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Exposure to Respirable Particulate Matter and Pulmonary Function Status of Traffic Wardens in Two Selected Local Government Areas in South-Western Nigeria

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Abstract

Traffic wardens have been reported to be at higher risk of respiratory impairment due to exposure to ambient emissions. This study determined the levels of suspended particulate matter at major road intersections and its effect on the pulmonary function of traffic wardens. A comparative study was conducted involving traffic wardens and regular policemen. Concentrations of particulate matter (PM10) were measured using personal respirable dust sampler model APM 801 within 30cm range of Traffic Wardens and regular Policemen nasal region. A calibrated spirometer was used to determine the Force Expiratory Volume in 1 second (FEV_1) and Peak Expiratory Flow Rate (PEFR) of selected respondents. Analysis was done at $P < 0.05$. The mean concentration of $58.39 \pm 2.22 \mu g/m^3$ was reported in one of the locations. This location is one of the busiest traffic intersections in the study area. There was a significant difference between the observed FEV_1 and PEFR of the traffic wardens as against the control group. A significant negative correlation was observed between PM_{10} and the actual FEV_1 of traffic wardens (r= -0.5). Traffic wardens are highly vulnerable to respiratory impairment due to their exposure to particulate matter. The use of nose masks and regular health checkup is recommended.

Une Exposition aux particules respiratoiresetétat de la fonction pulmonaire des agents de la circulation dans deux zones de gouvernement local sélectionnées dans le sud-ouest du Nigeria

Abstrait

Il a été signalé que les agents de circulation présentaient un risqueplus élevéde troubles respiratoires en raison de l'exposition aux émissions ambiantes. Nous visions àdéterminer les niveaux de particules en suspension aux intersections routièresprincipaleset son effet sur la fonction pulmonaire des agents de la circulation et des policiers réguliers. Les concentrations de particules (PM10) ont été mesurées à l'aide de l'échantillonneur de poussières respirable individuelle APM 101 dans un rayon de 30cm de la région nasale du directeur de la circulation et des policiers régulières. Une spirométrie étalonnéeaétéutilisé pour déterminer le volume expiratoire de force en 1 seconde (FEV 1) et le débit expiratoire maximal (PEFR)des *répondants sélectionnés. L'analyse a étéeffectuéeà P<0,05. La concentration moyenne de 58,39±2,22µg 1m3 a étésignalée dans l'un des emplacements. Cet emplacement est l'un des carrefours les plus fréquentées de la zone d'étude. Il y avait une différence significative entre le FEVI et PEFR observes par rapport au groupe témoin des agents de circulation. Une corrélationnégative significative aétéobservé entre les PM10 et le VEMS réel du surveillant de la circulation. (r = -0,5). Les agents de la circulation sont trèsvulnérables aux déficiences respiratoires en raison de leur exposition aux particules. L'utilisation d'un masque nasal et une surveillance régulière de la sante sont recommandées.*

Introduction

Traffic-related emissions are the dominant source of air pollutants which contribute to environmental problems (Yu *et al*., 2009). They are the principal source of intra-urban variation in the concentrations of air pollutants in many cities; thus, population-oriented central monitors cannot by themselves capture this spatial variability (HEI, 2010).They are a complex mix of pollutants consisting of nitrogen oxides (including nitrogen dioxide), Particulate Matter (PM), carbon monoxide, sulphur dioxide, volatile organic compounds, ozone, and many other chemicals such as trace toxics (Ebeshi and Ekanade, 2018).

A significant proportion of the population engage in traffic-related occupations such as asphalt workers and traffic officers requiring them to spend extended period of time on or near roads and highways or close to traffic which expose them to ambient emissions.(Randem *et al*., 2004; Dragonieri *et al*., 2006). The health impacts are greater for these groups who work close to traffic than for those that are not occupationally exposed.

Air pollution is an important environmental risk factor with global, public health implications. Exposure to outdoor air pollution is the ninth leading risk factor for mortality, and outdoor air pollution is responsible for 3.2 million deaths each year (Lim *et al*., 2012). The World Health Organization (WHO) also estimates that outdoor air pollution may have caused 3.7 million premature deaths worldwide in 2012 (WHO, 2014).The Global Burden of Disease (GBD) study reported that exposure to PM2.5 led to 4.2 million deaths and 103.1 million disability-adjusted life years (DALYs) worldwide in 2015. This accounts for 7.6% of the total global deaths and 4.2% of the global DALYs (Cohen, 2017). Exposure to ambient air pollutants can cause damage to multiple organs and systems of the human body, thus adversely affecting health (Loxham *et al*., 2019). The respiratory tract has direct exposure to external environment and is more vulnerable to pollutants. Studies have shown an association between air pollution and multiple respiratory diseases, especially in patients with underlying respiratory ailment such as chronic obstructive pulmonary disease (COPD) (Duan *et al*., 2020).

