Lung Function of Traffic Wardens Linked to Airborne Particulates in Nigeria

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Abstract: This study is about the possible effects of particulates air pollution on traffic wardens, especially on their lung function using peak expiratory flow rate (PEFR) as a measure. A sample of forty nine traffic wardens at the busiest road junctions in the metropolis of Port Harcourt, Nigeria, were selected at random and tested for their PEFR. The ambient particulate matter at the heights of between five to six feet where they are expected to breath was measured. The study determined peak and off-peak periods of concentration by taking a thirteen hour measurement of the various particulate fractions (i.e., PM_1, $PM_{2.5}$, PM_7, PM_{10} and TSP) in the ambient air. Particulates concentrations ranged between 46 – 358 μgm^{-3} and the Nigerian and WHO standards were exceeded in many instances. The mean PEFR of wardens who worked indoors was 419.2 $Lmin^{-1}$, while for those who worked outdoors it was 474.7 $Lmin^{-1}$. Taking 450 $Lmin^{-1}$ as a threshold, since normal lung function lies between 350 and 450 $Lmin^{-1}$., wardens with the least PEFR are those with the greatest exposure to particulates and the length of exposure was related to the number of years in service and age. Evidence in the literature suggests that particulates stimulation of the respiratory system is responsible for the reduced PEFR of exposed subjects. Wardens working outdoor should be made to work lesser hours and no group of persons in the police force should be made to work outdoor exclusively. There should be rotation of duty to ensure that no person is unduly over exposed to particulate concentration to avoid reduction in PEFR which may predispose such persons to respiratory illnesses. Standards and limits for particulates exposure in work places, including outdoors should be introduced to safeguard the health of wardens and the population as whole.
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Keywords: lung function; traffic warden; particulate pollution, Port Harcourt

1. Introduction

Road junctions and roundabouts are work environments for wardens all over the world. The occupational health and safety of these wardens are a major concern not only to the police force but also to the general public as well since wardens spend a large proportion of their working hours on the roads. However, despite its importance, there is currently no regulation on the air quality of this particular workplace and there has been a shortage of real time field data on road traffic impact on air quality in many instances. Some studies have been done in Nigeria on vehicular emissions but none has focused on particulates in spite of its adverse health effects. Ojolo *et al.* (2007), for instance, carried out a survey on the effects of vehicle emissions on human health in Nigeria, in which emissions such as oxides of nitrogen, sulphur, carbon, hydrocarbon, mercury and lead were quantified, but the survey failed to include particulates which are also a product of vehicle emission. Another study by Ndoke and Jimoh (2005) on the impact of traffic emission on air quality in a city in Nigeria, sampled carbon monoxide, nitrogen dioxide, sulphur dioxide and carbon dioxide, to test for their levels in the atmosphere, this study also did not consider particulates. Pope *et al*. (1995) however related mortality rate and particulate air pollution in studies conducted in the U.S. The Harvard Six City Study followed the health of over 8,000 adults and children in six cities for 14-16 years to study the effects of air pollution on human health (Dockery *et al*. 1993). The study found that even after eliminating factors such as cigarette smoking, occupational exposure, obesity and socio-economic status, a direct relationship between particle concentrations in the air and increased mortality rates was found. In another study by Laden *et al*. (2000) association of fine particulate matter from different sources with daily mortality was established in cities across the U.S.

