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# Lung morbidity of traffic wardens exposed to chronic vehicular pollution in Lahore, Pakistan

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## Abstract

Lahore being a highly populated metropolitan city was selected to monitor the lung capacity of traffic wardens. Vehicular pollution was monitored throughout Lahore at the main vehicular influx and outflow sites in both winters and summers for $NO_2$, CO, $PM_{2.5}$ and $PM_{10}$ along with temperature and humidity.Spirometery was conducted on 500 subjects by MDX Spiro Tron. The temperature, humidity, CO and $NO_2$ dioxide levels vary with the change in season whereas the values of $PM_{2.5}$ and $PM_{10}$ correlate with each other positively and negatively among the towns and depict dangerously high levels of both the PM concentrations.Moderate effect on lung capacity in 25% of the field duty officersand severe effect in 2.8% of the field duty officers (10 years) followed by 6.8% of the wardens (8 years) was observed. Thus, saying that chronic exposure of vehicular emissions leads to lower lung capacities and higher disease symptoms.

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## Introduction

Air pollution is known to be a severe issue worldwide mainly in the developing countries where remedial measures are almost nil. Air pollution being the fourth highest root cause of deaths occurring in the developing countries only followed by smoking, high blood pressure, and poor diet leads to higher numbers every year manly in the third world countries(McCarthy, 2018).

Vehicular Pollution arising from the fuel consumption on roads results in high ambient air pollution levels at a larger scale. Travellers and commuters are exposed to higher levels of pollution to the extent of time consumed in travelling but people like road side shop vendors and traffic wardens are exposed to higher levels for extended a chronic extended period of time. Long term exposure to vehicular pollutants has been linked to adverse health problems (Korani, 2016).

Several studies have shown an association between lung function decline and long-term exposure to air pollution in the entire population from infants to teens and adults to old people( Kan *et al.*, 2007, Forbes *et al.*, 2009).

It has been studied that reduction in exposure to the vehicular pollution may recover the loss that the individual has faced with the passage of time, it may also decline the process of decreased lung capacity with age (Downs *et al.*, 2007).

In Boston a cohort study was conducted over a period of seven years estimating the long term effects of ambient air pollution in low pollution exposed children. The study was linked to $PM_{2.5}$ exposure and proximity of the child to a major road, the study revealed decreased lung function in the children under study (Rice *et al.*, 2016).

As per WHO outdoor related premature ischaemic heart disease related deaths due to ambient air pollution were around 72% followed by COPD being the cause of 14% of the deaths and 14% were due to lung Cancer in the year 2012.(WHO, 2016).

It is projected that Pakistan will become the 16th largest economy globally by 2050 (Price Waterhouse Coopers, 2017). Thefacts and figures shows that the estimatedpopulation in the rural areas decreased from62.1 percent in 2013 to 59.46 percent in 2017, whereas, the population in urban areasincreased from 37.9 percent in 2013 to 40.54percent in 2017.

The environmental protection agency of Pakistan has made regulations stating " no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the National Environmental Quality Standards" (PEPA, 1997) but these rules are rarely followed.

Over the pastyears pollution of Lahore has been studied to determine the air quality index for the city. As per regular real- time measurements of the criteria pollutants which include carbon monoxide, lead, nitrogen dioxide, ozone,particulate matter, and sulphur dioxide the air quality index of Lahore ranges from unhealthy to hazardous around the year. Lahore a metropolitan city also being the engineering hub contributes to 13.2% of Pakistan's national economy with an average growth rate of 6% in industries like steel, IT, cars and chemicals. As per the 2017 census the city's population is about 11.12 million which has increased from 836,000 as of the population data of 1950 in 1772 $km^2$area.

Specialized recruitment for managementof increased traffic was established by conductingtraffic wardens as per guidelines of the city traffic officer the wardens are alternated between areas of high, moderate and low traffic but they are likely to be exposed to higher level of air pollutants long working hours on the roads more than the other individuals.The study was conducted to examine the impact of exposure to air pollutants on these traffic wardens.

