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Original Article

Spirometric Evaluation of Effect of Air Pollution on Pulmonary Functions of Traffic Police in Kathmandu Valley

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ABSTRACT

Background and objectives: Traffic police personnel are exposed to ambient air pollution which leads to important health hazards like impairment of lung functions. The objectives of this study were to measure and compare the pulmonary function parameters of traffic police and general duty police and also aimed to evaluate the effect of job duration on those parameters in Kathmandu valley.

Materials and methods: A cross-sectional comparative study was done in a total of 133 healthy, non-smoker, male policemen working in Kathmandu valley for a minimum of one year. Out of them, 70 were from traffic police and 63 were from general duty police. MIR Spirolab II was used for pulmonary function test (PFT) measurement. Statistical analysis was done using SPSS version 20. The results were presented as mean ±SD and Independent sample t-test: was used. The p-value <0.05 was considered statistically significant. Pulmonary functions of the two groups were compared.

Results: There was a statistically significant decrease in FEV_1, FEV_1/FVC and $FEF_{25\%-75\%}$ among policemen working in Kathmandu valley for seven years or more as compared to those working for less than seven years. Although the traffic police had lower FVC, FEV_1, FEV_1/FVC and PEF in comparison to the general duty police, these differences were not statistically significant.

Conclusion: The findings of this study demonstrated that pulmonary functions of both the traffic and the general duty police decrease with increase in duration of job in Kathmandu valley. The pulmonary functions of the traffic police were lower than their predicted values although they were not significantly lower than those of the general duty police.

Keywords: Lung function, Spirometry, Traffic policemen, FVC, FEV_1, PEF, $FEF_{25\%-75\%}$

INTRODUCTION

Air pollution has long been a serious public health concern worldwide. In urban areas, vehicular and industrial exhaust is the major cause of ambient air pollution. World Health Organization (WHO), global mortality rate attributable to air pollution was 100 per

100,000 in 2012 [1]. According to Environment Performance Index (EPI) reports, Nepal is ranked 177th out of 178 countries for air quality only better than Bangladesh [2]. The level of air pollution in Kathmandu valley was first monitored and documented in 1990. [3] The scenario of Nepal, especially that of Kathmandu is not much different; in fact, it is worse than the global scenario [2].

Ambient air has been found to be directly associated with a number of chronic respiratory and cardiovascular disease. A significant proportion of deaths caused by lung cancer, chronic obstructive pulmonary disease (COPD), cardiovascular disease and pulmonary infections are attributed to ambient air pollution [1,3]. Particulate matter (PM) is the most important traffic related air pollutant with regard to health effect. It refers to complex mixture of components such as acids, organic chemicals, metals and soil or dust particles [4]. Commonly used indicators of PM relevant to health are PM_{10} which refers to mass concentration of particle with diameter of less than 10 μm and $PM_{2.5}$ which refers to particles with diameter less than 2.5 μm. There are evidences of PM related to combustion such as in automobiles being more hazardous than PM from other sources [5].

The level of air pollution is on rise due to accelerated urbanization, population surge, increased number of vehiches and adulteration with fuel. Although, evidences of few available literatures related to air pollution and its impact on traffic police personnel are highlighted on capital of country. Kathmandu traffic police are the most exposed of all the occupations; about an average 51.2 μg/m^3 to the ambient air pollution with an hourly maximum >500 μg/m^3) [6].

There is rapid increase in population as well as vehicles in Kathmandu. Vehicular emission is the main cause of ambient air pollution in major cities and traffic policemen are continuously exposed to vehicular emission due to nature of their job. Rapidly increasing number of vehicles, questionable emission standard of many vehicles, poor road condition and outdated traffic management system increases ambient air pollution level and puts traffic police personnel on higher risks of health hazards. General duty policemen come through same recruitment process with similar level of physical fitness, they are not as continuously exposed to vehicular exhaust as their counterpart traffic policemen.

Therefore, considering all of them have same level of exposure to environmental air pollution present inside Kathmandu Valley, comparing the PFTs of these two groups will give a clear idea of effect of vehicular exhaust on PFT of traffic police who have been excessively exposed to the pollution. Therefore, the objectives of the study were designed to measure and compare the PFT measurement namely forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), ratio of forced expiratory volume in first second and forced vital capacity (FEV_1/FVC), forced expiratory $flow_{25-75\%}$ ($FEF_{25-75\%}$) and peak expiratory flow (PEF) of traffic police and general duty police and also aimed to evaluate the effect of job duration on those parameters at Kathmandu valley.

MATERIALS AND METHODS

This comparative cross-sectional study was done in the Department of Clinical

Physiology, Institute of medicine, Tribhuvan University, Nepal in 2015 AD. Ethical clearance was taken from institution review board of Institute of Medicine, Maharajgunj [Ref: 220(6-11-E)^2/071/072].