There has been a dramatic increase in automobiles registered in Port Harcourt, ranging from cars, buses, lorries, trailers, pick-ups, tractors, tankers and motorcycles. According to records of the Rivers State Internal Revenue Board, between 2002 to 2010, cars registration increased from 2,110 to 18,552, buses and mini buses from 1,989 to 10,604, lorries from 95 to 1,026, tractors from 63 to 687, pick-ups from 233 to 822, tankers from 253 to 2,630, trailers; 85 to 832 and motorcycles from 2,590 to 14,009 (data for motorcycles is only up to 2008). With the increase in motor vehicles in Port Harcourt and the attendant traffic congestion, there is the need for traffic to be controlled; hence, the use of traffic wardens in the city for easy flow of traffic and also to reduce road traffic accidents from careless motorists. For these traffic wardens to be effective, they are posted to very busy road junctions in the city were traffic tend to be heavy, such junctions include; Oil Mill, Rumuokoro, Eleme, Garrison, Water Lines and Rumuokwuta. Idling which is usual in hold-ups has also been shown to emit twenty times more pollutants than when the vehicle is running at least thirty two miles an hour (USEPA, 2007).

Particulates are known to stimulate the soft muscles thereby narrowing the diameter of airways and raising the resistance to air flow. Also, deposition of particles on the mucous membrane stimulates the flow of mucous, which also reduces the diameter of airways and the flow of air (USDA, 2000). Longtime exposure to particulates can result in respiratory diseases. Particulate matter is a component of the fume from automobile exhaust and has been linked to premature death, and is now at levels comparable to deaths from traffic accidents. This happens to be the major part of the air the traffic wardens breathe and as such there is need to evaluate it. This study is aimed at determining the effect of particulate air pollution on the peak expiratory flow rates (PEFR) of traffic wardens in Port Harcourt, Nigeria (see Figure 1).

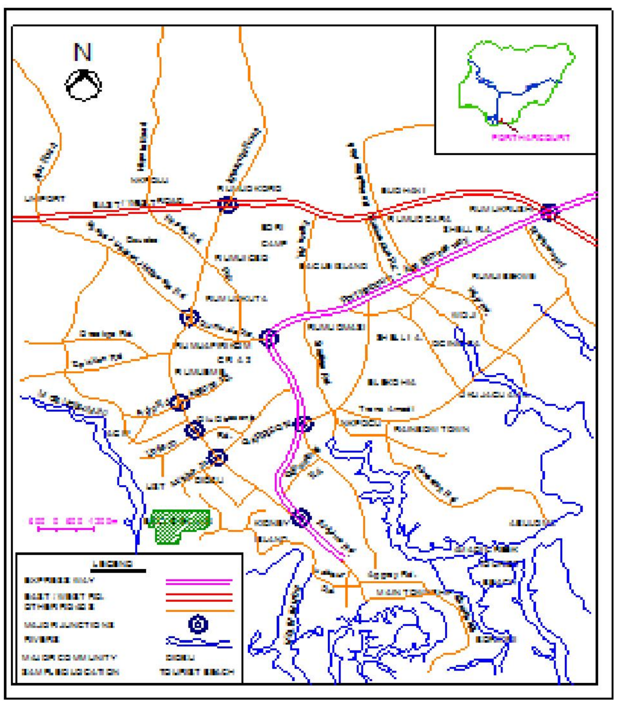

Figure 1: Major Junctions in Port Harcourt

2. Materials and Methods

Ambient metrological condition of sampling locations were monitored to establish that there were no extream situations that may interfare with particulate concentrations. The immediate weather condition was determined with Met One Instrument, Inc. A digital hand held Cole-Parmer Combination Anemometer that measures wind velocity, temperature and humidity was used to ascertain the weather condition of the various sampling locations. The instrument also determines the wind speed via wind vanes that generates on revolution signal that is directly proportional to the wind force.

The aerosol mass monitor Model GT-331 was used in the particulates measurements. Peak and off-peak periods for traffic were determined on the first day when measurements were carried out for thirteen hours, after which the periods of highest particulate concentration was referred to as peak and that at which the least concentration was obtained as off-peak. Peak hours coincided with when there is likely to be rush on traffic, that is, between 7 and 8 am, and also between 4 pm to 6 pm as people leave their offices. Off-peak hours coincided with when the traffic is light; this was taken as 10 or 11 am. The parameters that were measured for particulates are total suspended particulate (TSP), particulate matter PM_1, $PM_{2.5}$, PM_7 and PM_{10}.