## Materials and methods

Ten sites were selected randomly from the ten towns each. They were marked on the map by the help of GPS coordinatesas in Fig 1. Each site was monitored

for a total of sixteen hours (16hrs) at fifteen minute intervals as the wardens work in two shifts of 8 hours each from 700 to 1100hours on the roads but the traffic sectors are open during the night with no more than one staff member each. Data at each of the ten sites was collected both in winters and in summer's forNitrogen Dioxide ($NO_2$), Carbon Monoxide (CO), PM $_{2.5}$, $PM_{10}$ along with temperature and humidity, Traffic summary data was divided into three categories 1. Heavy Traffic (HT), 2.

Moderate Traffic (MT), and 3. Light Traffic (LT). The vehicles were counted manually in the 100 meter diameter on all sides of the equipment installed.

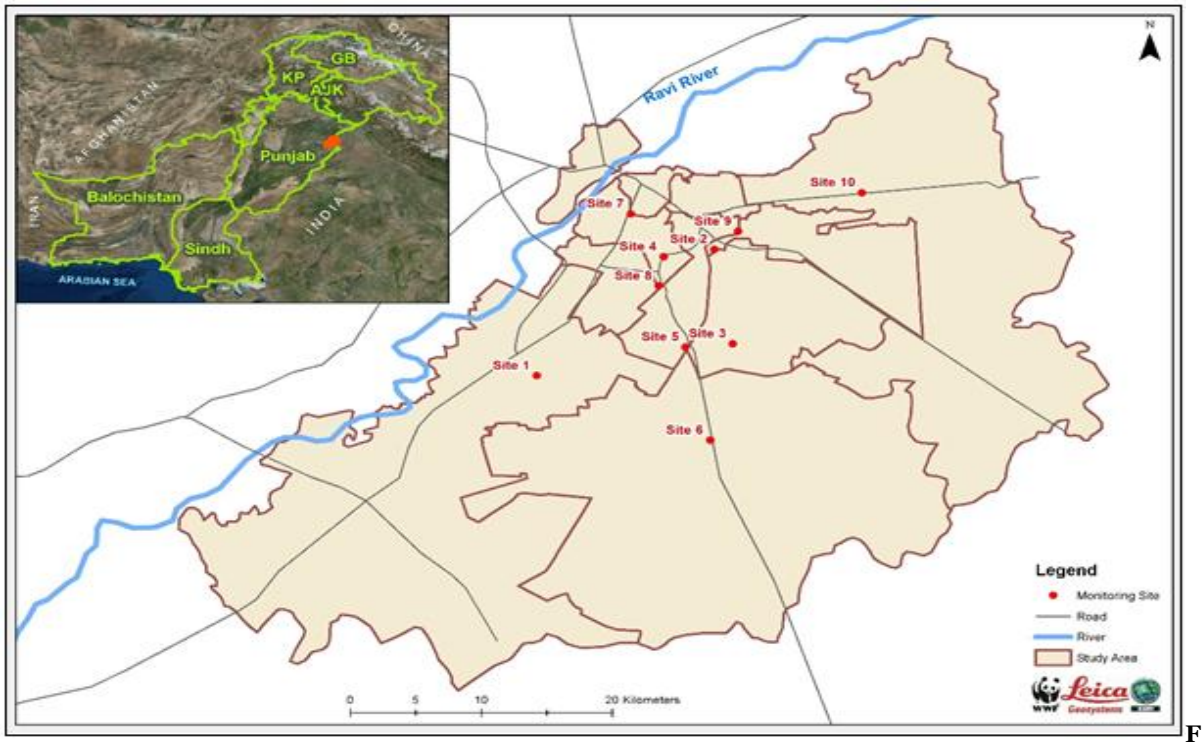


**Fig. 1.** Map of Study Area.

Aeroqual portable monitor 500 series was used to monitor the toxic vehicular pollutant gases including $NO_2$ and CO along with temperature and humidity.

Particulate matter (PM) was analysed in number concentrations by the portable GRADKO DC 1700 Laser Air particle Monitorwith the range of 2.5 µm and 10 µm. Both values of PM $_{2.5}$ and $PM_{10}$ were recorded at 15 minute intervals. These were then converted to their mass concentrations by the Dylos conversion sheet prepared with data derived.

Traffic warden system was implemented in Lahore for the first time as the city traffic police (CTP) and thus has the most exposure to vehicular pollution on roads. Five hundred (500) traffic wardens were selected randomly from all nine towns of Lahore and the cantonment. Wardens deputed on the road duties were considered as the Field duty staff (FDS, n=366) and workers deputed in main offices, sector offices and licensing stations were considered as the office duty staff (ODS, n=134).