Anthropogenic airborne particulate matter comes from variety of sources, which include, but are not restricted to traffic, industries, commerce as well as domestic heating and cooking (Janssen *et al*., 2002). Of the regulated pollutants, PM has been extensively studied and is associated with myriad of adverse health outcomes, including an adverse impact on lung function in both children and adults (Laden *et al.,* 2000; Anderson et al., 2012). PM is a complex mixture of liquid droplets and extremely small particles composed of organic and inorganic compounds (Laden *et al.,* 2000). PM with an aerodynamic diameter less than 2.5 µm (PM2.5) and O_3 are amongst the most studied air pollutants of health concern (Huang, 2014). The size of particles is directly linked to their potential for causing health problems. Particles less than 10µm in diameter can get deeper into the lungs and some may even get into the bloodstream (Nemmar *et al.,*2002). However, based on 23 estimates for causes of mortality, a 10 $\mu g/m^3$ increment in PM2.5 was associated with only a 1.04% increase in the risk of death (Atkinson *et al*,. 2014).

Air pollution may be associated with symptoms immediately upon exposure, such as coughing, tearing, difficulty in breathing, and angina. It may also be associated with long-term harm that is more subtle (Schraufnagel *et al*., 2019). Lung function specifically forced vital capacity (FVC) and forced expiratory volume in 1second (FEV_1), are objectively measurable quantitative parameters of respiratory health. It is an early indicator of respiratory and systemic inflammation, and associated with cardio-respiratory morbidity and mortality (Adam *et al*., 2015). Vehicular emissions represent the main source of atmospheric pollutants, and both short- and long-term exposure to traffic pollution have been associated with adverse health effects (Brook *et al*., 2009;Romieu *et al*., 2012). Studies (Kan *et al*., 2007; Forbes *et al*., 2009; Andersen *et al*., 2011) have shown an association between lung function decline and long-term exposure to air pollution in adults. This corroborates the fact that continuous vehicular exhaust inhalation can lead to symptoms of lower respiratory tract infections such as cough, shortness of breath and pain with inspiration (Dragonieri *et al*., 2006).

A study by Ingle *et al*., (2005) in India indicated a lung function efficiency of the traffic policemen exposed to vehicular pollution. Furthermore, the impact of urban road transportation on the ambient air was studied by Koku and Osuntogun (2007). Three cities in South-west region of Nigeria: Lagos, Ibadan and Ado-Ekiti were assessed. Air quality indicators namely CO, SO_2, NO_2, and total suspended particulates (TSP) measured were found to be above Nigeria's guideline limits. In addition, a study conducted in Abuja, by Erica Moen (2008) on the effect of vehicular emissions on the health of traffic wardens showed that 16% of the traffic wardens had runny nose, 15% had chest pain, 26% had cough while 14% and 8% had eye irritation and sore throat respectively (Moen, 2008). In the aforementioned studies, it was discovered that Total Suspended Particles (TSP) was the major air pollutant of interest and there was no personal exposure monitoring.

Therefore, this study determined the personal exposure of Traffic Wardens and regular Policemen to PM10 and assessed at baseline the lung function status of Traffic Wardens and regular Policemen.

Materials and Methods

Study Design and Ethical Review

A comparative study design was employed involving survey and personal exposure monitoring of traffic wardens and regular policemen to $PM_{10.}$ In addition, an assessment of pulmonary function status of traffic wardens and regular policemen was also carried out. This study went through proper required institutional review procedures at the College of Medicine, University of Ibadan, before its initiation and informed consents were obtained from participating respondents.

Study Area

Ibadan is the capital city of Oyo State and the largest indigenous city in West Africa. It is located in the south-western region of Nigeria. It is 78km inland from Lagos and is a prominent transit point between the coastal region and the areas to the north. It lies between latitude 7^0 and $9^0$30' east of prime meridian. Ibadan covers a land area of 12 kilometres radius. It has an altitude generally ranging from 152m to 213m with isolated ridges and peaks rising to 274m. Its population is estimated to be about 3.8 million according to Nigeria's census figures. The principal inhabitants of the city are the Yoruba's. The study was conducted in two Local Government Areas - Ibadan North and Ibadan Northeast in Oyo State, Nigeria.

Sampling procedure

A total sampling of all police officers (traffic wardens and regular policemen) in the two Local Governments was carried out for the survey. The list of major traffic intersections where traffic wardens perform their day-to-day activities was obtained from the Divisional Traffic Officers (DTO) in the respective police stations in the two Local Governments. The regular policemen who served as control were policemen that worked mainly in the offices and who were less exposed to the traffic emissions. Thirteen sampling points were randomly selected from the eighteen major road intersections within the two Local Government Areas while a systematic random sampling was used to select participants for the exposure assessment.