2.1 Peak Flow Rates Measurement: A sample of forty nine traffic wardens (police officers working outdoor) at the busiest road junctions in Port Harcourt metropolis were selected at random and tested for their peak flow rates. The ambient particulate matter at the heights of between five to six feet where they are expected to breath was measured. Then another forty nine police officers who were permanently assigned office work or who have worked mostly indoors were tested for their peak flow rates and the particulates concentrations in these offices were also measured. The control group consists of office workers of about the same age as the traffic wardens. This group is selected from police officers who work indoors as opposed to those on the road. In both groups sampled for the study, peak expiratory flow rates were determined after taking their weight, height, age and years of service.

Peak flow rates were measured with the Wright Peak Flow Meter. The traffic wardens were first familiarized with the equipment; the mouthpiece was then inserted into the flow scope. The subject was asked to hold the instrument by the handle in a horizontal position ensuring that the outlet located in the bottom of the handle is not obstructed by the hand or clothing of the subject. The subject was then asked to inhale deeply after which the mouthpiece was placed in his mouth asking him to seal it's circumference with his lips. The nose of the subject was clipped with a nose clip for maximum expiration to avoid air having to come out of the nose during forced expiration. The subject was asked to exhale sharply and as forcefully as possible using the chest and diaphragm muscles. The indicator ring was then read-off. Thereafter the pointer was returned to the starting position and two more readings were taken amongst which the highest reading was recorded.

3. Results

The mean concentration of particulates obtained when measurements were carried out in the indoor work environment of police officers was observed to be low (Table 1). The only anomaly was observed in some offices with windows facing the direction where a demolition was taking place. In another office the particulate concentrations were also high due to the fact that the occupants of the office just concluded a cleaning exercise before the measurement. Apart from these two aberrations, the indoor concentrations of TSP in the working environment of police officers were observed to be between 21.9 – 119.6 μgm^{-3} and other particulates fractions were even lower. This result is quite lower than the Federal Ministry of Environment limits of 260 μgm^{-3} that should not be exceeded during a 24-hour period.

The mean outdoors concentrations of TSP (46 – 356 μgm^{-3}) recorded in the dry season exceeded the WHO standard set to protect public health of 60 –90 μgm^{-3} and 150-230 μgm^{-3}, which should not be exceeded more than once annually and in a 24-hour period, respectively. Also, the 24-hour guideline limit of 260 μgm^{-3} stipulated by Nigeria was exceeded in some of the outdoor measurements. Overall, there were remarkable variations in the particulates concentration in all fractions due to diurnal and seasonal changes as can be glimpsed from the charts in Figures 2 and 3 reproduced from measurements in the various road junctions monitored. Rainy season measurements for particulates were generally below those for the dry season. Inhalable particles (PM_1 – PM_{10}) were in every instance lower than TSP. The mean range were from less than 10 $\mu g/m^3$ for PM_1 to over 150 μgm^{-3} for PM_{10}. It appeared that particulates fractions in the ambient air increased gradually in the order of TSP > PM_{10} > PM_7 > $PM_{2.5}$ > PM_1.

4. Discussion

Traffic wardens sampled in this study ranged between 20 and 49 years in age with a median age range of 26 – 29 years. The average years of service for the wardens sampled indoors was 6.2 years and for the wardens who worked outdoors it was 6.3 years. The mean PEFR for the two groups were 419.2 $Lmin^{-1}$ and 474.7 $Lmin^{-1}$, respectively. The most robust PEFR for those who work outdoor were over 600 and these wardens were generally taller, younger and have been less than five years in service. The least PEFR (150 $Lmin^{-1}$) was for a 20-year veteran in the force who was also much older (44 years). From Tables 2 and 3 it can be deduced that wardens with the least PEFR are those with the greatest exposure to particulates. The length of exposure therefore, being a function of the number of years in service and age.