All participants were interviewed for their general health and wellbeing parameters.

Spirometery was conducted on 500 wardens by a digital portable spirometer MDX Spiro Tron with disposable mouth pieces(Bellamy, 2005).

These wardens were divided in to 4 groups for Office duty Staff group (ODS1, ODS2, ODS3, ODS4) and four groups for Field Duty Staff Group (FDS1, FDS2, FDS3, FDS4) from with ODS1 and FDS1 badges

having the least years of service and ODS4, FDS4 being the first badge of induction in the warden force. Values of FVC, FEV1 and FEV1/FVC were then used to categorize the individuals ("Chronic obstructive pulmonary disease in adults | Guidance and guidelines | NICE," n.d.), for severity of Chronic Obstructive Pulmonary Disease (COPD).

A structurally designed questionnaire with affidavit of confidentiality from the researcher and consent from the warden was used during the course of research for all 500 wardens under consideration.

Data was analysed statistically for correlation between the environmental and lung function parameters by SPSS version 19.

**Results and discussion**

Maximum of high temperature was recorded in the summer season in all towns whereas minimum was recorded at Site 10 in the winter season.

The relative humidity being inversely proportional to the temperature remained low in the summer months when the temperature was high as compared to the winter months which showed lower temperature and higher levels of humidity.

High pollution levels mainly consisting of increasing vehicular pollution and degradation of both outdoor and indoor air quality related to suspended particles in air has been identified in Pakistan (Colbeck *et al.*, 2010).

**Table 1.** Personal Medical History (% of individuals with reported symptoms).

| Parameter | ODS | ODS1 | ODS2 | ODS3 | ODS4 | FDS | FDS1 | FDS2 | FDS3 | FDS4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Headache | 18 | 19 | 21 | 15 | 17 | 14 | 14 | 14 | 14 | 14 |
| Nausea | 2 | 4 | 1 | 2 | 0 | 3 | 3 | 3 | 2 | 5 |
| Breathlessness | 6 | 4 | 5 | 5 | 12 | 6 | 5 | 7 | 5 | 7 |
| Dizziness | 4 | 7 | 3 | 4 | 5 | 3 | 4 | 4 | 2 | 2 |
| Eye irritation | 11 | 12 | 13 | 9 | 12 | 12 | 13 | 12 | 13 | 9 |
| Ear irritation | 10 | 10 | 11 | 10 | 7 | 11 | 13 | 10 | 12 | 9 |
| Dry Cough | 6 | 7 | 6 | 5 | 7 | 8 | 8 | 8 | 7 | 7 |
| Wet Cough | 3 | 5 | 2 | 3 | 5 | 5 | 5 | 5 | 5 | 4 |
| Sneezing | 4 | 5 | 4 | 3 | 2 | 4 | 5 | 4 | 4 | 4 |
| Epistaxis | 3 | 3 | 1 | 3 | 5 | 2 | 1 | 2 | 3 | 2 |
| Dust Allergy | 10 | 10 | 10 | 13 | 5 | 10 | 9 | 10 | 10 | 7 |
| Sunburn | 4 | 4 | 3 | 5 | 0 | 3 | 3 | 4 | 3 | 2 |
| Angina | 5 | 1 | 6 | 5 | 2 | 4 | 5 | 5 | 4 | 5 |
| Blood Pressure | 11 | 5 | 11 | 14 | 7 | 10 | 11 | 9 | 10 | 18 |
| Blood Sugar | 1 | 1 | 0 | 1 | 7 | 1 | 1 | 1 | 1 | 0 |
| Pulmonary Issues | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 4 |
| Cardiac Issues | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 |
| Contagious Diseases | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |

This trend has also been studied in many Asian countries including China (Chan and Yao, 2008),