PM_{10} Monitoring

Concentrations of PM_{10} were measured using an Envirotech personal respirable dust sampler model APM 800. The sampler is made up of a rotameter (pump unit) which houses a DC 6V rechargeable battery, a sampling head (which holds the filter paper) to be worn on the collar of the respondents so that it could suck air from their breathing zone, a flexible tube (which connects the sampling head to the rotameter) and a side clamp (which allows the instrument to be worn on the belt of the respondents). Pre-weighed filter papers were used for the sampling while sampling rates were calibrated before sampling and checked immediately after sampling. The filter papers were transferred into sterile nylon packs and the mass gain on the filter was determined in an accredited laboratory. Measurements were conducted two times (during the peak periods) between 7am – 12pm, and 1pm –6 pm. Particulate matter monitoring was carried out between May and August, 2011.

Survey

A semi structured questionnaire was designed and used to elicit information on the socio-demographic characteristics and occupational history of the police officers working in the two Local Governments.

Pulmonary Function Tests

Pulmonary function test was carried out following the American Thoracic Society (ATS) guidelines. A Ferraris digital spirometer was used to determine the actual Forced Expiratory Volume in one second (FEV_1) and Peak Expiratory Flow Rate (PEFR) of the Traffic Wardens and regular Policemen. Systematic random sampling was used to select 124 police officers (61 traffic wardens and 63 regular policemen) who were non-smokers representing 50% of the survey population. The equipment was used on each of the participant at three manoeuvres and the best test result was recorded following ATS guidelines. The height and weight of the participants were measured using a meter rule and weighing scale respectively to calculate the Body Mass Index (BMI). The values were inputted into the lung function calculator in order to get the expected FEV_1 and PEFR. The expected $FEV_1$and PEFR are the normal ones expected of healthy individuals. The mean FEV_1 for the various age groups was obtained and % FEV_1 was also estimated.

Statistical Analysis

All the data obtained were subjected to descriptive statistics, chi-square and t-tests at 5% level of significance. T-test was used to test for significant differences between the actual $FEV_1$and PEFR of the two groups as well as the expected $FEV_1$and PEFR while Spearman rank correlation test was used to determine the strength of the linear relationship between concentration of PM_{10} and the actual FEV_1 of the respondents. Logistic regression was used to adjust for cofounders in the study.

Results

Socio-demographic characteristics of the Respondents

Majority 87 (71.3%) of the traffic wardens were males while 35 (28.7%) were females. A higher proportion 96 (78.7%) of traffic wardens were married while 26 (21.3%) were single. Among the regular policemen, 95 (76.0%) were married while 29 (23.2%) and 1 (0.8%) were single and divorced respectively. Majority 47 (38.5%) of the traffic wardens and regular policemen (44.8%) were in the 30-39 age group. Age group 20-29 accounted for 21.3% of traffic wardens and 19.2% of regular policemen while 32 (26.2%) traffic wardens and 33 (26.4%) regular policemen were in the 40-49 age group. 13.9% of traffic wardens and 9.6% of regular policemen were in the 50-59 age group. In terms of level of education, majority 80 (64.0%) of regular policemen had tertiary education while 44 (35.2%) and

Table 1: Socio-demographic characteristics of respondents

Variable	Options	Traffic wardens N (%)	Regular policemen N (%)	P-value
Sex	Male	87 (71.3)	83(66.4)	0.41
	Female	35 (28.7)	42(33.6)	
Marital Status	Single	26 (21.3)	29 (23.2)	0.57
	Married	96 (78.7)	95 (76.0)	
	Divorced	0 (0.0)	1 (0.8)	
Educational Status	Primary	0 (0.0)	1 (0.8)	0.00
	Secondary	75 (61.5)	44 (35.2)	
	Tertiary	47 (38.5)	80 (64.0)	

*Mean age of Traffic wardens: 37.7 ± 9.3 years
*Mean age of Regular policemen: 37.0 ± 7.7 years

1 (0.8%) had secondary and primary education respectively compared with traffic wardens where more than half 75 (61.5%) had secondary education and 47 (38.5) had tertiary education (Table 1).

