A survey on the effects of vehicle emissions on human health in Nigeria

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Abstract

Vehicular emissions generally include oxides of nitrogen, sulphur, carbon hydrocarbon, mercury and leads. The effects of vehicular emissions on human health, vegetations, and environments were investigated in three locations of Lagos (Oshodi, Mushin and Apapa), Nigeria while a fourth location (Fola Agoro) was used as a control since it has low levels of pollution. The investigation was carried out with the use of questionnaires and laboratory experiments. Experiments were conducted on rainwater collected from each location to determine the level of acidity, pH, and the presence of dissolved substances such as NO_3, SO_4 and CO_2 in them. Physical effects on vegetations, buildings and structures were also observed. The results obtained from questionnaire show that on the average, 28.3%, 16.6%, 23.3%, 18.3%, 13.3% were respectively affected by sleeplessness, running nose, heavy eyes, asthmatic attack, and headache respectively. The location (distance from the coast type of fuel, availability of industries, and concentration of traffic) determine the impacts of these emissions on the ecosystem.

Keywords: Vehicular emissions, illness, rainwater, Nigeria, pH level, survey

Introduction

Vehicle emissions significantly pollute air and require control (Karlsson, 2004). With increasing concern for air toxics and climate modification caused by exhaust emissions, the need for tighter control increases in importance. There is therefore a great need for studies involving emission factors and impact. In recent years, there has been considerable research on vehicle emissions and fumes (Bailey 1995; Lilley 2000; Marshall *et al* 2003; Ababio 2003; Cadle *et al* 1997, 2000-2004).

Carbon monoxide causes blood clotting when it reacts with haemoglobin, which cuts the supply of oxygen in the respiration system after long exposure. This is a common occurrence in urban centres with a high level of commercial activity (Ackerman *et al* 2002; Gibbs *et al* 1995; Glen *et al* 1996; Johnson *et al* 2000). The worst levels of pollution are seen in such urban cities as are densely populated with a low standard of living (Addy and Pietrass 1992; Washington *et al* 1998). Unfortunately, vehicle emissions present an important environmental hazard that needs to be investigated, since it may shorten the lifespan of exposed people. Research has also indicated that the depletion of ozone layer is largely due to pollution from industries and the use of automobiles.

The rest of this section reviews the vehicle emission literature. Studies on modelling have centrally focused on a variety of tasks. In a study, computer modelling was used to compare diesel and hybrid vehicle emission (Ackerman *et al* 2002). Modelling frameworks have also been used to predict the future emission levels in Europe (Bailey 1995). Emission levels have also been predicted and mentioned through modelling in Australia (Johnson *et al* 2000). The effects of vehicle emissions on air quality have also been modelled (Lilley 2000). Through modelling, or relationship has been established between fuel consumption and vehicle emissions for the Trav Tek System (Van Aerde and Baker 1993).

A study has also been carried out on forecasting vehicle models of operations as an impact to modelling emissions (Washington *et al* 1998). An extensive body of growing research is provided on experimental issues relating to vehicle emission. In a related study, an investigation was made on vehicle exhaust gas casting in a diesel emissions control system (Addy and Pietrass 1992). The use of intra-red and ultraviolet spectrometers to measures vehicle emission on urban air quality has also been investigated experimentally (Gibbs *et al* 1995). Another study relates metrological variables and trends in motor vehicle emissions to monthly urban carbon monoxide (Glen *et al* 1996). Another experimentally bared research was conducted to determine the intake fraction of primary pollutants from motor vehicle emission in the South Coast Air Basin (Marshall *et al* 2003). In two cases, the scientific behaviours and effects at unregulated emissions were studied.

A case concerns the experimental measurement of unregulated emission for vehicles operated under low speed condition (Smith 1993). Four other studies relate to emissions of Nitrous oxide from vehicle (Dasch 1992, Becker and Lorzer 1999) and emissions of ammonia from light-duty vehicles (Durbin *et al.* 2001a) and emission sates of ammonia and other toxic and low-level compounds using FTIR

(Durbin 2001b). Experimental investigation has also been conducted on the detection of excess ammonia emissions from in-use vehicles (Fraser and Cass 1989). Furthermore, another study on ammonia emissions relates to on-road measurement of ammonia and other motor vehicle exhaust emissions (Kean and Harley 2000).