Indonesia (Kim Oanh *et al.*, 2006), Vietnam (Phung i., 2016), Malaysia( Simoneit, 2004, Omar *et al.*, 2007;), Bangladesh (Begum, Biswas, and Hopke, 2006), Phillipines, Thailand(Uttamang, *et al.*, 2018) and India(Jain and Khare, 2007). High CO levels (Fig. 2) observed in majority of the sites rose beyond permissible limits only in cases of heavy traffic load at particular point of time of the highest observed at Site 5 (0.44±1.22ppm) were due to the train junction at times when train passes and both sides of the road are blocked leading to high vehicle number on both sides of the junction and also the exhaust produced by the train that rises the CO level. Winter season also

depicts higher pollution level due to condensed and concentrated air pollutants mainly the carbon monoxide levels whereas lower levels of nitrogen dioxide levels were observed in the winter months and rose during the summers ( Goldstein, 1972; Kan, 2011, Cheng and Kan, 2012; Kan, Chen, and Tong, 2012).

**Table 2.** BMI index of individuals of particular group.

| BMI Index | ODS | ODS1 | ODS2 | ODS3 | ODS4 | FDS | FDS1 | FDS2 | FDS3 | FDS4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Underweight | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Thin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Normal | 42 | 58 | 46 | 37 | 12 | 40 | 58 | 36 | 40 | 31 |
| Overweight | 39 | 32 | 37 | 44 | 38 | 49 | 40 | 53 | 46 | 44 |
| Obese | 18 | 10 | 17 | 17 | 50 | 11 | 2 | 11 | 14 | 25 |

Highest levels of particulate matter concentrations (Figs 4 and 5) were found mainly in the summer months in all parts of Lahore and correlated significantly with levels of humidity in all towns under study. (Watt, Godden, Cherrie, and Seaton, 1995, GoP, 2016; Uttamang *et al.*, 2018).

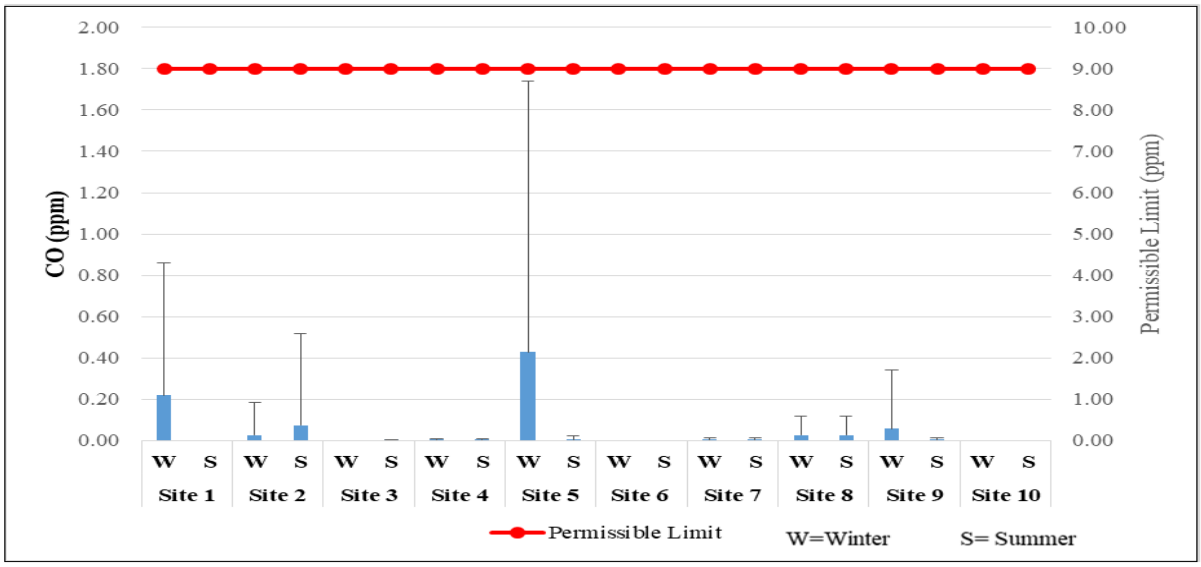


**Fig. 2.** Mean carbon monoxide with standard deviations of ten sites in summer (S) and winter (W) seasons.

Carbon monoxide (CO) levels presented in Fig. 2, were mainly low and within permissible limits which is 9pp for 8 hours in most of the sites but higher levels were observed at Site 5 during the winter season.

Site 1 also showed higher levels of carbon monoxide in the winter due to heavy traffic load mainly including loader trucks and heavy capacity passenger vans.