Table 1: Mean Particulate Concentrations Indoors

Stations	PM_{10} $\mu g/m^3$	PM_7 $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PM_1 $\mu g/m^3$	TSP $\mu g/m^3$	Remarks
MTD Office Mile one	17.0	10.7	2.1	0.5	35.1	Well ventilated Office, door always ajar
Office 2	28.6	17.1	2.0	0.5	40.0	
SO Office	35.0	19.2	2.2	0.4	48.5	Office upstairs, door mostly shut.
Office 3	82	40.5	3.4	0.5	146.1	Office being cleaned
Office 4	27.1	18.1	1.9	0.4	40.2	Well ventilated office with 2 windows and a fan.
Office 5	45.4	35.0	2.8	0.5	78.5	Well ventilated office.
Office 6	68.0	34.0	5.5	0.8	80.3	Well ventilated general office with files and other paraphernalia.
Office 7	19.6	13.0	2.0	0.5	29.1	Small office, two windows with a fan on.
Office 8	18.4	11.4	1.6	0.4	32.9	Office of 3 persons (downstairs) with three windows and two fans on.
Office 9	57.7	43.1	1.8	0.6	274.1	Downstairs office with one window, a building was being demolished nearby.
Office 10	86.7	57.5	6.7	0.8	119.6	Downstairs window and door always closed.
Office 11	56.6	36.5	3.6	0.5	102.2	Crime office, two windows and a fan on.

In order to determine if there is a difference between the peak expiratory flow rates of traffic wardens exposed to high particulate dosage when compared to others working indoor, the measurements were plotted on a line graph and presented in Figure 2. Taking 450 $Lmin^{-1}$ as a threshold, since normal lung function lies within the range of 350-450 $Lmin^{-1}$., the PEFR of wardens who work indoors were below that of wardens who worked outdoors. Within the same age range, height and years of service also, it was observed that the PEFR of officers working indoors were higher than that of those working outdoors.

Table 2: PEFR of Traffic Wardens Working Indoors

S/no.	Age range	Height (m)	Weight (kg)	PEFR l/min	Years of service
1	20 - 24	1.68-1.83	71-80	550	2
2	25 - 29	1.68-1.83	51-60	500	2
3	25 - 29	> 1.83	81-90	450	2
4	25 - 29	1.68-1.83	61-70	400	4
5	20 - 24	1.52-1.65	>90	500	8
6	25 - 29	1.68-1.83	81-90	500	10
7	30 - 34	> 1.83	71-80	650	4
8	25 - 29	1.68-1.83	71-80	420	7
9	20 - 24	> 1.83	81-90	450	2
10	25 - 29	1.68-1.83	61-70	450	4
11	30 - 34	1.68-1.83	61-70	520	15
12	25 - 29	1.68-1.83	61-70	400	4
13	45 - 49	1.68-1.83	80-90	500	20
14	25 - 29	1.52-1.65	61-70	480	3
15	40 - 44	1.68-1.83	71-80	650	3
16	30 - 34	1.52-1.65	71-80	410	1
17	40 - 44	1.68-1.83	61-70	400	21
18	25 - 29	> 1.83	81-90	400	3
19	30 - 34	1.68-1.83	71-80	450	4
20	25 - 29	1.52-1.65	50-60	230	5
21	30 - 34	> 1.83	71-80	480	4
22	20 - 24	1.68-1.83	61-70	650	5
23	40 - 44	> 1.83	>90	550	2
24	25 - 29	1.52-1.65	71-80	500	5
25	25 - 29	1.52-1.65	61-70	600	10
26	25 - 29	1.69-1.83	61-70	600	3
27	30 - 34	1.68-1.83	81-90	500	14
28	25 - 29	1.68-1.83	71-80	500	4
29	30 - 34	> 1.83	61-70	550	15
30	25 - 29	> 1.83	71-80	500	4
31	30 - 34	1.52-1.65	71-80	520	3
32	40 - 44	1.68-1.83	51-60	550	4
33	30 - 34	1.68-1.83	61-70	450	10
34	25 - 29	> 1.83	51-60	400	8
35	25 - 29	1.68-1.83	61-70	420	6
36	20 - 24	> 1.83	71-80	450	2
37	30 - 34	1.68-1.83	61-70	450	10
38	25 - 29	1.68-1.83	61-70	550	4
39	30 - 34	1.52-1.65	61-70	600	12
40	25 - 29	1.68-1.83	51-60	410	12
41	20 - 24	> 1.83	71-80	480	8
42	40 - 44	1.68-1.83	71-80	500	5
43	25 - 29	1.68-1.83	61-70	550	10
44	25 - 29	1.68-1.83	61-70	500	10
45	20 - 24	> 1.83	61-70	620	1
46	20 - 24	> 1.83	71-80	500	2
47	30 - 34	1.68-1.83	71-80	550	2
48	25 - 29	1.68-1.83	71-80	450	3
49	30 - 34	1.52-1.65	51-60	550	4
Mean				**419.2**	**6.2**

