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THE IMPACT OF AUTOMOBILE EXHAUST FUMES ON CONCENTRATION LEVELS OF LEAD ON BREAD IN PORT HARCOURT CITY, NIGERIA.

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ABSTRACT: *The study examined the spatio-temporal analysis of Lead (Pb) concentrations in bread in five selected bus terminals in Port Harcourt metropolis A total of one thousand and two hundred loaves of bread were exposed to air with two hundred in each bus terminals on Mondays and Fridays in the morning, afternoon, and evening for four weeks and used for laboratory analysis. Volume of vehicular counts was also determined in the morning, afternoon and evening across the selected bus terminals. Thirty samples of premium motor spirit (PMS) were randomly collected between July and September 2013 to determine the amount of Pb and octane rating present in the laboratory. The area of each bus terminal was determined by multiplying the length and the breadth of each bus terminals. Mean value of Pb concentration and octane ratings; the volume of vehicular counts, size of the bus was determined. ANOVA and regression analysis were used in the study. Result showed that the mean values of Pb concentrations in bread were highest in Flyover Mile 1 Park in the morning, afternoon and evening with a value of 0.464 μg/g, 0.305μg/g and 0.339μg/g respectively. Generally, the Pb concentration in bread was highest in the morning (0.271μg/g) and least in the evening (0.235μg/g). A direct relationship existed between the concentration of Pb in bread in bus terminals and volume of vehicular counts (r^2= 0.194). Similarly, the size of bus terminals accounted for 60.0% of the concentration of Pb in bread (r^2 = 0.600). There was a significant variation in the Pb concentrations in bread recorded in the morning, afternoon and evening as F calculated was 10.451 at 0.5 significance level. Similarly, there was a significant variation in the Pb concentrations recorded in the selected locations as F calculated was 10.788 at 0.5significance level. Policy measured aimed at stopping the sale of bread at the bus terminals and the use of leaded petrol in the city is advocated.*

KEYWORDS: Spatio-temporal, Lead (Pb) concentration, White bread, Bus terminals, Port Harcourt

INTRODUCTION

The use of organic lead (Pb) compounds such as tetra-ethyl lead and tetra-methyl lead as additives in petrol has been of continual concern to environmental scientists and policy makers. Studies have shown that the body Pb levels of modern humans are about 500times higher than those of pre-industrial times. The ubiquity of Pb and its known toxicity to man and wildlife necessitates its continual determination in the environment. Petrol is petroleum derived liquid mixture which is primarily used as a fuel in internal combustion engines, is also used as a solvent, mainly known for its ability to dilute paints. It consists mostly of aliphatic hydrocarbons obtained by the fractional distillation of petroleum. Lead (Pb), is a member of group IVB element of the periodic table. It exists in Pb (II) and Pb (III) with electron valency of 2 i.e. Pb^{2+}, atomic number 82, atomic weight 207.19 and a specify gravity of 11.34, is a bluish or silvery-grey metal with a melting point of

327.5^0C and a boiling point at atmospheric pressure of 174^oC. The major areas of Pb are galena (PbS), Cerussite ($PbCO_3$) and anglesite ($PbSO_4$) is persistent in the environment, which exists in dangerous form for a very long time. Studies showed that Africa's contribution to global Pb pollution has increased from just 5% in the 1980s to 20% in 1996 (Nriagu, 1978). An important characteristic of petrol is its octane rating, which is a measure of how resistant petrol is to the abnormal combustion phenomenon known as pre-detonation. Octane rating is measured relative to a mixture of 2, 2, 4- trimethylpentane (an isomer of octane) and n-heptane. There are different conventions for expressing octane ratings, so a fuel may have several different octane ratings based on the measure used. Research octane number (RON) for commercially-available gasoline varies by country. In Finland, Sweden, and Norway, 95 RON is the standard for regular unleaded gasoline and 98 RON is also available as a more expensive option. In the UK, ordinary regular unleaded gasoline is 95 RON (commonly available), premium unleaded gasoline is always 97 RON, and super unleaded is usually 97-98 RON. However, both Shell and BP produce fuel at 102 RON in Nigeria for cars with high-performance engines, and the supermarket chain Tesco began in 2006 to sell super unleaded gasoline rated at 99 RON. In the US, octane ratings in unleaded fuels can vary between 86 and 87 AKI (91-92 RON) for regular, through 89-90 AKI (94-95 RON) for mid-grade (European premium), up to 90-94 AKI (95-99 RON) for premium (European super). Thus the monitoring of this metal in food items especially bread which is affordable by all classes of persons and sold along major traffic routes and at bus terminals is of particular importance because it is one of the major routes by which toxic substances find their way into the human body.

