Comparing the impairment in lung age due to various etiologies among Bus Rapid Transit System traffic wardens of Indore city

Garima Shrivastava[1], Sumit Sinha[2]

[1]Department of Physiology, Mahatma Gandhi Memorial Medical College, Indore, Madhya Pradesh, India, [2]Consultant Physician, V Care Hospital, Indore, Madhya Pradesh, India

Correspondence to: Sumit Sinha, E-mail: drsumitsinha@gmail.com

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ABSTRACT

Background: Increased vehicular pollution is an occupational hazard to people working in traffic such as bus rapid transit system (BRTS) wardens which impairs the lung functions causing a discrepancy between chronological and observed age of lung, resulting in early lung aging. **Objectives:** The objective of this study is to compare the increase in lung age (LA) due to various etiologies by assessing the lung functions of people working in traffic such as BRTS wardens. **Materials and Methods:** A total of 174 subjects were studied after dividing them into cases ($n = 87$, BRTS traffic wardens who were exposed to vehicular exhaust) and control ($n = 87$, age- and sex-matched subjects who were not exposed to vehicular exhaust) from June to July 2017 at BRTS bus depot and workshop, Indore. Detailed history along with pulmonary function test was done using computerized spirometer. **Results:** Comparison of percentage prediction of LA between cases and controls was 110.8 ± 33.6 and 97.9 ± 23.8, respectively ($t = 2.90$; $P = 0.004$), between non-smokers cases ($n = 67$) with that of non-smoker control group ($n = 77$) was 109.4 ± 34.1 and 95.3 ± 19.5 ($t = 3.10$; $P = 0.002$), between smokers cases ($n = 4$) with that of smokers in control group ($n = 4$) was 100.3 ± 25.5 and 154.8 ± 36.2 ($t = -2.46$; $P = 0.049$), between cases ($n = 47$) and controls ($n = 79$) depending on the duration of exposure was (>1 year) was 114.6 ± 38.5 and 97.7 ± 23.2 ($t = 3.08$; $P = 0.003$), and between cases ($n = 47$) and controls ($n = 69$) depending on the duration of exposure in hours (8 h) was 109.2 ± 37.2 and 96.1 ± 21.3 ($t = 2.41$; $P = 0.018$), respectively. **Conclusion:** LA was significantly more among non-smoker cases (BRTS wardens) and particularly the cases more exposed to the pollution. However, smoking among cases and controls overshadowed the effect of air pollution in causing lung aging. These findings suggest that though air pollution causes lung aging, smoking, still, is the major etiology causing increased lung aging.

KEY WORDS: Smoking; Lung Age; Pulmonary Function Tests; Pollution, Bus Rapid Transit System Wardens

INTRODUCTION

Rapid population growth, urbanization, suburban sprawl, rising income, and sharply rising motor vehicle ownership have led to transport crisis in Indian cities which is associated with an enormous increase in vehicular traffic emitting exhaust and polluting atmosphere.[1,2]

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Exhaust emission is significantly higher in Indian cities than developed countries because of low-grade fuel, defective engine performance, poor maintenance of engine, lack of traffic planning, and multiplicity of the type of vehicle on the same road. This has resulted in alarming levels of congestion, air pollution, noise, traffic, and decreased physical activity. All these have negative impact on the health of the society.[3,4]

Indore is the largest city in the state of Madhya Pradesh and 11th most populous in India. It is a major economic center in Central and Western India and serves as an educational, medical, industrial, and trade hub.[5] Population growth, economic growth, and migration have led to increased vehicle numbers and traffic within the city.[6]

It is also one of the cities in India with the highest number of two-wheelers. Keeping these issues in focus, Indore had implemented "Bus rapid transit system (BRTS)," also known popularly as "i-bus" or "intelligent bus" in 2013, which is a rubber-tired mode of public transport, also running in cities such as Ahmedabad and Bhopal.[7]

Traffic-related air pollution is an occupational hazard to individuals performing a duty or physical labor close to traffic such as vendors, traffic policemen, and BRTS wardens, who are posted at various traffic junctions, through which a number of vehicles pass. This makes such group of persons vulnerable to develop respiratory health hazards from air pollution due to automobile exhaust. Similarly, smoking too affects the respiratory health directly. The rate of cigarette smoking among young people has increased steadily. Many of the BRTS wardens who are exposed to vehicular exhaust are also smokers which may further degrade their lung function.

