Original Article

Study of computerized spirometric parameters of traffic police personnel of Saurashtra region, Gujarat, India

Amit H Makwana, Jayesh D Solanki, Pradnya A Gokhale, Hemant B Mehta, Chinmay J Shah, Bhakti P Gadhavi

Department of Physiology, Government Medical College, Bhavnagar, Gujarat, India

ABSTRACT

Background and Objectives: Air pollution due to road traffic is a serious health hazard and air quality crisis in cities is mainly due to vehicular emission. Thus the persons who are continuously exposed are at an increased risk. The study was carried out to evaluate the extent of impairment in lung function in traffic police personnel compared to matched unexposed control group. **Materials and Methods:** A cross-sectional study was conducted to measure the spirometric parameters of 100 traffic police personnel, aged 20-55 years, working in Saurashtra region, as compared to matched control group, consisting of 100 unexposed males. Measurement of lung volumes and capacities was done with SPIROEXCEL. The statistical analysis was carried out with Graph pad instat 3. **Results:** Traffic police personnel had significantly declined forced vital capacity (FVC), forced expiratory volume in one second (FEV 1), slow vital capacity (SVC) and maximum voluntary ventilation (MVV) when compared with predictive normal values, which is probably due to exposure to vehicular exhaust. Comparison of test values between groups showed significantly reduced FVC, MVV and increased FEV1/FVC ratio and insignificantly declined FEV1 and SVC in cases as compared to controls. Traffic personnel with longer duration of exposure showed significantly reduced lung functions than those with shorter duration. Smokers showed lower test values as compared to non-smokers with significance only in unexposed group. **Conclusion:** The effect of pollution by vehicular exhausts may be responsible for these pulmonary function impairments and traffic police personnel should be offered personal protective or preventive measures.

KEY WORDS: Computerized spirometry, lung volumes, traffic police personnel, vehicular exhaust

Address for correspondence: Dr. Jayesh D Solanki, F1, Shivganga Appartments, Plot No - 164, Bhayani Ni Waadi, Oppsite Bawaliya Hanuman Temple, Gadhechi Wadlaa Road, Bhavnagar - 364 001, Gujarat, India. E-mail: drjaymin_83@yahoo.com

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.

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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[6] 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

Table 1: Baseline data of traffic policemen (exposed group) and matched controls (unexposed) (n=100 in each group)

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

Table 2: Comparison between predicted value and test value of computerized Spirometric parameters in case and control group. (*n*=100 in each group)

Parameter	Case (mean±SD)		Control (mean±SD)		*P* value		
	A=Predicted	B=Test	C=Predicted	D=Test	A vs B	C vs D	B vs D
FVC (L)	4.27±0.46	3.01±0.55	4.07±0.67	3.32±0.88	<0.0001*	<0.0001*	0.0032*
FEV_1 (L)	3.57±0.43	2.66±0.57	3.45±0.59	2.78±0.83	<0.0001*	<0.0001*	0.23
FEV_1/FVC (%)	80.27±2.10	88.33±9.83	82.25±5.08	83.31±7.44	<0.0001*	0.025*	0.0001*
SVC (L)	4.46±0.50	3.05±0.77	4.21±0.61	3.14±0.64	<0.0001*	<0.0001*	0.37
MVV (L/min)	129.35±12.3	60.44±8.6	124.63±14.1	75.88±22.9	<0.0001*	<0.0001*	0.0001*

*Statistically significant. FVC=Forced vital capacity, FEV_1=Forced expiratory volume in one second, SVC=Slow vital capacity, MVV=Maximum voluntary ventilation, SD=Standard deviation

Table 3: Comparison of test value of computerized spirometric parameters in traffic police personnel group based on duration of exposure

Parameter	Mean±SD		*P* value
	Duration <4 years (*n*=56)	Duration >4 years (*n*=44)	
FVC (L)	3.18±0.54	2.90±0.52	0.0067*
FEV1 (L)	2.84±0.51	2.52±0.56	0.0026*
FEV1/FVC(%)	89.89±9.83	86.83±9.08	0.0064*
SVC (L)	3.23±0.78	2.91±0.73	0.0240*
MVV (L/min)	71.98±26.61	83.22±30.57	0.0288*

*Statistically significant. FVC=Forced vital capacity, FEV1=Forced expiratory volume in one second, SVC=Slow vital capacity, MVV=Maximum voluntary ventilation

pulmonary system also contribute to disparity between actual and predicted value in control group. With aging, there is reduced respiratory muscle strength, stiffness of chest wall with reduce compliance, decreased ciliary and macrophage activity, drier mucus membrane, decreased cough reflex and diminished response to hypoxia and hypercapnia.[7] 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.[8] 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,[9] 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.[5]

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.[10,11] 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.[12,13] 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.[14] 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.[15-18] The present study supports the findings of previous studies[8,19,20] 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.

