INTRODUCTION

Air pollution, a modern problem is known to produce deleterious effects on respiratory system.[1] Air pollution due to road traffic is a potential health hazard worldwide wherein vehicular emission is causative for air quality crisis in cities.[2] Road traffic generate volatile organic compounds, suspended particulate matter, sulfur oxides, oxides of nitrogen, and carbon monoxide which imposes adverse health effects on the population exposed.[3] It is very obvious 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. Chronic exposure to the air pollutants generated by motor vehicles, diesel exhaust particles is causative of cough, sputum production, and decremented lung function.[4] Pulmonary disease can be detected by periodic retesting in the earliest stages when preventive or corrective measures are more likely to be beneficial.[5] Present study was aimed at measurement of lung volumes and capacities in traffic police personnel posted at various traffic junctions in Saurashtra region, 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.

MATERIALS AND METHODS

Study subjects
The present study was carried out at pulmonary function laboratory, Department of Physiology, Government Medical College, Bhavnagar, Gujarat.
The study was conducted in 200 male subjects of Saurashtra region of Gujarat, India from three cities namely Bhavnagar, Rajkot and Surendranagar. Subjects had Indian ethnicity and Southern Indian origin. Out of them 100 subjects were working as traffic police personnel and a group of 100 healthy males of similar age, who were serving in various departments of government of Gujarat and were not exposed to traffic-related pollution served as controls. The study population was selected from three different cities of Saurashtra region namely Bhavnagar (n = 50), Rajkot (n = 25) and Surendranagar (n = 25).

The control group was comparable in age, gender, region and physical activity to study group.

**Inclusion and exclusion criteria**

We included traffic police personnel working at traffic signals, aged 20-55 years, with minimum 1 year of job and ready to give written informed consent.

We excluded traffic police personnel working at office, aged >55 years, having presence of any active lung disease, history of any major respiratory illness, exposed to any other type of air pollution and unwilling to give written informed consent.

**Anthropometric parameters**

Height in centimeters (nearest to 0.1 cms) without shoes, feet together, standing as tall as possible with the eyes level and looking straight ahead, and using an accurate measuring device.

Weight in kilograms (nearest to 0.1 kgs) of subject wearing light clothing and bare footed and empty bladder before lunch was measured on a standardized weighing scale.

**Instrument used**

The present study was carried out by computerized software of pulmonary function testing named “SPIROEXCEL”.

**Procedure for spirometry**

All the subjects were physically healthy on basis of clinical examination, without any symptoms of any acute respiratory illness. The approval of institutional review board of our government medical college, Bhavnagar was 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. Subjects were given practice and minimum three attempts. All recordings were accomplished between 8 am and 12 noon in the morning before the police personnel could resume their duty. For MVV we used frequency of 60-80/min and testing was done for 15 second. We used Indian Kamat reference values to get predicted values to compare with the test results.

**Statistical analysis**

Numerical data were expressed in mean ± SD while categorical data were expressed as numbers. The spirometric parameters were compared in both groups by unpaired Student’s ‘t’ test with the help of Graph pad instat3 statistical software. Effect of duration of exposure was compared by subgrouping based on duration less or more than mean duration of job. Statistical significance was indicated by P value < 0.05.

**RESULTS**

Traffic policemen (exposed group) were comparable to controls (unexposed group) in age, height but not in weight with higher prevalence of smoking in the former group as compared to later [Table 1].

Comparison between predicted value and test value of computerized spirometric parameters in case and control group revealed test value to be lower than predicted for all values with statistical significance for all. Similarly comparison of test values in between groups showed statistically significantly less FVC, MVV and more FEV1/FVC results in case group as compared to controls but SVC and FEV1 lacked significance [Table 2].

Comparison of test value of computerized spirometric parameters in traffic police personnel group based on duration of exposure showed that subjects with exposure duration more than 4 years had lower values of PFT parameters than those with less than 4 years [Table 3].

Smokers had lesser values of almost all parameters as compared to non-smokers in both group, but results were significant only in control group and not in case group [Table 4].

**DISCUSSION**

Present study was a community-based observational cross-sectional study among in-service traffic police personnel of Saurashtra region to measure lung volumes and capacities by computerized spirometry to quantify effect of occupational hazards of air pollution in them as compared to unexposed age matched controls.