The $NO_2$ levels went up to 0.47 ppm in summers for Site 8 and dropped as low as 0.07ppm in winters as per Fig. 3. Summer season showed higher levels of pollutant gases $NO_2$(EPA, 2014), than the winter months and higher levels of CO in the winter months(USEPA, 2012). Highest levels of Particulate matter concentrations were found mainly in the summer months in all parts of Lahore (Figs 4 and 5) and correlated significantly with levels of humidity in all sites under study.

Traffic summary data for the sites under study was collected from the Punjab Highway Authority for the year 2011 (GOP, 2011) and data for 2016 was collected by physically counting the vehicles during research to compare the number of increase in motorized vehicles which further depicts an increase in the number of pollutants present in the air and also supports the increase in population of the area as per Fig 6.

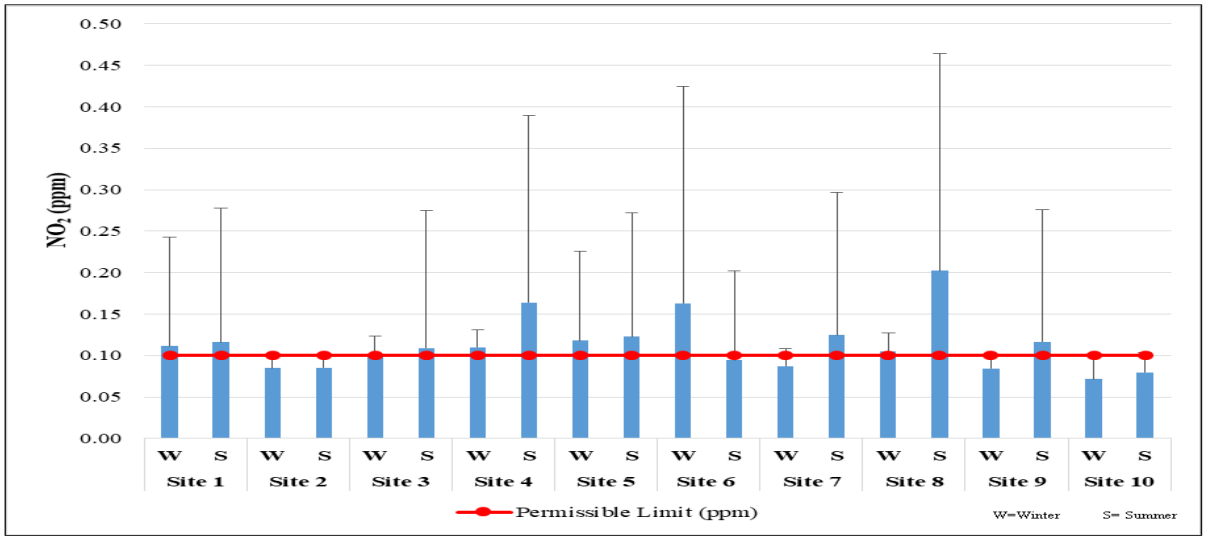


**Fig. 3.** Mean nitrogen dioxide with standard deviation of ten sites in summer (S) and winter (W) seasons.

Exposure to pollutants is elevated in urban areas with high traffic volumes and heavily travelled highway corridors(Zeka, 2005). Higher traffic density areas result in high levels of vehicle-related gaseous pollution(Mckeown, 2007)**.** Streets with sky scrapers, other tall buildings and areas close to busy roads inhibit air dispersion leading to pollution locked pockets having high concentration of emissions (Longley *et al.*, 2004). Congested traffic leads to higher vehicular emission degrading the quality of air, comparatively excess morbidity was observed in people exposed directly or indirectly to the emission including drivers, pedestrians and commuters (Zhang and Batterman, 2014). The personal medical history was collected from each individual during the interview (Table 1).

