all the subjects. All the subjects were males. The traffic police personnel (study group) were between 29 to 50 years of age and with 5 years of exposure to air traffic pollution; that means they were working for a minimum of 5 years in busy traffic area. The general police personnel (control group) were between 28 to 50 years of age. Height and body weight was measured to calculate the body mass index (BMI). A primary screening was done in the medicine outpatient department of JIPMER to exclude gross pulmonary diseases, anatomical deformity of the chest or spine that may affect the respiratory parameters or any infective lung diseases like tuberculosis. Subjects having any known anatomical deformity of the chest or spine that may affect the respiratory parameters or any infective lung diseases or gross pulmonary diseases were excluded from the study. The subjects were further divided into smoking and non-smoking group with 15 subjects in each group, based on their smoking history and age and BMI were matched. The data sheet of the subjects was collected in the form of questionnaire and was kept confidential.

Pulmonary function test (PFT), carried out with the help of a computerized spirometer is a non-invasive and quite accurate method of assessing respiratory health status of an individual, specially the ventilation functions of lung. PFT parameters were measured by Microlab spirometer of Micro Medical Limited of Rochester, England. At the beginning, satisfactory demonstrations were given regarding the equipment and the procedure of the study. The following parameters were recorded by the computerized spirometer: vital capacity (VC), forced expiratory volume in 1 second (FEV_1), peak expiratory flow (PEF), FEV_1 as a percentage of VC (FEV_1/VC), forced expiratory flow at 25% of volume as a percentage of VC (FEF25%), forced expiratory flow at 50% of volume as a percentage of VC (FEF 50%), forced expiratory flow at 75% of volume as a percentage of VC (FEF-75%), forced expiratory flow at 25-75% of volume as a percentage of VC (FEF 25-75%), maximum voluntary ventilation (MVV), peak inspiratory flow (PIF), forced inspiratory flow at 50% of inhaled volume (FIF50%), and tidal volume (TV).

Before recording, subjects were allowed to relax in and familiarize with the laboratory environment. They were asked to inhale from and exhale into the disposable mouthpiece of the spirometer twice. The lips were tightened around the mouthpiece to prevent leakage of air and the noses were clipped to allow airflow only through the mouthpiece to and from the lungs. The maneuvers were repeated thrice and the best of the three readings was taken.

RESULTS

The collected data were analyzed by Students' *t* test and the values were expressed as Mean±SE. The age, body weight and BMI were compared between the control and study groups. It was found that there was no significant difference between the two groups (Table I). Comparison was made between nonsmokers of general policemen and that of traffic policemen. It was observed that there was significant decrease in VC ($P<0.05$), FEV_1 ($P<0.01$), FEF-25 ($P<0.05$) and

TABLE I: Demographic features of control and study groups.

	Control group (n=30)	*Study group (n=30)*
Age (years)	37.1±0.93	38.83±1.17
Weight (kg)	68.9±1.14	70.96±1.06
Height (cm)	168.5±0.65	166.8±0.83
BMI (kg/m^2)	24.26±0.57	25.50±0.48

Values are Mean±SE.

PIF (P<0.05) in study group compared to the control group (Table II). In smokers, there was significant decrease in VC (P<0.05), FEV_1 (P<0.0001), PEF (P<0.0001), MVV (P<0.0001), FEF-25 (P<0.0001), FEF-50 (P<0.0001), FEF-75 (P<0.05), FEF 25-75 (P<0.0001), FIF-50 (P<0.01) and PIF (P<0.01) in study group compared to the control group (Table III).

TABLE II : Comparison of PFT parameters between non-smokers of general policemen (control group) and non-smokers of traffic policemen (study group).

Parameters	*Non-smokers of control group (n=15)*	*Non-smokers of study group (n=15)*
VC	3.92±0.13	3.56±0.11*
FEV1	3.29±0.1	2.79±0.10**
FEV1/VC	84.15±2.53	78.40±2.12
PEF	423.93±23.96	362.47±25.91
FEF-25	6.65±0.37	5.03±0.57*
FEF-50	4.82±0.28	4.51±0.34
FEF-75	2.32±0.20	2.83±0.27
FEF25-75	4.25±0.26	3.76±0.34
MVV	132.23±8.44	120.49±6.35
PIF	240.4±19.86	180.3±14.19*
FIF50	3.75±0.31	2.69±0.25*
TV	0.56±0.05	0.62±0.04

Values are Mean±S.E; *P<0.05; **P<0.01.

TABLE III : Comparison of PFT parameters between smokers of general policemen (control group) and smokers of traffic policemen (study group).