Another major group of research centres on reviews of the literature on some themes on emission research. A series of is review as provided on real-world vehicle emissions in a consistent study of over 7 years (Cadle *et al* 1997, 2000-2004). The review summarises presentations a series of workshops organised by a research council on road emissions for seven periods. A review is also provided on the profanation of natural gas vehicle in Nigeria as a possible source of emission (Kpaka 2003). An interesting review on ammonia inventory update for the South Coast Air Brain is provided (Chitjian *et al* 1997). Another interesting study on emissions relate to ammonia, motors oxide and hydrogen cyanide emissions from five passenger vehicles (Karlsson 2004). Experimental of vehicles emission also include unregulated emission from three-way catalyst cars (Bardow and Stump 1997).

Having reviewed studies in modelling, experimental, reviews and application in vehicle emission, there seems no documentation relevant to tropical regions, particularly Lagos Nigeria. This paper is therefore motivated to close the important gap.

The objectives of this study are: (i) to investigate the state of vehicular emission in Lagos (ii) to investigate the state of vehicular emission on people, the vegetations, and the environments; and (iii) To prescribe ways of reducing these emissions. These objectives are justified when one considers the argument by Kpako (2003), who stated that vehicular emissions accounts for about 60% of the total pollutants emitted when compared to other sources and are a dangers to society.

Data was collected in Lagos, a commercial city in Nigeria. Lagos is a city surrounded by water bodies with a population of 12 million people. It belongs to the tropical rainforests having a wet season from April to October and a dry season from November to March. It is a gateway to goods and services into Nigeria (Babatola 2002). Of more than 4 million vehicles in Nigeria, there are about 700,000 vehicles in Lagos spreading harmful exhaust emissions daily into the city and thereby causing pollution (Kpaka 2003).

Materials and methods

Methods of sampling and samples

The research focused on congested areas of Lagos where heavy vehicular emissions are common. The sample areas are densely populated. They were observed both in the day and night. A common characteristic of these areas is the presence of heavy flow of transportation and high industrial activities where the heavy combustion of fossil fuel from the internal combustion chambers exists. The sample areas are Oshodi, Mushin and Apapa, while Fola Agoro was used as a control location since it has low levels of pollution. In these study areas, concentration of pollutants such as carbon monoxide, sulphur oxide, nitrogen oxides, organic acids, and hydrocarbons (obtained mostly from exhaust gases) in the atmosphere is high. However, vehicular emissions account for more than 60% of the total pollutants emitted when compared to other sources.

In this investigation, the following effects and impacts were assessed:

- the effects of emission on the health of the people living in the sampled location;
- the effects of emissions on buildings and structures;
- the effects of emission on vegetation in the sampled location; and
- analysis of the rainwater samples located in the study locations.

The effect of emission on health: In determining the health effects in the samples location, questionnaires were prepared and administered on 100 selected individuals each who live or work in the study areas. The data obtained from the questionnaires were analysed based on the information obtained from them. The questionnaire also sampled people’s opinions on what they think should be done to reduce these harmful exhausts.

Effects of emissions on buildings and structures: 10 buildings and structures were observed closely in the sampled locations. Those affected by emissions were then photographed and reported in this work.

Effect of emission on plants: The investigation carried out in the work entails observing vegetations in the sampled area to determine samples showing the effects of emissions. The symptoms are usually stunted growth, yellowing effect (chlorosis), flecks (tiny light and irregular spots), stipples (small darkly pigment), boozing and reddening of the plants. Such affected plants were photographed.

Experimental analysis

A collection of samples of rainwater was made in clean bottles that were fitted with a funnel covered with cloth and placed on top of buildings in the sampled locations. The aim of this was avoid adulteration of the water samples since if it comes in contact with anything (i.e. roofs, walls, etc.), the results of the tests carried out in the laboratory could be affected. Efforts were made to determine the acidity level of the rainwater collected, the presence of nitrate in the samples, the sulphate and carbon dioxide levels, and the pH of the samples. The procedures are stated in the subsections that follow here.

Test of the presence of nitrates

The description hereunder shows the reagents used for the test and the procedure followed. Reagents used were: 0.25 M NaOH, Hydrazine sulphate + copper sulphate (reduction mixture), 0.1 M hydrochloride acid (HCL), EDTA, Sulphanilic acid, Naphthy lamic and Sodium acetate.