In the present study, we have focused on the estimation of lung age (LA), which is the predicted age of the lung depending on the ventilatory functions assessed by performing pulmonary function tests. This LA so obtained was compared to the chronological age of the person, and thus, a tentative prediction of falling respiratory health was made which could act as an eye-opener for urgent need to implement steps for stopping the disease progression.

MATERIALS AND METHODS

The present prospective study was performed on 87 BRTS traffic wardens exposed to vehicular air pollution (case group) and 87 subjects that are not exposed to vehicular exhaust (control group) from June 2017 to July 2017 at BRTS bus depot and workshop, Indore, using RMS Helios 401, portable computerized spirometer with Medspiror Software (under Department of Physiology, MGM Medical College, Indore). The study cohort was further grouped as smokers and non-smokers.

Males aged between 18 and 50 years, BRTS wardens with job duration >1 year with working not <8 h/day, and BRTS wardens willing to participate and have given written informed consent for participation in the study were included in the study.

Patients with any evidence of cardiac disease, respiratory disease, endocrinal disease, eye surgery, recent abdominal surgery, recent thoracic surgery, and refusal to participate in the study or not consenting to participate in the study were excluded from the present study.

Pre-requisites for Procedure

Subjects were asked not to have large meals immediately before test and to wear light and loose clothes while performing pulmonary function test (PFT).

History was obtained using pre-approved questionnaire which included relevant medical, personal, family history, and socioeconomic status. The general physical examination was done, and vital data are taken to meet inclusion and exclusion criteria.

The institutional ethical committee approval and written permission were obtained from BRTS authorities. Air Quality Index was obtained from the Pollution Control Board, Indore office, Madhya Pradesh.

PFT was carried out with the help of a computerized spirometer which is a non-invasive and quite accurate method for assessing the respiratory health of an individual, especially the ventilatory functions of the lung.[8] Before recording, subjects were asked to relax. The test was done in sitting position of the subject. They were asked to inhale from and exhale into the disposable mouthpiece twice with lips tightened around mouthpiece to prevent leakage of air, and nose-clip was placed to allow the airflow only through mouthpiece to and from the lungs. The procedure was demonstrated to them. The maneuvers were repeated thrice, and the best of three readings was taken.

The inbuilt software of the computerized spirometer assessess for the PFT parameters such as forced vital capacity (FVC), forced expiratory volume in 1st s (FEV1), FEV2, FEV3, FEV1/FVC (forced expiration as percentage of vital capacity), peak expiratory flow rate, forced expiratory flow (FEF) 25%, 50%, and 75% (FEF at 25%, 50%, and 75% of volume as percentage of vital capacity, respectively), FEF 25–75% (FEF at 25–75% of volume as a percentage of vital capacity), and also calculated predicted LA of the individual performing PFT.

- LA for men was calculated using: 2.87H-31.25 (Obs FEV1)-39.375
- LA for women was calculated using: 3.56H-40.00 (Obs FEV1)-77.280.

Where H is height in inches, and the LA so obtained was compared with the chronological age of the person and assessed for aging of the lungs.

All the data were analyzed using IBM SPSS version 20 software. Data are expressed as mean ± standard deviation (SD). Quantitative data were analyzed using student *t*-test and two-way ANOVA. Level of significance is assessed at 5% level.

RESULT

Mean age (years), height (cm), weight (kg), and body mass index (kg/m^2) among cases and control were 30.9 ± 1.50 and 31.06 ± 0.73 (P = 0.941), 168.72 ± 0.76 and 170.41 ± 0.68 (P = 0.359), 58.7 ± 1.20 and 60.2 ± 1.1 (P = 1.00), and 20.36 ± 0.46 and 20.72 ± 0.37 (P = 543), respectively [Table 1].

DISCUSSION

Since there is hardly any evidence of a direct relation between vehicular pollution and LA, it is better to correlate FEV1 with air pollution as FEV1 is considered as the single most important parameter for calculation of LA using the equation given by Morris and Temple.[2]