Occupational History of Respondents

Majority of the respondents had served in their respective workplaces for a period of 0 – 9 years. There was no significant difference (p >0.05) in the years of service of respondents as majority 66 (54.1%) of the traffic wardens had served in the profession for about 9 years, 26 (21.3%) had served between 10 and19 years, 23 (18.9%) had served between 20 and 29 years while 7 (5.7%) had served for about 35 years. Likewise, a higher proportion, 61 (48.8%) of the regular policemen had been in the profession for about 9 years, 44 (35.2) had served between 10 and 19 years, 23 (18.9%) had been in the profession between 20 and 29 years while 5 (4.0%) had served for about 35 years. There was a significant difference (p <0.05) in the number of hours respondents worked daily. Majority 67 (54.9%) of the traffic wardens worked for more than 8 hours a day, 40 (32.8%) worked for 8 hours while 5 (4.1%) worked for less than 8 hours a day compared with the regular policemen where a higher proportion, 116 (92.8) worked for more than 8 hours daily and 9 (7.2%) worked for 8 hours. A higher proportion, 121 (99.2%) of the traffic wardens do not use Personal Protective Equipment (PPE) while performing their duties on the road while only 1 (0.8%) used Personal Protective Equipment while working (Table 2).

Table 2: Occupational History of Respondents

Variable	Options	Traffic wardens N (%)	Regular Policemen N (%)	P-value
Years of service in the profession	0-9 years	66 (54.1)	61 (48.8)	0.078
	10-19 years	26 (21.3)	44 (35.2)	
	20 – 29 years	23 (18.9)	15 (12.0)	
	30 – 35 years	7 (5.7)	5 (4.0)	
Hours at work daily	< 8 hours	15 (12.3)	0 (0.00)	0.000
	8 hours	40 (32.8)	9 (7.2)	
	> 8 hours	67 (54.9)	116 (92.8)	

Respirable Particulate Matter (PM_{10}) Burden

The spatial and temporal variations in levels of PM_{10} are shown in Figures 1 and 2. Mean concentration of PM_{10} peaked at location 10 (58.38µg/m^3) during the evening period while the least concentration was recorded at location 7 during the morning period. The highest concentration of PM_{10} in the morning was recorded at location 13 (18.33 µg/m^3) while the least concentration was recorded at location 2. PM_{10} concentration recorded at location 10 (58.38 µg/m^3) was about four folds higher than the concentration during the morning hours (9.45µg/m^3).

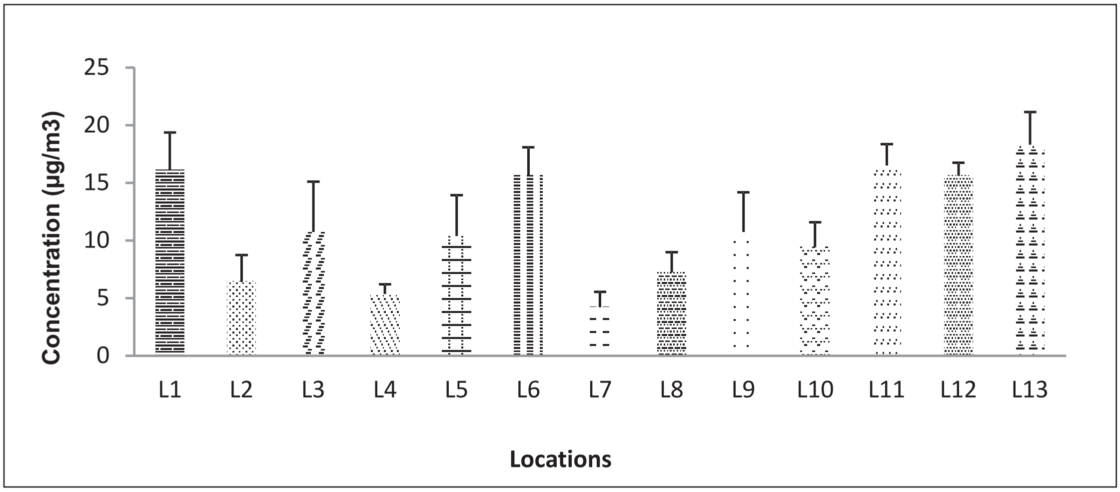

Figure 1: Mean particulate matter concentration for all the thirteen locations in the morning period