Table 3: PEFR of Traffic Wardens Working Outdoors

S/no	Age range	Height (m)	Weight (kg)	PEFR l/min	Years of service
1	20 - 24	1.68-1.83	61-70	450	2
2	25 - 29	1.68-1.83	51-60	370	5
3	25 - 29	1.68-1.83	71-80	450	2
4	25 - 29	1.68-1.83	61-70	300	4
5	20 - 24	1.52-1.65	81-90	300	2
6	25 - 29	1.68-1.83	>90	500	2
7	30 - 34	1.68-1.83	71-80	350	4
8	25 - 29	1.68-1.83	71-80	370	7
9	20 - 24	1.68-1.83	61-70	450	4
10	25 - 29	1.68-1.83	61-70	450	4
11	30 - 34	1.68-1.83	61-70	300	20
12	25 - 29	1.68-1.83	61-70	400	4
13	40 - 44	1.68-1.83	71-80	150	20
14	25 - 29	1.52-1.65	61-70	250	3
15	40 - 44	1.68-1.83	71-80	180	3
16	30 - 34	1.52-1.65	71-80	410	1
17	40 - 45	1.68-1.83	51-60	220	20
18	25 - 29	> 1.83	51-60	400	3
19	30 - 34	1.68-1.83	71-80	450	4
20	25 - 29	1.52-1.65	51-60	230	2
21	30 - 34	> 1.83	71-80	480	4
22	20 - 24	1.68-1.83	71-80	350	2
23	45 - 49	> 1.83	81-90	400	27
24	25 - 29	1.52-1.65	71-80	320	3
25	25 - 29	1.52-1.65	61-70	350	3
26	25 - 29	1.69-1.83	61-70	450	3
27	30 - 34	1.68-1.83	71-80	450	4
28	25 - 29	1.68-1.83	71-80	500	4
29	30 - 34	1.68-1.83	61-70	480	5
30	25 - 29	1.68-1.83	71-80	500	4
31	30 - 34	1.52-1.65	71-80	520	3
32	45 - 49	1.68-1.83	51-60	350	4
33	30 - 34	1.68-1.83	61-70	450	10
34	25 - 29	1.68-1.83	51-60	400	8
35	25 - 29	1.68-1.83	51-60	420	6
36	20 - 24	1.68-1.83	71-80	450	22
37	30 - 34	1.68-1.83	61-70	500	20
38	25 - 29	1.68-1.83	61-70	550	4
39	30 - 34	1.52-1.65	61-70	600	2
40	25 - 29	1.68-1.83	51-60	410	12
41	20 - 24	1.68-1.83	71-80	480	8
42	40 - 44	1.68-1.83	71-80	500	5
43	25 - 29	1.68-1.83	61-70	550	12
44	25 - 29	1.68-1.83	61-70	480	10
45	20 - 24	1.68-1.83	61-70	620	1
46	20 - 24	1.68-1.83	71-80	500	2
47	30 - 34	1.68-1.83	71-80	550	2
48	25 - 29	1.68-1.83	71-80	450	3
49	30 - 34	1.52-1.65	51-60	500	4
Mean				**494.7**	**6.3**