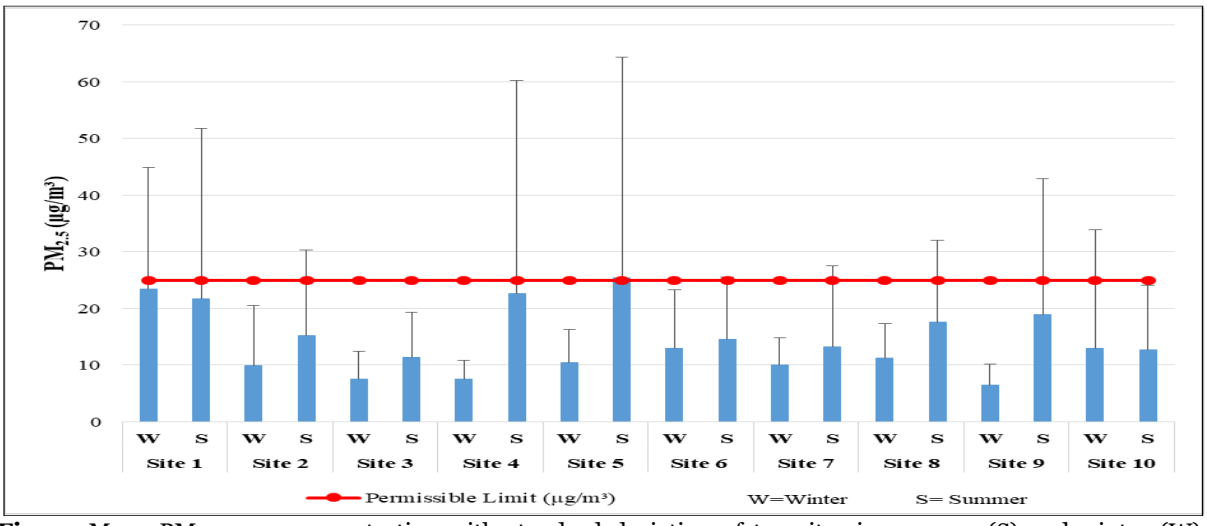


**Fig. 4.** Mean $PM_{2.5}$ mass concentration with standard deviationsof ten sites in summer (S) and winter (W) seasons.

Headache, Dizziness, Epistaxis, Angina and Sunburn were prevalent in office duty staff more as compared to the field duty staff. Higher blood pressure levels were also followed by lower levels of FVC, lung damage and cardiac disorders in the first badge inducted as FDS4.

Both chronic dry and wet cough were prevalent in the field duty staff with higher levels of eye problems, ear ringing and irritation. Low levels of forced vital capacity, higher levels of blood pressure, lung and heart morbidity were prevalent in the first inducted badge. This correlated with higher blood pressure

levels followed by lower levels of FVC, lung damage and cardiac disorders in the first badge inducted as FDS4 which correlated with the study conducted by Kan(Kan *et al.*, 2007). A study conducted by(Dallafior, 2012)also suggested that longer sitting in office individuals leads to higher blood pressure and sugar levels as less time is left for exercise ad mental exertion increases than the rate of physical exertion which leads to body damage which was also observed in the office duty group of wardens under study.