Procedure:

1. 25ml of sample was pipette into 250ml baker;
2. 4ml of 0.25M NaOH was then added to the mixture and stirred gently, after a while,
3. 12.5ml of reduction mixture was added
4. The mixture was shaken vigorously and allowed to stand for 45 minutes,
5. 6ml each of 0.1M of HCL, Im of mixed thoroughly
6. It was then allowed to stand for 5miniutes after which 1ml sodium acetate was added.
7. The mixture was allowed to stand for 10miniutes.
8. The absorbance of the mixture was read on a spectrophotometer at 520mm; and the concentration of nitrate in the sample test for the presence of carbon dioxide.

Test of the presence of sulphate (Gravimetric method)

By using the Gravimetric method, the following procedure should be carried out.

Procedure:

1. Filter the water sample
2. Pour 200 ml of the filtrate into 400 ml baker, and add 5ml of diluted (2M) acid to the filtrate.
3. Raise the temperature of the liquid to boiling point and add 10ml of 10% Bacl to it.
4. After waiting for 30 minutes or alternatively, wait overnight, filter the solution.
5. Wash the filter paper until it is free of excess barium chloride.
6. The precipitate is then shed and weighed as BaSO4.
7. Calculate the parts per million of sulphate

Test of the presence of carbon-dioxide

The following reagents and procedure are used for testing carbon-dioxide from the sample. Regents used were: Phenolphthalein and Sodium carbonate.

Procedure:

1. Collect 10ml of sampled water in a measuring cylinder
2. Add 4 drops of phenolphthalein.
3. The colourless solution is then titrated with 0.045 M of sodium carbonate solution.
4. Stir gently with iron rod.
5. Add sodium carbonate in bits
6. A faint pink colour that remains for at least 30 seconds is observed. The indicates the presence of carbon-dioxide.

Calculation of carbon-dioxide quantity in the sample

The following formula shows how the calculation is made.

$$Co_2 \text{ in mgl litres} = \frac{\text{Mg/g NaCo}_3 \times N \times 22 \times 100}{\text{Volume of sample}}$$

Determination of level of acidity

For this scheme, the methyl orange titration method is used as follows:

1. Procedure:
2. 0.1ml of methyl orange was added to 50ml of the sample in a conical flask over a white surface.
3. The mixture is then titrated with standard 0.02M NaOH until the colour changed to the faint orange, which is the characteristic of pH of 4.5.

Calculation of carbon-dioxide quantity in the sample

The following formula shows how the acidity as mild as $CaCO_3$ is calculated.

$$\text{Acidity as mild as } CaCo_3 = \frac{A \times N \times 50000 \times D}{\text{Volume of sample}}$$

Where = A = ml of titrated sample, N = normality of NaOH and D = diluted factor (if any).

Determination of pH

This was done with the use of pH meter (PW 9504 Philips pH meter). e pH meter was standardised with butter solutions of pH 4, pH 9.2, and pH 7 before the water was tested.

Questionnaire

Questionnaires (see appendix) were administered in four local government areas of Lagos: Oshodi, Mushin, Apapa, and Yaba. The fourth local government, Yaba, was used as a control site with which comparison of results were made. Yaba is a relatively low-emission area of the four sites. Questionnaires were administered on a total of 310 respondents to determine the effects of emissions on their health, particularly in congested areas of Lagos where heavy vehicular emissions are common. Preliminary observations were done for 2 months in many areas before selecting the sampled areas. These are the areas where there are heavy flows of transportations. A total of 100 respondents were carefully selected each from the three locations, while 10 respondents were chosen from the control area. Questionnaires were administered on them over a period of 12 months. The selected respondents include office workers, market women, street hawkers, drivers, conductors, traders and residents. Those that had difficulty in responding to the questionnaires were assisted by the crewmembers. The questionnaires were analysed based on the factors/symptoms that constitute health problems.

The procedure carried out in achieving the objectives of the current work could be classified into two: (i) procedure related to questionnaire administration and analysis; and (ii) procedure related to testing of substances.

Procedure related to questionnaire administration and analysis

1. A pre-survey is carried out by going to the field to understand what classes of respondents would be involved and answering the questionnaire, and possibly estimating the population so that sample size could be determined.
2. Based on (1), questionnaires are designed and a test-survey is carried out to refine the questions posed in the instrument and to determine its adequacy.
3. Based on the target number of respondents, the questionnaire is designed and administered on the respondents. A response rate of 100% is the target since the questions are simple enough not to consume much of respondents' time, and for economic purpose.
4. Based on the returned questionnaires, analysis of items contained therein is then made.