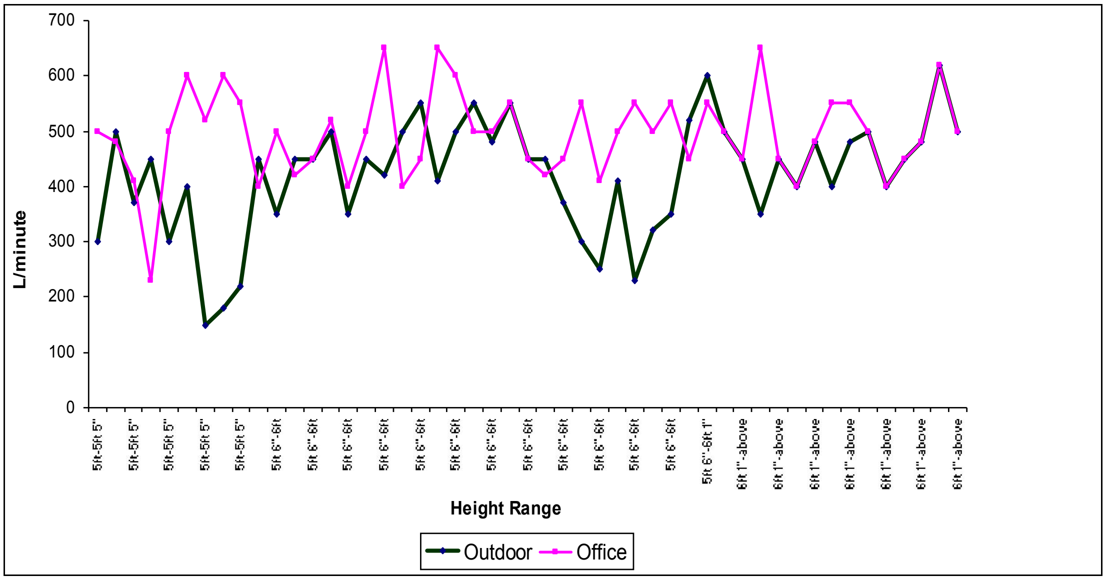

Figure 2: Peak Expiratory Flow Rates in Indoor and Outdoor Officers against Height.

Although many scientists claim that the lung function or peak expiratory flow rate of adults have been established, it has been proven that daily variations in ambient particulate air pollution are associated with variations in respiratory lung function (Penttinen *et al.*, 2001). The effects of particulate matter have been suggested to be due to particles in the ultra fine size range (0.01-0.1 micron), which was higher than regulatory limits in some instances in this study for Port Harcourt. Although coarse particle fraction and total suspended particles were not consistently associated with mortality (Pope *et al.* 2002). The capacity of particulate matter to produce adverse health effects in humans depend on its deposition in the respiratory tract. Particle size, shape, and density affect deposition rates. The most important characteristics influencing the deposition of particles in the respiratory system are size and aerodynamic properties. The aerodynamic diameter of a particle is the diameter of a unit density sphere having the same settling velocity as the particle in question, whatever its size, shape or density. Particles between 2.5 and 10 µm in aerodynamic diameter correspond to the inhalable particles capable of being deposited in the upper respiratory tract (Fierro, 2000).

4. Discussion

The mechanism by which particulate matter causes restriction on the airway is similar to the pathway by which cigarette smoke affect the lungs, this is because both ambient particles and inhaled cigarette smoke are processed by alveolar macrophages and lung epithelial cells (American Lung Association, 2005). These cells produce proinflammatory mediators such as cytokines that elicit a local inflammatory response in the lung which contribute to the exacerbation of chronic obstructive pulmonary disease (COPD) and asthma, and promote lung infection. These inflammatory mediators may also translocate into the circulation and induce a systemic inflammatory response. This response can include stimulation of the marrow to release leukocytes and platelets, activation of protein and fibrinogen that may increase coagulability and activation of the vascular endothelium, the layer of cells that line the blood vessels and are in direct contact with the blood.