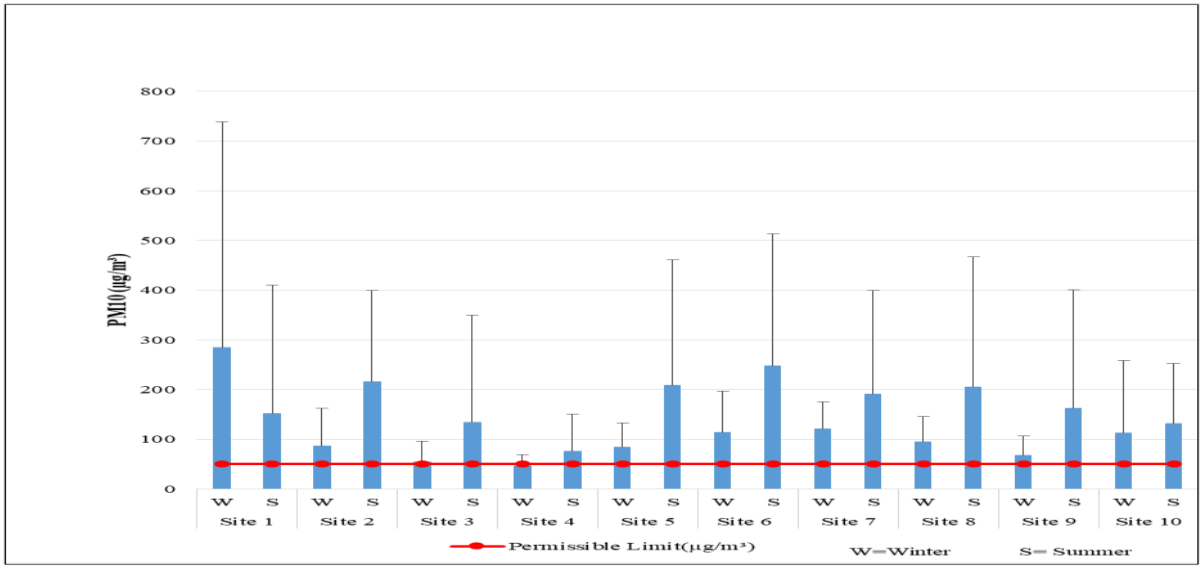


**Fig. 5.** Mean $PM_{10}$ mass concentration and standard deviationof ten towns insummer (S) and winter (W) seasons.

Both chronic dry and wet cough were prevalent in the field duty staff with higher levels of eye problem and ear ringing and irritation as of the wardens under study who are losing their hearing ability due to constant vehicular noise as well as close wireless systems.

It was observed during the interview sessions that majority of the wardens talked loudly and understood the questions when they were talked loudly to. Nausea, dust allergy and angina were observed in both groups but higher percentage was observed in FDS4 group. The ODS4 and FDS4 are seen as higher level of unhealthy individuals as compared to the ones who have just joined service.

Their Body mass index (BMI) were calculated and the percentages for the groups are given in Table 2. Highest levels of obesity in the oldest group of office working individuals is supported by the studies conducted in both males and females in Australia leading to same eating and long sitting habits being the major cause of obesity which might further lead to higher levels of cardiac and lung morbidity(Kim *et al.*, 2016). As per standard guidelines 52.2% of the people are suffering from moderate (50-79%) airflow obstruction.

The highest category of wardens affected severely (2.8%) and moderately (25.8%) are the ones from the first batch Field duty staff group (FDS4) that has been on duty for the last 10 years.

The office duty staff on the contrary who have worked for the same amount of time are effected moderately (10.8%) and severely (0.2%).

Only one individual was found to be severely affected and had dangerously low level of lung capacity. As for the second badge in service the individuals working in the field were effected moderately (FDS3=6.8%) and for the office staff (ODS3= 3%) proving that more the amount of time spent exposed to vehicular pollution leads to drastic decrease in the lung capacity It was

observed in the study that people are more prone to lung damage severity in lung obstruction which makes it difficult to breathe as well as lead to lower oxygenation of blood. Longer exposure leads to severe and very sever levels of COPD followed by higher number of individuals who have been moderately affected and could soon enter the severe category.