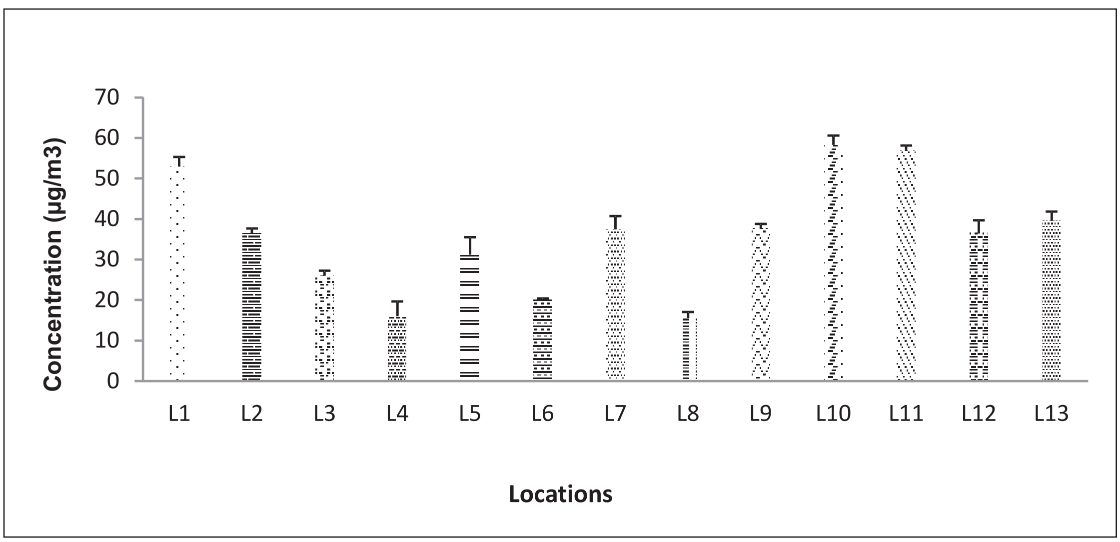

Figure 2: Mean particulate matter concentration for all the thirteen locations in the afternoon period

Table 3: Anthropometric characteristics and Lung Function Status of the selected participants

Anthropometric characteristics	Traffic wardens (N=61)	Regular policemen (N=63)	P-value
AGE			
Mean ± SD (yrs)	32.84 ± 8.28	33.89 ± 7.52	0.460
Range (yrs)	23 – 58	25 – 56	
SEX			
Male N (%)	46 (47.9)	50 (52.1)	0.378
Female N (%)	15 (53.6)	13 (46.4)	
HEIGHT (m)			
Mean ± SD	1.72 ± 0.05	1.74 ± 0.05	0.083
Range	1.62 – 1.84	1.60 – 1.84	
WEIGHT (kg)			
Mean ± SD	67.95 ± 10.73	73.06 ± 13.27	0.020
Range	48 – 100	52 – 112	
BMI (kg/m^2)			
Mean ± SD	22.84 ± 3.47	24.01 ± 3.82	0.076
Range	16.6 – 33.0	17.3 – 35.8	
Spirometry			
FEV_1 actual (litre)			
Mean ± SD	2.21 ± 0.71	3.07 ± 0.55	0.000
Range	0.88 – 3.97	2.15 – 4.57	
FEV_1 expected (litre)			
Mean ± SD	4.01 ± 0.57	3.95 ± 0.67	0.647
Range	2.07 – 4.96	2.07 – 4.80	
PEFR actual (litre/min)			
Mean ± SD	266.64± 81.93	369.79± 95.67	0.00
Range	133 – 487	162 - 563	
PEFR expected (litre/min)			
Mean ± SD	553.13± 64.56	560.46± 63.98	0.527
Range	429 – 628	410 - 623	

Socio-demographic Characteristics of Participants selected for Spirometry

A higher proportion (75.4%) of traffic wardens was males while 24.6% were females. Majority 29 (47.5%) of the traffic wardens were from the 20 – 29 age group. Likewise, majority 50 (79.4%) of the regular policemen were males while 13 (20.6%) were females. A good proportion (46.0%) of the regular policemen was from the 20 – 29 age group (Table 3).

Anthropometric Characteristics of Participants selected for Spirometry

The mean weight among traffic wardens was highest among the age group 50 – 59 years with weight of 76.20±8.08kg and lowest among the age group 20 -29 years with mean weight of 65.69±10.17kg. The mean weight of traffic wardens across the different age group tends to increase with age which consequently reflects on the mean BMI across the different age groups. Among the traffic wardens, the age group 20 - 29 recorded the lowest BMI of 21.83±3.19kg/m^2 and this increased with increase in age with the age group 50 - 59 years having a mean BMI of 25.85± 2.37 kg/m^2 (Table 4).

Pulmonary Function Status

Among the traffic wardens, the mean FEV_1act recorded its highest value of 2.38 ± 0.60L among age group 20 - 29 years and lowest value of 1.78 ± 0.88L among age group 50 - 59years while the mean FEV_1act of regular policemen peaked among age group 20 – 29 years and it decreased with increase in age. On the other hand, the mean FEV_1exp of traffic wardens was highest among the age group 20 - 29 years (4.19± 0.59L) and lowest among age group 50 - 59 years (3.39± 0.14L) while the mean FEV_1exp of regular policemen was highest among the age group 20 - 29 years (4.19 ± 0.59L) and lowest among age group 50 - 59 years (3.47± 0.46L) (Table 5).