Certain occupations do escalate respiratory disorder. Ebomoyi *et al.* (2006) in a study to assess respiratory function in Benin City, Nigeria, using 150 saw mill workers have reported higher respiratory rates and lower Peak Flow Rates (PFR) in saw mill workers compared to the controls. The observed rates of 20.83+– cyclesmin^{-1} and 516.72+– 38.48 Lmin^{-1}. For sawmill workers, 15.45+– 1.23 cyclesmin^{-1}, and 575.37 +– 27.34 Lmin^{-1} for controls, respectively, compares well with results of this study. Ebomoyi and Iyawe (2005) in their work on variation of PEFR with anthropometric determinants in a population of healthy Nigerians, found variations of PEFR with respect to height, weight and chest circumference in their subjects. PEFR values fell within the middle to the lower limit of the range for general male and female populations. They came up with the findings that there was a linear increase in PEFR with respect to the three anthropogenic variables (weight, height and chest circumference) only in the young adult males, whereas in the older adult males and females, PEFR fluctuated considerably with the variables. Also in a similar study, Nwafor (2004) took measurements of PEFR on young Nigerians in Port Harcourt who have lived around the oil refinery and fertilizer production company for at least 5 years. He came up with the findings that those who have lived in the vicinity of oil refinery and fertilizer production company had a significantly lower PEFR than the control.

4.1 Measures to Safeguard the Health of Road Users and Workers:

The Federal Road Safety Commission of Nigeria (FRSC) shares the burden of improving air quality in line with its enabling Act which makes provision for the regulation of vehicle emissions. By the late quarter of the 1990s, the FRSC along with the Federal Environmental Protection Agency (FEPA), and the Standards Organization of Nigeria (SON) initiated an awareness campaign for a reversal in the tragic trend of vehicular emission. Through that tripartite arrangement, the FRSC made effort to introduce mechanical devices that reduce vehicular emission and fuel consumption, invariably serving the dual advantage of social and economic benefits. FEPA was expected to bring into the exercise its expertise in determining when a pollution-related offence was committed while SON was to ensure that vehicles imported into the country conform to national standards in line with the requirement of the International Standards Organization (ISO 1400 series) which compels industries to environment-friendly technologies (All Africa, 2008).

In cities and other human dwellings including smaller clusters of settlements, commercial motorcycles offer a ready alternative transport mode for commuters. The motorcycles are viable options for overcoming traffic hold-ups and for accessing narrow roads. Consequently, Nigeria is now a big market for both new and fairly used 2-stroke engine motorcycles. Ironically, these 2-stroke engine motorcycles have been phased out and banned outright in large cities of many countries because of their high emissions. The effort of FRSC, however, suffers a severe set-back from the inaction of SON to regulate the standard of vehicles imported into the country. Without specific regulatory criterion on vehicle emissions at the point of entry, fairly used and overused vehicles, properly described as junks or scraps, have continually found their ways into Nigerian roads. Apart from government and a few corporate vehicles, many vehicles plying Nigerian roads release dangerous levels of emissions.