Procedure related to testing of substances

1. Visit the field to collect samples (i.e. vegetation polluted by the environment)
2. Preserve such samples
3. Visit laboratories with the samples where tests are administered on the vegetation.
4. Analyse the results obtained and make conclusions.

Results

Tables A1, 1 and 2 show details of the selected respondents for the survey. Table 2 shows the results of the responses from the questionnaires administered on the respondents. It should be stated that in all cases, Fola Agoro is chosen as a control area in view of its relatively low emission level.

Table A1: Effects of automobile emissions on the respondents at Oshodi, Mushin, Apapa, and Fola Agoro (Control area)

Respondent	Number of people affected by: Sleeplessness (OS,MU,AP,FA)	Catarrh (OS,MU,AP,FA)	Heavy eye (OS,MU,AP,FA)	Asthmatic attack (OS,MU,AP,FA)	Headache (OS,MU,AP,FA)
Office workers	(2,1,1,0)	(4,3,4,0)	(1,6,5,0)	(0,0,1,0)	(5,4,5,0)
Market women	(2,4,3,0)	(6,3,6,0)	(3,2,2,0)	(0,0,0,0)	(1,1,3,0)
Street hawkers	(3,2,3,0)	(4,6,6,0)	(6,5,5,0)	(1,0,0,0)	(4,3,4,0)
Drivers	(2,2,1,1)	(1,2,3,3)	(4,3,3,2)	(0,0,0,1)	(2,5,3,0)
Conductors	(2,2,2,2)	(3,3,3,2)	(2,3,2,2)	(1,1,1,0)	(0,2,2,2)
Traders	(4,2,5,2)	(5,4,6,5)	(3,5,2,8)	(1,1,1,5)	(3,4,4,2)
Residents	(4,3,1,0)	(2,4,3,0)	(4,7,6,0)	(2,1,2,0)	(3,3,4,0)
Totals	(29,16,16,5)	(25,25,31,10)	(21,31,25,12)	(4,2,4,6)	(18,22,25,4)

Key: OS – Oshodi; MU – Mushin; AP – Apapa; and FA – *Fola Agoro

Table 1: Distribution of the respondents in the study areas

Respondents	Oshodi		Mushin		Apapa		*Fola Agoro (Control)		Totals
	M	F	M	F	M	F	M	F	
Office workers	3	8	9	6	9	7	-	-	42
Market women	-	12	-	10	-	14	-	-	36
Street hawkers	6	12	9	10	10	8	-	-	55
Drivers	10	-	12	-	10	-	4	-	32
Conductors	9	-	10	-	9	-	3	-	29
Traders	10	9	7	10	6	12	6	6	50
Residents	6	12	8	10	10	7	-	-	53
Totals	44	53	55	46	54	48	13	6	319

M – Male; F – Female; *Fola Agoro (Control area not added up in totals)

Table 2: Effects of automobile emission on the respondents in the study areas

Ailment	No. of respondents affected: Oshodi	Mushin	Apapa	*Fola Agoro (Control)	Totals
Sleeplessness	19	16	16	9	51 (17%)
Flu	25	25	31	0	31 (27%)
Heavy eye	21	31	25	18	87 (29%)
Asthmatic attack	4	2	3	10	9 (3%)
Headache	18	22	25	7	65 (21.7%)

* Fola Agoro (Control area not added up in totals)

Table 3: Results from analysis on rainwater samples in three locations. Lagos industrial and Norway drinking water values are presented for comparison.

Pollutant	Oshodi	Mushin	Apapa	Lagos Industrial*	Drinking water in Norway**
NO_3 (mg/l)	1.50	1.60	1.40	1.77	0.46
SO_4 (mg/l)	8.0	9.0	7.0	3.12	5.3
CO_2 (mg/l)	8.9	9.8	7.8		
Acidity (mg/l)	16.0	17.0	15.0		
pH	7.6	7.8	7.4	7.06	6.8

* Uzomah and Sangodoyin (2000)
** Flaten (1991)

Discussion

Limitations

We did not measure the emission rates of different vehicles or the volume of traffic so our comments on the influence of vehicle type and traffic volume are purely observational. Although we did not measure rainwater pollutants in the control area, we have personally verified that the traffic there is lower in volume. Using this observational information, we can suggest that the health effects measured in the areas that experienced higher levels of vehicle emissions were in fact attributable to vehicle emissions.