FEV1/FVC was more than 80% in 96 out of 100 cases with decreased FVC and decreased FEV1 in majority indicating restrictive nature of pulmonary dysfunction as against obstructive.[21] These may be due to exposure to vehicular pollution for several hours in a day for many years causing decreased functional capacity of the lungs

Table 4: Comparison of test value of computerized spirometric parameters in case and control group between smokers and non-smokers

Parameter	Case group		*P* value	Control group		*P* value
	Smoker (*n*=27)	Non-smoker (*n*=73)		Smoker (*n*=13)	Non-smoker (*n*=87)	
FVC (L)	3.10±0.52	3.29±0.50	0.09	3.046±0.45	4.27±0.67	0.0001*
FEV1 (L)	2.71±0.64	2.79±0.49	0.32	2.52±0.54	3.73±0.54	<0.0001*
FVC/FEV1 (%)	86.82±11.30	85.10±10.26	0.21	82.002±8.39	87.56±6.10	0.040*

*Statistically significant. FVC=Forced vital capacity, FEV1=Forced expiratory volume in one second

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, FEV1, FEV1/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.

REFERENCES

1. Ghose MK, Paul R, Banerjee SK. Assessment of the impacts of vehicular pollution on urban air quality. J Environ Sci Eng 2004;46:33-40.
2. Ghose MK, Paul R, Banerjee RK. Assessment of the status of urban air pollution and its impact on human health in the city of Kolkata. Environ Monit Assess 2005;108:151-67.
3. Ingle ST, Pachpande BG, Wagh ND, Patel VS, Attarde SB. Exposure to vehicular pollution and respiratory impairment of traffic policemen in Jalgaon City, India. Ind Health 2005;43:656-62.
4. Sydbom A, Blomberg A, Parnia S, Stenfors N, Sandstorm T, Dahlén SE. Health effects of diesel exhaust emissions. Eur Respir J 2001;17:733-46.
5. Pramila T, Girija B. Study of pulmonary function tests in traffic policemen exposed to automobile pollution in Bangalore City. Nat J Basic Med Sci 2013;3:35-8.
6. Kamat SR, Sarma BS, Raju VR, Venkataraman C, Balkrishna M, Bhavsar RC, *et al*. Indian norms for pulmonary function: Observed values prediction equations and intercorrelations. J Assoc Physicians India 1977;25:531-40.
7. Joshi AR, Singh R, Joshi AR. Correlation of the pulmonary function tests with body fat percentage in young individuals. Indian J Physiol Pharmacol 2008;52:383-8.
8. Kim SM, Cheon GR, Kim YW, Kim JH, Lee HH, Hong SC, *et al*. Comparison study of the pulmonary function and serum carboxyhemoglobin level between the traffic policemen and clerk policemen. Tuberc Respir Dis 2003;55:560-70.
9. Pal P, John RA, Dutta TK, Pal GK. Pulmonary function tests in traffic police personnel in Pondicherry. Indian J physiol Pharmacol 2010;54:329-36.
10. Dickson RP, Schwartz DA. Acute and chronic responses to toxic inhalations. In: Fishman AP, Elias JA, Fishman JA, Grippi MA, Senior RM, Pack AI, editors. Fishman's Pulmonary Diseases and Disorders. 4th ed. New Delhi: Mc Graw Hill Medical; 2008. p. 995-1002.
11. 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 Pul Med 2001;7:20-6.
12. Inoue K, 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 2006;79:595-9.
13. 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.
14. Ganong WF. Altered Airflow in Disease. In: Barrett KE, Barman SM, Boitano S, Brooks H, editors. Ganong's Review of Medical Physiology. 24th ed. New York: McGraw Hill Medical; 2012. p. 630.
15. 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.
16. Thippanna G, Lakhtakia S. Spirometric evaluation of traffic police personnel exposed to automobile pollution in twin cities of Hyderabad and Secunderabad. Ind J Tub 1999;46:129-31.
17. Wongsurakiat P, Maranetra KN, Nana A, Naruman C, Aksornint M, Chalermsanyakorn T. Respiratory symptoms and pulmonary function of traffic policemen in Thonburi. J Med Assoc Thai 1999;82:435-43.

18. Binawara BK, Gahlot S, Mathur KC, Kakwar A, Gupta R, Rajnee, *et al*. Pulmonary function tests in three wheeler diesel taxi driver in Bikaner City. Pak J Of Physiol 2010;6:28-31.
19. 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.
20. Patil PJ, Thakare GV, Patil SP. Comparative study of lung function test of policemen in traffic control with those in general duty. Natl J Physiol Pharm Pharmacol. 2013;3:162-6.
21. Sayyad R, Yadav PK, Shekhar M, Aliyaraj A, Kar SK. Evaluation of pulmonary function tests on non smoking traffic police men at tirupati, AP, India. Int J Physiother Res 2013;1:279-82.
22. Bano R, Ahmad N, Mahagaonkar AM, Latti RG. Study of pulmonary function tests among smokers and non smokers in a rural area. Pravara Med Rev 2009;4:11-6.

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