In the present study, it was found that air pollution causes lung aging, which indirectly suggests that there is some deficit in the FEV1 among the exposed group. Evans *et al*. investigated the effects of emission from the internal combustion engine on PFT of tunnel workers and found that they had significantly lower FEV1 and higher carboxyhemoglobin levels as compared to bridge workers.[1] Similar results were found by Nihfir *et al*. in a study among traffic police personnel of Batticaloa city, Sri Lanka, where there was a significant reduction in FEV1 in traffic police officers as compared to control group.[9] In another study carried out by Karita *et al*., on the traffic police personnel of Bangkok, there was significantly lower mean FEV1 level as compared to general police who were the controls.[10] A study done on the traffic police personnel in Pondicherry, India,found that FEV1 was significantly decreased among the cases who were exposed to vehicle exhaust as compared to controls, who were not.[8] Ingle *et al*. studied PFT and vehicular pollution on traffic policemen in Jalgaon city, India, and found that FEV1 was significantly affected among the cases compared to controls.[11] Another study on automobile pollution and its effect on traffic policemen was done in Bangalore city by Pramila and Girija and found a reduction in FEV1 among cases as compared to controls.[12] In a similar study, Singh *et al*. reported a significant difference in FEV1 data of subjects exposed to traffic generated pollution than those who are not exposed.[3] All the cited studies are in concordance with the findings of the present study that exposure to vehicular exhaust reduces FEV1, which indirectly increases the aging of the lungs more than the chronological age. The present study also suggests that duration of exposure to vehicular exhaust in terms of years of exposure and hours of exposure per day also reduces FEV1. The study conducted in Batticaloa, Sri Lanka, among the traffic policemen, suggested that there was a significant reduction in FEV1among the cases who were exposed for more than 5 years.[9] In another study conducted among the traffic policemen of Patiala, Gupta *et al*. reported that there was a significant reduction in FEV1 among the cases exposed to vehicular emissions for nearly 9 h a day since 8 years.[4] A similar decline in FEV1 was found among the traffic policemen of Saurashtra region, Gujarat, who were exposed to automobile pollution for more than 4 years as compared to those exposed for a lesser duration.[13] The cited studies corroborate well with the concept of this study that increased duration of exposure to vehicular emissions reduces FEV1 and causes progressive lung aging. However, the most striking finding is that smoking overshadows the effect of air pollution on lung aging and emerges as even more powerful factor for causing it. This implies that the constituents present in the smoke of cigarette due to the burning of nicotine are far more hazardous than those found in vehicular exhaust. In the current study, smokers included, those who smoke cigarette daily and have smoked ≥5 packs of cigarettes before the date of performing PFT. Non-smokers include those who have smoked <5 packs of cigarettes during their lifetime or not smoked at all in the past. Our study suggests that LA was increased significantly among the controls who were found to be smokers. This may be due to the fact that there is more consumption of cigarettes among controls as compared to cases, because of affordability, status symbol, etc. Hence, in spite of spending more time between vehicular exhaust LA is less among cases, as compared to controls that spend very less time in air pollution. In a Korean study conducted by Oh *et al*. it was seen that lifelong total amount of smoking was positively associated with LA even after adjusting for other factors known to influence LA.[14] A similar increase in LA was seen among smokers in a study conducted by Wada at Jikei University Hospital, Japan.[15] While evaluating variables associated with changes in the spirometry in patients with obstructive lung diseases, Kanner *et al*. found that less favorable changes were associated with more years of cigarette smoking, more airway reactivity, and more frequent lower respiratory tract illness.[16] Thus, we can say that demonstration of ventilatory impairment to the smoker and estimating his LA can be used for motivating smoking cessation.[2]

Table 1: Comparison for percentage prediction of LA between different parameters of groups

Parameters	Cases	Control	t	P
Non-smokers	109.4±34.1 (n=67)	95.3±19.5 (n=77)	3.10	0.002
Smokers	100.3±25.5 (n=4)	154.8±36.2 (n=4)	−2.46	0.049
Duration of exposure (≥1 year)	114.6±38.5 (n=47)	97.7±23.2 (n=79)	3.08	0.003
Duration of exposure (8 h)	109.2±37.2 (n=47)	96.1±21.3(n=79)	2.41	0.018

Data are expressed as mead±SD, P<0.05 is considered as statistically significant. SD: Standard deviation, LA: Lung age

The present study is not devoid of limitation; main is small sample size; a large randomized trial is needed to strengthen the present study findings.

CONCLUSION

Although LA is not a direct measure of pulmonary functions, its estimation can be used to explain the respiratory health hazards to a common man in a very simplified manner which can help in improvement of the ventilatory functions in due course; therefore, the use of spirometery, especially for smoking cessation, needs much emphasis. An abnormal test or increased aging of the lung can be related to smoking (among smokers) or to air pollution exposure among people exposed to it. An improvement in LA can act as re-enforcement for smoking cessation or for the use of safety measures from air pollution or to encourage passive smokers to spread awareness in their surroundings. However, the equation for the estimation of LA needs to be reviewed.

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