Table 4: Variations in the lung function status with Anthropometric characteristics of Traffic wardens

S/N	Age Group (yrs)	Mean Height (m)	Mean Weight (kg)	BMI (kg/m^2)	$FEV1_{act}$ Mean	$FEV1_{exp}$ Mean
1	20 – 29	1.73 ± 0.05	65.69±10.17	21.83±3.19	2.38±0.60	4.19±0.59
2	30 - 39	1.72 ± 0.06	69.05±9.55	23.39±3.16	2.16±0.62	4.00±0.49
3	40 - 49	1.74 ± 0.02	68.00±18.19	23.31±5.55	1.87±0.88	3.56±0.42
4	50 – 59	1.71± 0.02	76.20±8.08	25.85±2.37	1.78±1.31	3.39±0.14

Table 5: Variations in the lung function status with Anthropometric characteristics of Regular policemen

S/N	Age Group (yrs)	Mean Height (m)	Mean Weight (kg)	Mean BMI (kg/m^2)	$FEV1_{act}$ Mean	$FEV1_{exp}$ Mean
1	20 – 29	1.74± 0.06	70.80±6.98	22.67±1.72	3.17±0.51	4.16±0.64
2	30 - 39	1.74± 0.56	75.07±13.67	24.73±3.80	3.09±0.60	3.86±0.67
3	40 - 49	1.77± 0.02	71.88±14.63	23.67±4.25	2.71±0.22	3.87±0.59
4	50 – 59	1.74± 0.07	68.75±6.24	22.73±2.86	2.64±0.49	3.47±0.46

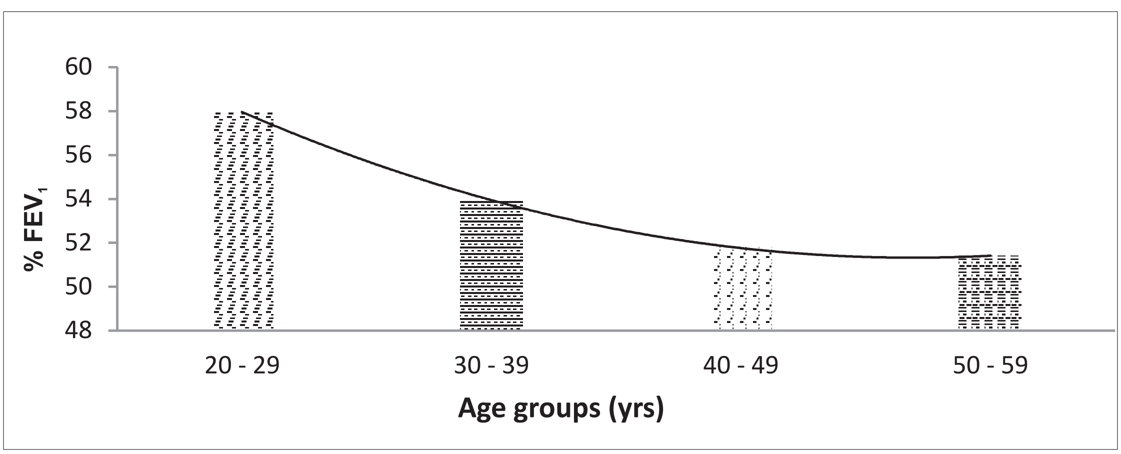

Figure 3: Trend in the % FEV_1 of Traffic wardens across the different age groups

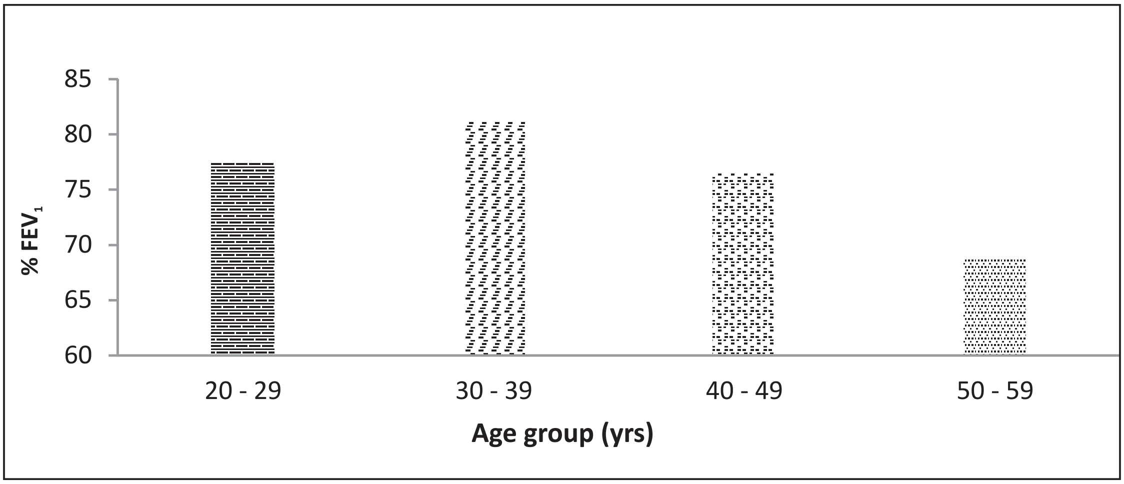

Figure 4: Trend in the % FEV_1 of Regular policemen across the different age groups