5. Conclusions

Although the mechanisms by which particles cause these effects are not well known, there is general agreement that the cardio-respiratory system is the major target of particulate matter impacts. Particulate concentrations in the two major roads (Aba and Ikwerre Roads) of Port Harcourt are beyond acceptable limits and are as such responsible for the reduced peak expiratory flow rates of officers working outdoors when compared to their counterparts who worked indoor. Presently, there is no coherent legislative framework nor a set standard in the city to monitor emissions from mobile sources unlike what is obtainable in the developed countries like the United States were each state has its own regulatory body that set standards. Also, in Nigeria there is no set standard for the regulation of the various particulate fractions rather what is obtainable is standard for TSP; a standard which is rather low, that is, 600 μgm^{-3} yearly and 260 μgm^{-3} for 24 hours exposure limits. It is therefore recommended that a more specific standard for the various fractions of respirable particulates be enacted to better protect public health in the country. Furthermore, wardens working outdoor should be made to work lesser hours and no person or group of persons in the police force should be made to work outdoor exclusively. There should be rotation of duty to ensure that no person is unduly exposed to continuous particulate concentration to avoid reduction in peak expiratory flow rates which may result in predisposing such persons to respiratory illnesses.

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References

1. Ojolo, S.J, Oke, S.A., Dinrifo, R.R and Eboda, F.Y., 2007. A survey of the effects of vehicular emissions on human health in Nigeria. *Journal of Rural and Tropical Public Health.* VOL.6, 16-23.
2. Ndoke, P.N. and Jimoh, O.D., 2005. Impact of traffic emission on air quality on air quality in a developing city of Nigeria. Retrieved March 23rd, 2008 from: http://www:journal.au.edu/au_techno/2005/apr05/vol8no4-abstract10.pdf.
3. Pope C.A., Thun, M.J, Namboodiri, M.M, Dockery, D.W, Evans, J. S., Speizer, F.E and Health Jr, C.W., 1995. Particulate air pollution as a predictor of mortality in a prospective study of U.S adults. Department of Environmental

Health, Harvard School of Public Health Boston, Massachusetts.

4. Laden, F., Neas, L.M, Dockery, D.W and Schwartz, J., 2000. Association of fine particulate matter from different sources with daily mortality in six US cities. *Environ Health Perspect*. Retrieved 30th May 30, 2008 from: http://lib.bioinfo.pl/meid:150004.
5. USEPA, (United States Environmental Protection Agency) 2007. Office of Transportation and Air Quality. National idling reduction campaign.
6. USDA, (united state department of Agriculture) Forest Service, Technology and Development, 2003. Retrieved 20th February, 2008 from: http://www.fs.fed.us/eng/pubs/htmlpubs/htm94512802/page04.htm.
7. Penttinen, P., Timonen, K.L., Tittanen,P., Mirme, A., Ruuskanen, J. and Pekkanen, J., 2001. Number concentration and size of particles in urban air: effects on spirometric lung function in adult asthmatic subjects. *Environmental Health Perspect*. 109 (4) 319-323.
8. Pope, C. A., Burnett, R. T., Thun, M.J., Calle, E. E., Krewski, D., Ito, K., Thurston, D.G., 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine Particulate air pollution. *Journal of the American Medical Association*. 287 (9).
10. Fierro, M., 2000. Particulate matter. Retrieved February 6, 2008 from: file:///L/Air_updates/particulatematter-singspace.htm.
11. American Lung Association, 2005. 2005 Research Highlights: Health effects of Particulate Matter and Ozone Air Pollution, ALA, January 2006, 19 pp.
12. Ebomoyi, M.I., Iyawe, V.I. and Ugheoke, A.J., 2006. Respiratory Symptoms among smoking sawmill workers in Edo state, Nigeria. *Journal of Physiological Science,* 21 (1-2) 49-54.
13. Ebomoyi, M.I. and Iyawe, V.I., 2005. Variations of peak expiratory flow rates with anthropometric determinants in a population of healthy adult Nigerians. *Nigerian Journal of Physiological sciences*. Volume 20, No.1. pp 85-89.
14. Nwafor, A. 2004. A survey of peak expiratory flow rate and anthropometric characteristics of young Nigerians in Port Harcourt. *Journal of Tropical Medicine and Health*, 1 (1).
15. All Africa.com, 2008. Retrieved on 28th june 2008 from: http://allafrica.com/stories/200803171136.html

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