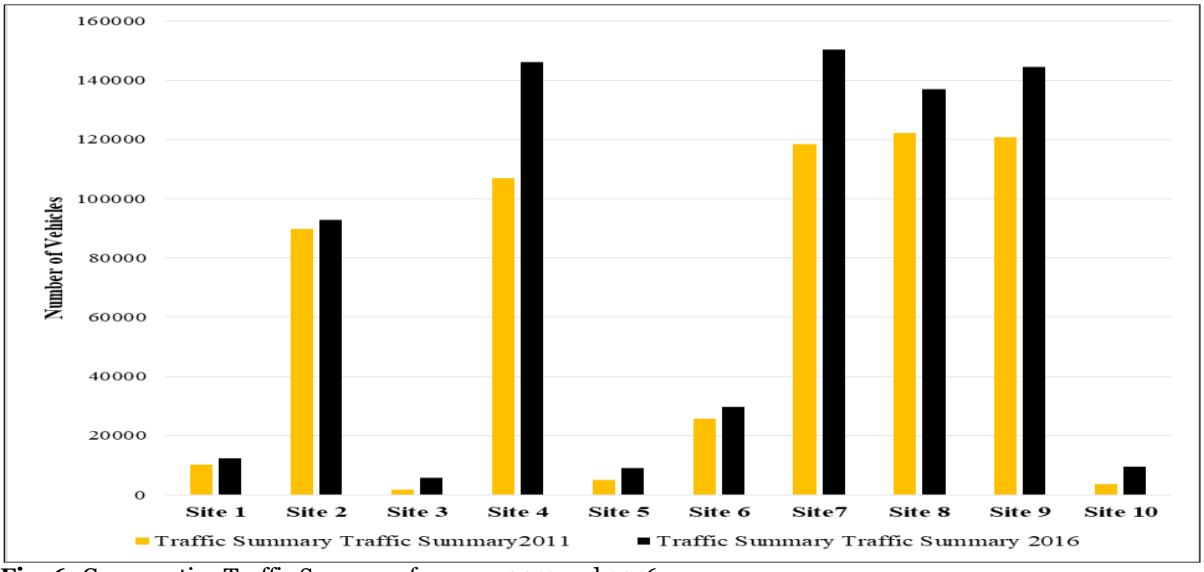


**Fig. 6.** Comparative Traffic Summary for years 2011 and 2016.

This drastic effects on the traffic wardens that are exposed to it for longer and continuous periods of time every day this is also applied to people who live near major roads and are highly exposed to air pollution throughout the day(Adam *et al.*, 2015; Brunekreef *et al.*, 2009; Hoek, Brunekreef, Goldbohm, Fischer, and van den Brandt, 2002).

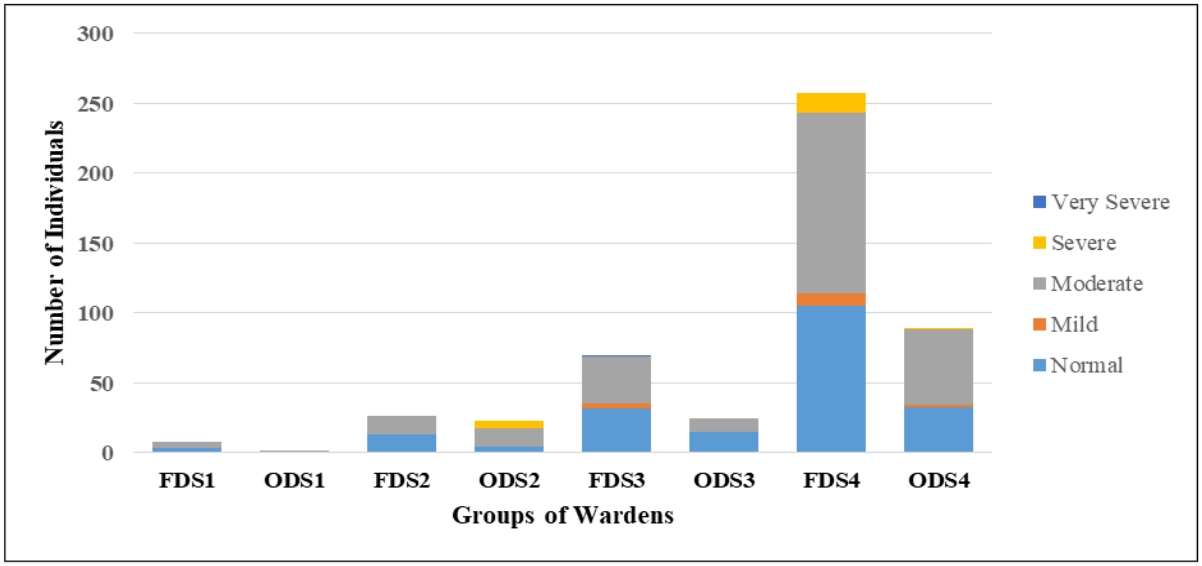


**Fig. 7.** Number of Individuals for each NICE (Lung Obstruction) category.

Spearman's correlation depicting the strength of correlation was applied to the environmental and lung function parameters showing significant correlation between $FEV_1$ and FVC. Relative humidity changes significantly with change in season and temperature whereas Carbon monoxide and $PM_{2.5}$ change significantly with the change in season, temperature and nitrogen dioxide concentration. PM

$_{2.5}$ varies positively with the value of $PM_{10}$.

**Conclusion**

The study concluded that lung capacity of traffic wardens decreases with chronic exposure to vehicular pollution as the lung capacity of the wardens working for the longest period was affected moderately in 25% of the individuals followed by 2.5% whose lung are affected severely. The second badge with eight years of service has followed the trend as 6.8% of the individuals have been affected moderately. This leads us to the conclusion that chronic exposure might leads to lung damage and lowered lung capacity.

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