Linear Regression Model

The linear regression model for the FEV_1 of the respondents using significant predictor variable at 5% level of significance is as shown. The variables include age, gender and occupation. After adjustment, all the variables were significant predictors (R^2 = 0.41; $P<0.05$). The model shows that for a unit increase in age, the FEV_1 decreases by 0.18; being a traffic warden and a male reduces the FEV_1 by 0.89 and 0.49 respectively.

Relationship between PM_{10} and actual FEV_1

Figure 5 shows the outcome of the Spearman Rank correlation test between actual FEV_1 and PM_{10} concentrations for the traffic wardens and regular policemen. A significant negative correlation was observed between concentration of PM_{10} and the actual FEV_1 of the traffic wardens (rs = - 0.5). This implies that the actual FEV_1 of the traffic wardens decreases with increase in the concentration of PM_{10} although a correlation coefficient of 35.0% was observed which shows a weak linear relationship. On the other hand, a positive correlation was observed between the particulate burden and the actual FEV1 of the regular policemen ($r = 0.04$, $p > 0.05$).

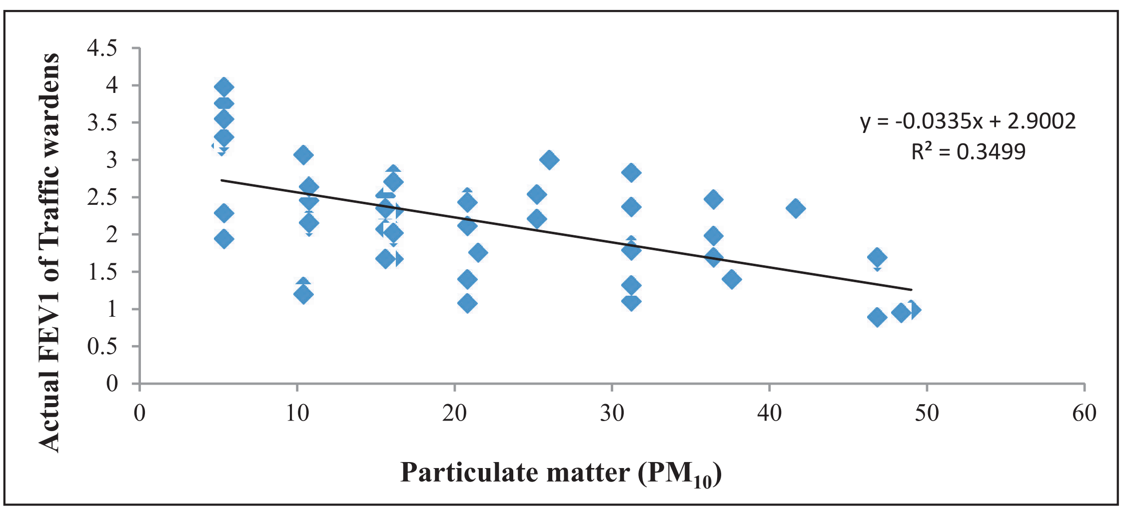

Figure 5: Relationship between actual FEV_1 of Traffic wardens and PM_{10} burden

Discussion

In developing countries, rapid industrial growth and population increase coupled with rising standards of living are likely to lead to patterns of motorization that is similar to those of industrialized countries. Since the 1960s, the world's motor vehicle fleet has been growing faster than its population. The problems are acute in certain cities in both the developing and the industrialized world. Furthermore, in developing countries like Nigeria, poor vehicle maintenance culture and importation of old vehicles due to changes in government policies has increased the concentration of traffic-related air pollutants on major highways tremendously in the past ten years of democratic rule.

Ibadan North and Northeast Local Governments are two of the major areas with high traffic density in Ibadan metropolis based on previous studies conducted in the city. They are situated in the heart of the metropolis and they house the state secretariat and other major government institutions as well as commercial enterprises. In addition, one of the major markets in the state (Bodija market) is located in one of the Local Government Areas (Ibadan North).This study determined the levels of respirable particulate matter in the major traffic intersections and assessed the pulmonary function status of both the exposed traffic wardens and the non-exposed regular policemen.