Data were collected from 140 subjects but spirometry was performed in 133 subjects fulfilling inclusion criteria in both groups (70 from traffic police and 63 from general duty police). The non-smoker subjects of age between 18 and 40 years who worked either as traffic police or general duty police for a minimum of one year without significant interruption (more than one month) in their duty posting were included. The subjects with obesity (BMI more than or equal to 30), chest or abdominal pain, dementia or confusional state, stress incontinence, known case of respiratory or cardiovascular disease and any disease of mouth and oral cavity interfering with insertion of mouthpiece were excluded.

Cluster random sampling method was used. Policemen working at a one post were taken as a cluster. Ten to fifteen subjects were selected randomly from 12 posts of traffic and general duty police. Data were collected from 140 subjects but spirometry was performed in 133 subjects fulfilling inclusion criteria in both groups (70 from traffic police and 63 from general duty police).

The questionnaire survey, an occupational health questionnaire was designed based on the modified ATS-DLD-78-A (The American Thoracic Society, Division of Lung Diseases)[7] accompanying the queries about their sociodemographic variables and clinical history were collected by face-to-face interviews on the day of their medical examination.

The check-up integrated anthropometric measurements like height in centimeter (cm), weight in kilogram (kg), calculation of Body Mass Index-BMI (kg/m^2) and measurement of blood pressure. Weighing machine (Krups model- Doctor Beli Ram and Sons), height Scale, MIR Spirolab II were the tools used for the anthropometric measurements and PFT measurements respectively. Body mass index (BMI) was calculated by Quelet formula given as BMI = Weight (in kg)/ Height^2 (in meter). Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 20. The results were presented as mean±SD. Comparison of means between the traffic police and general duty police groups was determined by Independent sample t-test. The p-value < 0.05 was considered statistically significant.

RESULTS

Out of total of 133 subjects, 70 were traffic police and 63 were general duty police working in Kathmandu Valley for at least one year. Table 1 shows the demographic and anthropometric profile of the subjects.

Table 1: Age, job duration and anthropometric profile of the subjects

Parameters	Traffic Police (n=70)	General duty police (n=63)
Age (years)	29.57 ± 4.60	29.57 ± 5.25
Job duration (years)	5.73 ± 2.87	6.64 ± 3.75
Height (cm)	164.87± 2.85	165.85± 5.98
Weight (kg)	66.81± 4.87	67.70± 7.47
BMI (Kg/(m^2)	24.77± 1.29	24.69± 2.17

Table 2 depicts that there was no statistically significant difference in any PFT parameters between traffic police and general duty police. However, all the PFT parameters except FEV_1/FVC were lower than their predicted value in both the traffic police and general duty police. Both the observed and percent predicted value of FEV_1, FEV_1/FVC and $FEF_{25\%-75\%}$ were significantly lower in the policemen working for 7 years or more compared to those working for less than 7 years. However, there was no statistically significant difference in FVC and PEF between two groups. Both the groups have less FVC and PEF than their predicted value however there was no statistically significant difference in two groups as shown in Table 3.

DISCUSSION

Air pollution not only increases the cases of lung and heart disease, it also increases the hospitalization time and mortality related to

Table 2: Comparison of observed and percent predicted PFT parameters between traffic police and general duty police

Parameter	Traffic police (n=70)	General duty police (n=63)	p value
FVC (observed)	3.82 ±0.36	3.96 ±0.59	0.098
FVC (percent predicted)	96.13±5.64	97.60±10.99	0.325
FEV_1 (observed)	3.14 ±0.32	3.28 ±0.54	0.085
FEV_1 (percent predicted)	93.04±6.67	95.33 ±12.04	0.173
FEV_1/FVC (observed)	82.33 ±3.55	82.85 ±6.02	0.541
FEV_1/FVC (percent predicted)	100.51±3.96	101.08±7.20	0.565
PEF (observed)	7.69 ±1.02	7.91 ±1.13	0.288
PEF (percent predicted)	86.01±10.95	88.41±14.75	0.286
$FEF_{25\%-75\%}$ (observed)	3.65 ±0.62	3.54 ±0.99	0.458
FEF25%-75% (percent predicted)	79.51±12.13	78.95±19.18	0.839

Table 3: Comparison of observed and percent predicted PFT parameters according to duration of work in Kathmandu Valley