Oshodi

Variations in the effects of automobile emissions from one local government area to another were observable in this study. The respondents in Oshodi were frequently affected by catarrh. This may be due to the heavy emissions from big buses (*Molue*) that ply Oshodi to other parts of Lagos. These vehicles are mainly powered by diesel fuel and in most cases, are not frequently serviced. They operate almost 20 hours a day, hence the possibility of worn rings thereby causing heavy soot from their exhaust pipes. Asthmatic attacks were rare in all areas, but traders in Fola Agoro showed the highest complaints. Heavy eye, which is closely linked to sleeplessness, ranks second in Oshodi. Since this is a commercial nerve centre of Lagos, there is the possibility of the respondents staying around this area for the greater part of their day. Therefore after assimilating different kinds of emissions for a large number of hours, they suffer from heavy eye which is the cause of sleeplessness.

Mushin

The percentage of respondents affected by heavy eye was the highest in Mushin. This may be due to the fact that small buses are more common in this area. The emissions from these vehicles are lighter as compared to those from the big buses that are common in Oshodi. The effects of these emissions may not be more noticeable during the day on the people but a night, the people find it difficult to sleep due to heavy eye. A fourth of the respondents of Mushin suffered from catarrh. This may be due to the fact that offices, banks and business areas are along the bus stops in this area. Twenty percent of the respondents in Mushin are affected by headache. It is observed that majority of the small buses lying Mushin are not well maintained therefore, the more poisonous coexists from exhaust pipes due to worn rings, leakages from the mufflers, etc. Asthmatic effects were very small (3%) in Mushin area. This is due to the fact that the small buses plying this area are not usually overloaded which gives room for more air spaces inside the vehicles in this area, therefore, there are more spaces for the rapid diffusion of the emission from the vehicles.

Apapa

In Apapa area, there is a mixture of big buses (*Molue*) and small buses (*Danfo*), this allows for the co-neengling by diesel and petrol. Since these emissions are a mixture of gases from different sources, it results quickly into adverse effects on the respondents hence the greatest percentage (31%) of the respondents in this area suffer from catarrh. Apapa is the gateway to Lagos economy, the Nigerian orts are located here. There are many types of vehicles plying this area mainly big buses which produce heavy emission. Twenty-five percent of respondents suffer from headache and the aftermath is sleeplessness. This is due largely to the amount of gases (exhaust) that they have emitted during the day while undergoing their business activities. There is a high percentage (16%) of respondents being affected by sleeplessness in Apapa. This area is partly residential and commercial. The subtle emission from neighbouring bus stops, car parks are being felt during the nights resulting in sleeplessness. The level of sleeplessness here is heavier than that in Oshodi, (19%).

Conclusion

The study is worth considering in view of the cost savings that would result if adequate traffic controls were implemented. Future studies need to consider the development of models, analysis, and empirical scrutiny of vehicle emission models. For example, a scientific model could be developed to monitor the path that vehicle emissions follow, from the exhaust pipe to the human respiratory system. Such a study may consider the relationship between the type, concentration and speed of emitted gases/spill oils and the atmospheric natural gas. The result of such a research will be useful to the vehicle manufacturers in the design of new exhaust pipes. Another fertile research area may be the study of the diffusion rate of emitted substances into the blood stream of victims.

Appendix: questionnaire

Introduction

The questionnaire is designed to obtain information from you on a research work. Responses sought from administering this questionnaire will be used for the purpose of the research work. Please answer the questions correctly and accurately.

Thank you.

Questionnaire I.D. No.	
Date	
Place of Study	
Name of Interviewer	
Signature	

Please tick ( ) corresponding to the appropriate answer under the code indicated. Also, fill in the necessary information in the spaces provided.

S/No.	Questions	Coding categories	Code
1.	Sex	Male Female	1 2
2.	Age	Specify……………. 15 – 19 20 – 24 25 – 29 30 – 34 35 and above	1 2 3 4 5 6
3.	Respondents	Driver (private/personal) Conductor Commuter Traders	1 2 3 4
4.	Type of Automobile	Cars of all types Buses (Danfo) Big Buses (all types) Trucks (all types)	1 2 3 4
5.	Type of Fuel	Petrol Diesel	1 2
6.	Duration of Exposure to Exhaust/day	1 – 3 hours 6 – 10 hours 10 and above	1 2 3
7.	Effect on Individual	Sleeplessness Running nose Heavy eye Asthmatic attack Headache	1 2 3 4 5
8.	Suggest ways of reducing exhaust	Please specify	
9.	Suggest ways you think government can help	Please specify	

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