The mean concentrations of PM_{10} determined in all the sampling locations in the morning ranged between 4.2µg/m^3 and 18.2µg/m^3. The low particulate burden in the morning period may be attributed to some meteorological parameters including temperature and wind speed. Studies have shown that ambient temperature and local meteorology influences the concentration and location of vehicle-emitted pollutants (Goldberg *et al.*, 2001).

Amongst all the meteorological variables, wind speed has been the most closely scrutinized with regard to exposure since it influences the dispersion and dilution of pollutants. Generally, both exposure (Kingham *et al.*, 1998; Alm *et al.*, 1999; Krausse and Mardaljevic, 2005) and ambient (Molnar *et al.*, 2002; Holmes *et al.*, 2005) studies have identified that an increase in wind speed results in a decrease in exposure concentrations to fine particulate matter. Temperature and relative humidity might also have affected the concentrations of particulate matter in the morning since the temperature is normally cold and low in the morning. This makes the environment moist and may further trap dust particles in the air thereby reducing the particulate concentrations in the morning.

The mean concentrations of PM_{10} determined in the afternoon in all the sampling locations ranged between 15.62µg/m^{3}and 58.39µg/m^3. Particulate matter concentration peaked at location 10 in the afternoon which is almost two folds higher than the morning concentration. This is consistent with a study conducted by Seaton *et al.*, 1995 that reported that particulate matter increased progressively from the morning hours, reaching their peak during the midday hours. It has been previously reported that meteorological condition had implications on the particulate kinetic properties and this might also be responsible for higher concentrations of particulates in the afternoon than in the morning periods (Chan, 2002).

It was observed from the study that there was a significant difference in the mean actual FEV_1 between traffic warden and regular policemen. This was consistent with a study by Ingle *et al.*, (2005) in India. They found out that the FEV_1 of traffic policemen were severely affected when compared with the controls. They recorded a 0.8litres difference in the expected and observed FEV_1 of the traffic policemen. This is an indication of the definite acute effect on their FEV_1. Another study carried out by Pravati *et al.*, (2010) in Pondicherry India indicated a decrease in the FEV_1 of traffic policemen compared with the general policemen.

Studies have shown that anthropometric parameters have significant relationship with lung function indices (Adewole *et al.*, 1983). A weak positive correlation was observed between the BMI (Body Mass Index) and FEV_1 actual (lung function status of respondents) (r= 0.272, $p< 0.05$).This suggests that as BMI increases, FEV_1 also increases. This is in conformity with a study by Thyagarajan *et al*., (2008) in the United States where participants with baseline BMI <21.3kg/m^2 experienced 10 year increases of 71ml in Forced Vital Capacity (FVC) and 60ml in FEV_1.

Chronic exposure to traffic-related air pollutants may be a factor that contributes to lung function impairment. Brauer *et al*., (2001) reported an association between lung function and personal exposure to particulate matter in a panel of subjects with COPD in Vancouver, BC. Although not significant, decrement of 3% and 1% in FEV_1 were associated with PM10 or PM < 2.5µm in diameter respectively. Also in a study in Finland by Penttinen *et al*., (2001), they reported that both the concentration and the size of particles (0.1 to 1 µm) were determinants of associations between particulate matter and decreased lung function. This is in line with the findings of this study where correlation test between particulate concentration and lung function status of traffic wardens showed a significant negative correlation implying that as particulate load increased, lung function may decrease.

Although, one of the limitations of this study is that the Forced Vital Capacity of the respondents was not determined which would have enable the calculation of the FVC/FEV_1 ratio, this study is novel in its approach to causality studies. Personal air monitoring was conducted on the traffic wardens and this is the first study with such a design in Nigeria.

Conclusion

This study assessed the levels of exposure of traffic wardens PM_{10} at major road intersections as well as the pulmonary function status of police officers in two selected Local Government Areas in South-Western Nigeria. Findings of this study showed that the concentrations of PM_{10} at most of the road intersections in the afternoon period were higher than the morning period.

The actual Forced Expiratory Volume in one second (a measurable quantitative parameter of respiratory health) of traffic wardens exposed group was significantly lower than that of the regular policemen (comparison group).

It was also observed that there was an inverse relationship between the lung function of traffic wardens and the burden PM_{10} at study locations. This indicates that increase in the concentration of PM_{10} has a negative impact on lung function.

Though the true causality associated with the decreased lung function status of populations at the more exposed groups cannot be ascertained from this study based on several other factors. It is imperative to state that the traffic wardens on major roads in Ibadan are key at-risk group.

Therefore, routine monitoring of ambient air, vehicular emissions and lung function of traffic wardens should be encouraged coupled with a strict enforcement of use of PPE while on duty.

Conflict of Interest

The authors declare that there is no conflict of interest.

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