Lung functions were declined in cases as well as controls. This declination even in un-exposed controls can be explained by the fact that (1) for purpose of matching mean age was 38 years (2) 13 out of 100 were smokers (3) to match by activity they were chosen from office staff personnel having sedentary life style and lack of physical exertion. Moreover, age-associated changes in the

| Parameter     | Exposed group | Unexposed group | P value |
|---------------|---------------|-----------------|---------|
| Age (years)   | 37.98±11.65   | 38.31±11.71     | 0.4620  |
| Height (cm)   | 167.09±5.84   | 162.42±18.87    | 0.121   |
| Weight (kg)   | 71.9±12.14    | 64.49±12.47     | <0.0001*|
| Smoking (%)   | 27/100 (27%)  | 13/100 (13%)    | <0.0001*|

*Statistically significant
As evident from our study that actual value of forced expiratory volume in one second (FEV1) was reduced in traffic police personnel as compared to control. FVC, FEV1 and FEV1/FVC ratio are used for differentiating obstructive pattern from restrictive pattern of lung diseases. In obstructive lung diseases FEV1 is reduced disproportionately more than FVC, so FEV1/ FVC ratio is reduced. In restrictive lung diseases, FEV1 is disproportionately less reduced than FVC, so FEV1/ FVC ratio is increased. Our study included middle aged individual in both group so one can expect age related changes which explains to some extent significant difference between actual and predicted value.

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, like the subjects of our study, traffic policemen. Vehicular exhaust particularly organic extracts of diesel exhaust induce reactive oxygen species in macrophages and bronchial epithelial cells which are key cell type 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 particle, via a mitochondrial pathway, induce apoptosis and necrosis in bronchial epithelial cells. These diesel 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 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 actual value of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) are reduced in traffic police personnel as compared to predicted values. This shows some degree of restriction being present in the respiratory tract of traffic police personnel. The changes might be in the tissue of the lungs due to chronic irritation by pollutants. FEV1 was less in traffic police personnel indicating that there was some obstruction during the expiration.

FEV1/FVC indicates the condition of the bronchial musculature. In our study FEV1/FVC was statistically significantly increased in traffic police personnel as compared to control. FVC, FEV1 and FEV1/FVC ratio are used for differentiating obstructive pattern from restrictive pattern of lung diseases. In obstructive lung diseases FEV1 is reduced disproportionately more than FVC, so FEV1/ FVC ratio is reduced. In restrictive lung diseases, FEV1 is disproportionately less reduced than FVC, so FEV1/ FVC ratio is increased. As evident from our study that reduction of FEV1 is more than that of FVC with FEV1/FVC ratio being more than normal which indicates restrictive pattern of lung diseases in our exposed study subjects. We observed significant reduction in slow vital capacity (SVC) in study group indicating restrictive type of pulmonary dysfunction in our study group. Our findings are similar to few other studies conducted in various regions of India. The present study supports the findings of previous studies and suggests that impairment in pulmonary function parameters in traffic police personnel is 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. This pattern reflects failure of subject to inhale or exhale completely or it may also occur when the flow is so slow that subject cannot exhale long enough to empty lung to RV. We found SVC differing insignificantly and FVC significantly between case and control groups. When FVC maneuver is performed, there is high dynamic compression and airway collapse which reduce the ability to mobilize air volume during expiration and therefore causing air trapping. Consequently, FVC values could be lower than SVC values; because SVC is measured through an unforced attempt, there is comparatively less intrathoracic pressure, and, consequently, one could mobilize a larger volume of air.\(^2\)

While reading this inference one can also think of effect of aging that physiologically reduces the lung function parameters, yet mean duration of job being 4 years in our study, age seems to be of lesser significance. MVV is recorded high in longer duration group due to some uncertain reasons. Our study revealed adverse effects of smoking on FVC, FEV\(_1\), FEV\(_1\)/FVC in the form of reduced test value in smokers (27\%) as compared to non-smokers (63\%) in traffic police personnel group. Smoking and declined pulmonary functioning is well evident regardless of occupation\(^{[9,19,22]}\) and same was significantly present in unexposed group. However, difference so observed proved to be small and statistically insignificant in traffic policemen indicating that the occupational exposure proved to be main culprit for observed effects of lung function parameters in traffic police group. Moreover exposure to roadside pollutants among traffic police personnel far exceed in duration than the one of habitual smoking.

Complete demarcation between obstructive and restrictive dysfunction cannot be achieved by simple spirometry, even though we can demarcate the two varieties of lung diseases by visual interpretation of flow volume loop of spirometry but this is not reliable hence not used. This is the main limitation of our study.

**CONCLUSIONS**

Computerized spirometry-based evaluation of pulmonary functions in middle-aged traffic police personnel as compared to age-matched controls reveals overall declined lung function parameters in both groups, deficit being more so in exposed group than un-exposed group. Comparison of deficit between actual and predicted is significantly higher in case group indicating harmful effects of occupational exposure to vehicular exhaust, more so with habit of smoking and increase duration of job, adding up to age-induced respiratory dysfunctions. This can be prevented by reducing exposure, interrupted duty hours, periodic spirometric assessment, use of personnel protective devices and awareness amongst exposed people.

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