Parameter	Job duration in Kathmandu Valley <7years (Group A)	Job duration in Kathmandu Valley ≥ 7 years (Group B)	p value
FVC (observed)	3.94±0.45	3.82±0.51	0.169
FVC	97.10±8.09	96.52±9.20	0.598
FEV_1 (observed)	3.34±0.43	3.06±0.41	0.000
FEV_1	96.13±9.12	91.83±9.75	0.010
FEV_1/FVC (observed)	84.72±4.04	80.13±4.59	0.000
FEV_1/FVC (percent predicted)	102.77±4.89	98.50±5.75	0.000
PEF (observed)	8.05±1.11	7.51±1.18	0.08
PEF (percent predicted)	88.85±11.75	85.21±13.94	0.105
FEF25%-75% (observed)	3.91±0.70	3.25±0.80	0.000
FEF25%-75% (percent predicted)	82.80±14.80	75.18±16.04	0.005

them [8]. Traffic police is one of the most exposed populations to ambient air pollution especially the vehicular air pollution [9]. The major finding of this study reveals that the long-term exposure to environmental air pollution at Kathmandu valley has detrimental effect on pulmonary functions. The policemen (both general duty and traffic) working in Kathmandu Valley for seven years or more had a statistically significant decrease in FEV_1, FEV_1/FVC and $FEF_{25\%=75\%}$ as compared to those working for less than seven years. The traffic police have impaired FVC, FEV_1, FEV_1/FVC and PEF in comparison to the general duty police but these differences were not statistically significant.

Several studies done in different parts of the world have suggested that different environmental conditions affect human respiratory functions. Traffic related air pollution has been found to have high public health effect [10]. Spicer et al [11] studied the relation of pulmonary function to different environmental functions such as temperature, wind speed, barometric pressure and sulfur dioxide levels. Qian et al [12] observed that one year mean level of PM_{10} and ozone was negatively associated with FVC, FEV_1, and FEV_1/FVC. Abbey et al [13] found that increase in PM_{10}, sulphur oxide and ozone were associated with decrease in pulmonary function. Olivieri and Scoditti [14] also suggested that air pollutants particularly ozone, nitrogen oxide, particulate matter and sulphur dioxide interfere with lung defense, facilitating the development of lung disease. Forbes et al[15] observed the association between PM_{10} and decreased FEV_1 in adults.

Traffic police have higher exposure to those air contaminants than others. Crebelli et al[9] found that traffic policemen in Rome had consistently higher level of benzene exposure than the individuals working indoor. In Nepal, personal exposure of $PM_{2.5}$ was found to be higher in traffic police than in others [6]. Studies done in Milan, Italy suggested that exposure to lead, benzene, CO and PM were higher in traffic police [16,17]. The above findings suggest that traffic police personnel are vulnerable to multiple occupational hazards. Majority of studies have reported decrease in lung functions and increased respiratory morbidity among traffic police [18].

This study showed that FVC and FEV_1 were less than predicted in both the traffic police and general duty police without decrease in FEV_1/FVC ratio. This suggests restrictive pattern of pulmonary function impairment. The PEF and $FEF_{25\%-75\%}$ are also markedly decreased in both groups. All of the parameters except $FEF_{25\%-75\%}$ are less in traffic police than in general duty police but these values were not statistically significant. The decrease in pulmonary function of traffic police is supported by various studies. Ingle et al [19] found that FVC, FEV_1 and PEF of traffic police were significantly less than their predicted and also less than the control group in general population. Ranganadin et al [20] observed that all PFT parameters (FVC, FEV_1, PEFR and MMEF) were lower than predicted in traffic police.

Sayyad et al [21] also noted the significant decrease in pulmonary functions in traffic police compared to general population in a study done in Tirupati, India. Only few articles were found to support our findings of non-significant difference in pulmonary functions between traffic police and general duty police probably because in most of the studies, the control were taken from general population or from general duty police who

worked strictly inside the office. However, study conducted by Karita et al [22] supports these findings. They found that pulmonary functions of policemen working in more polluted Bangkok city were lower than those working in less polluted Ayutthaya. However, there was no significant difference in pulmonary functions between traffic police and non-traffic police working in Bangkok [22].

Patil et al [23] also had similar observations in their study which showed decrease in pulmonary functions in both the traffic police and general duty police with more decrease in traffic police. Another study done in Bogota, Columbia did not find any difference in traffic police to control group despite the difference in PM_{10} exposure [24]. This study also shows that policemen working in Kathmandu valley for more than six years not only have decreased FVC and FEV_1 but also FEV_1/FVC ratio suggesting mixed pattern of pulmonary impairment. These findings are supported by study done in Bangalore which showed linear relation between duration of exposure and pulmonary functions parameters like FEV_1, FEV_1/FVC, PEF and $FEF_{25\%-75\%}$ [25]. Gupta et al [26] also observed significant decrease in FVC, FEV_1 and PEF in traffic police working for more than 8 years than in those working for less than 8 years. A study done in Kathmandu, Nepal also showed the relationship between duration of work as traffic police and decline in pulmonary functions [27]. Similarly, mixed pattern of lung impairment was found in auto rickshaw drivers with significant decrement of pulmonary functions in those working for more than 10 years [28].

LIMITATIONS

Due to cross-sectional study, the effects of pollution in a linear fashion for longer duration of time under controlled manner were not followed up. Personal exposure to the specific air pollutants could have been monitored among the traffic police equipped with the device used to measure the pollutant concentration over 24 hours to make it more informative. The decline in PFT with normal ageing could contribute to the decrease seen in policemen with longer job duration. An age-matched comparative study with general population is recommended.

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