Parameters	*Smokers of control group (n=15)*	*Smokers of study group (n=15)*
VC	3.62±0.12	3.23±0.09*
FEV1	2.88±0.09	2.25±0.08****
PEF	419.07±20.50	283.40±13.77****
FEV1/VC	79.55±1.45	69.65±1.50
FEF-25	6.38±0.39	4.30±0.25****
FEF-50	5.43±0.22	3.61±0.25****
FEF-75	3.01±0.21	2.31±0.21*
FEF25-75	4.79±0.20	3.36±0.21****
MVV	130.4±3.39	95.3±3.65****
PIF	220.3±18.24	136.4±12.38**
FIF50	3.41±0.31	2.07±0.21**
TV	0.65±0.09	0.78±0.10

Values are Mean±SE; * P<0.05; **P<0.01; ****P<0.0001.

DISCUSSION

The most important function of the lung is to maintain tension of oxygen and carbon dioxide of the arterial blood within the normal range. This is achieved by uptake of oxygen from the inspired air and giving up carbon dioxide in the expired air. The fundamental mechanisms involved in attaining this goal are ventilation, diffusion and perfusion. The computerized spirometers used by most of the hospitals and research labs assess the ventilation function of the lung (22); such as the TV recorded give an idea about the normal requirement of oxygen during rest, FEV_1/FVC indicates the obstructive or restrictive type of disorders of lung, FEF25-75% reflects patency of small and large airways and so on. Various studies have been carried out in India as well as outside India to evaluate the effect of pollutants on the respiratory parameters. But, no study was done in Pondicherry to assess the effect of air traffic pollution on the respiratory health of traffic police personnel. In the present study, to assess the effect of traffic air pollution per se we compared the PFT parameters in non-smokers of both the groups after matching the age of the individuals, since chronic smoking affects the lungs and alters the PFT parameters.

Vital capacity is the maximum amount of air taken in or out of the lungs per breath. MVV is the maximum amount of air breathed in or out of the lungs per minute (MVV = VC × Respiratory rate). Both are indicators of functional capacity of the lungs. In case of increased need or to compensate for any deficiency, a person can increase his total oxygen consumption by increasing the rate of breathing as VC cannot be increased any more. We observed that VC, and MVV were reduced in traffic policemen. This shows that some degree of restriction is present in them that are limiting the lungs to expand. The changes might be in the tissues of the lungs due to chronic irritation by pollutants.

FEV_1 is the amount of air expired in 1 minute. PEF is the maximum rate of flow during expiration. Both are indicators of the capacity of the expiratory muscles. FEV_1 and PEF were less in non-smoker traffic policemen indicating that there was some obstruction during expiration. FEV_1/VC is the amount of air expired in 1 minute as a percentage of VC or FVC. FEV_1/VC is a better indicator of the condition of the bronchial musculatures. In our study, FEV_1/VC was less, though not significant in the traffic policemen. This may be due to the decreased vital capacity in them. FEF 25% and FEF 25-75% indicate the conditions of larger and smaller airways respectively. Both are reduced in the traffic police personnel. This suggests that the airways in general are narrowed preventing the free flow of air during respiration. PIF and FIF 50% are indicators of the condition of inspiratory muscles and the airways status during inspiration. Both these parameters were reduced in the traffic police personnel.

The tidal volume (TV) is the amount of air taken in or taken out during quite breathing. This volume of air fulfils the oxygen requirement of the body during rest. It was found to be higher in traffic police personnel. Due to reduction in functional status of the lungs, the volume of air inhaled may not be sufficient to fulfill the oxygen demand of the body at rest. Also, there may be increased anatomical dead space (due to closure or destruction of many alveoli) or increased physiological dead space (due to decreased or narrowed capillaries supplying blood to the alveoli), resulting in decreased diffusion of gases. All these findings are similar with those of Evans RG et al (4), Ogunsola J et al (5), Karita et al (6), Chhabra SK et al (20) and others. However, our findings contradict those of Nakai et al (14), who did not find any consistent difference.

In the smoker group, there was similar decrease in all the values in the traffic police personnel compared to the general police personnel, except the TV. But compared to the non-smoker group, there was greater decrease in parameters like FEV_1, FVC, PEF, FEF 25%, FEF 50%, FEF 75%, MVV, PIF, and FIF 50%. This indicates that traffic air pollution that is detrimental to the respiratory health when combines with another detrimental factor like chronic smoking, the lung functions decreases more.

We conclude that long- term exposure to chemicals; gases and fumes present in the environment near heavy traffic are harmful for the lungs. It decreases the various lung functions that result in alteration in pulmonary function test parameters. It was suggested that the traffic police personnel should use masks during the duty hours in busy traffic area and should undergo regular health check up to identify respiratory symptoms if any, and follow suitable management procedures. Awareness should be created in the public regarding the harmful effects of traffic air pollution and be advised to switch-off the engine when the signal time is more.

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