LITERATURE REVIEW

In Nigeria, automobile exhaust constitutes 75-80% of the gross air pollution, the remainder coming from the dust arising from untarred roads, smoke and gases from industries and the burning of bush and refuse. The lead level in Nigeria's super petrol is in range of 210- 520mg/litre (Ademoroti, 1986). Awofolu (2004) examined the impact of automobile exhaust on the levels of lead in commercially produced and sold white bread at bus terminals in Lagos, Nigeria. He used the Atomic Absorption Spectrometer to measure the total lead concentrations. He detected metals in over 80 percent of the 160 samples analyzed. The overall mean concentration of the metal varied between $0.015 – 0.026ug^{-1}$. However in Port Harcourt with intractable Traffic situation and heavy hydrocarbon industrial foundations, the traffic wardens, transport workers, oil industry workers, host communities of oil industry, etc are subjected to hazards and diseases emanating from Pb fumes and particles emitted into the air of environment through oil companies operations or from automobiles. Innocent infants, adults living around highly trafficked areas such as bus terminals, companies with the fuel as source of power to its equipments and automotive or automobile are unduly exposed to high concentration of larger and smaller particles sizes of Pb on daily basis in air, water, soil, land even food. The name given to the disease caused by lead poison is plumbism or saturnism. There are some symptoms for acute lead poison but they are ill defined. These include weariness, nausea, abdominal pain, uncoordinated body movements, convulsions and stuper, eventually producing coma and death. Chronic lead toxicity symptoms includes loss of appetite, vomiting, long-term effects are kidney malfunction, hyper-activity, mild anemia, liver disease, brain damage and general intellectual and psychological impairment. Children who survive brain damage eventually suffer permanent damages of the central nervous system (CNS). In a survey of men cutting lead painted steel, and who were inhaling and ingesting lead, the effects were

excessive weakness and fatigue 100%, aneamia 90%, abdominal pain 80%, constipation 50% chest pains, 50% and loss of appetite 50%. The blood lead levels of the men were found to be very high 104-139 mg/l (Shadick et al; 2000). Lead is known to inhabit the biosynthesis of heam resulting in anaemia. Other health effects where lead has been implicated and cot deaths (sudden infant death syndrome) and stillbirths (Bryce Smith 2005; Park *et al*., 2008; Bellinger, 2005) as lead can pass through the placenta barrier in any pregnant woman to effect the embryo.

It is believed that the non-excreted fraction of absorbed Pb is distributed among three compartments: blood, soft tissues and the mineralizing tissues (bones and teeth). About 95% of the Pb body burden in adults is located in the bones, compared with about 70% in children. Some 99% of the lead in the bloodstream is bound to erythrocytes. Lead concentration in bones increase with age and this increase is more noticeable in males in the denser tibia bones. Lead poisoning is a global reality, and fortunately is not a very common clinical diagnosis yet in Nigeria except for few occupational exposures (Anetor et al., 1999). In an urban center, it is believed that the bus stop terminals could be a point of measuring the concentration of Pb because of the taking off and landing of vehicles in which their exhaust is a major source of Pb. The use of bread as a commercial food to determine the level of Pb concentration is a good way to investigate the concentration of Pb as bread is produced all over the city and sold in all bus terminals. In addition, the influence of time of the day on the Pb concentration on bread cannot be over emphasized. This study examined the spatial and temporal concentration of Pb derived from exhaust of vehicles on the commercial food (bread) at bus terminals. It also determined the relationship between the Pb concentration in bread and the volume of vehicular flow in the bus terminals and the size of the bus terminals.

Area of study.

The study area is Port Harcourt Metropolis in Port Harcourt City Local Government Area of Rivers State. It lies in latitudes between latitude 4º 72'N and 4º 91'N and longitude 6º 88'E and 7º 12'E (Figure 1). The selected bus terminals included Rivers State Bus Terminals in Olu Obasanjo Street, Flyover Bus Terminal in Mile 1, Mile 3 Park, Garrison Bus Stop, and Lagos Bus Stop (Figure 1). The area is found in the South-south geo-political zone of Nigeria and also in the Niger Delta Region. Port-Harcourt metropolis has three very important trunk A roads. These are the Port-Harcourt-Aba Expressway, the Ikwerre Road and the East-West Road. The Port-Harcourt-Aba Expressway, which runs north-east wards, links directly, such hinterland towns like Aba, Umuahia, Okigwe and Enugu in the east and Ughelli, Warri, and Benin in the west. The Ikwerre Road on the other hand runs in south-north direction and links the city directly with Owerri and Onitsha. Trunk B roads include Choba-Rumuokwuta Road and Rupokwu-Eliozu-Air Force Base Road. There are several trunk C roads. The trunk A and B roads are dualized. Major bus terminals or bus stops are found along these roads. Figure 1 below shows the major roads and selected bus terminals used for the study in the city.

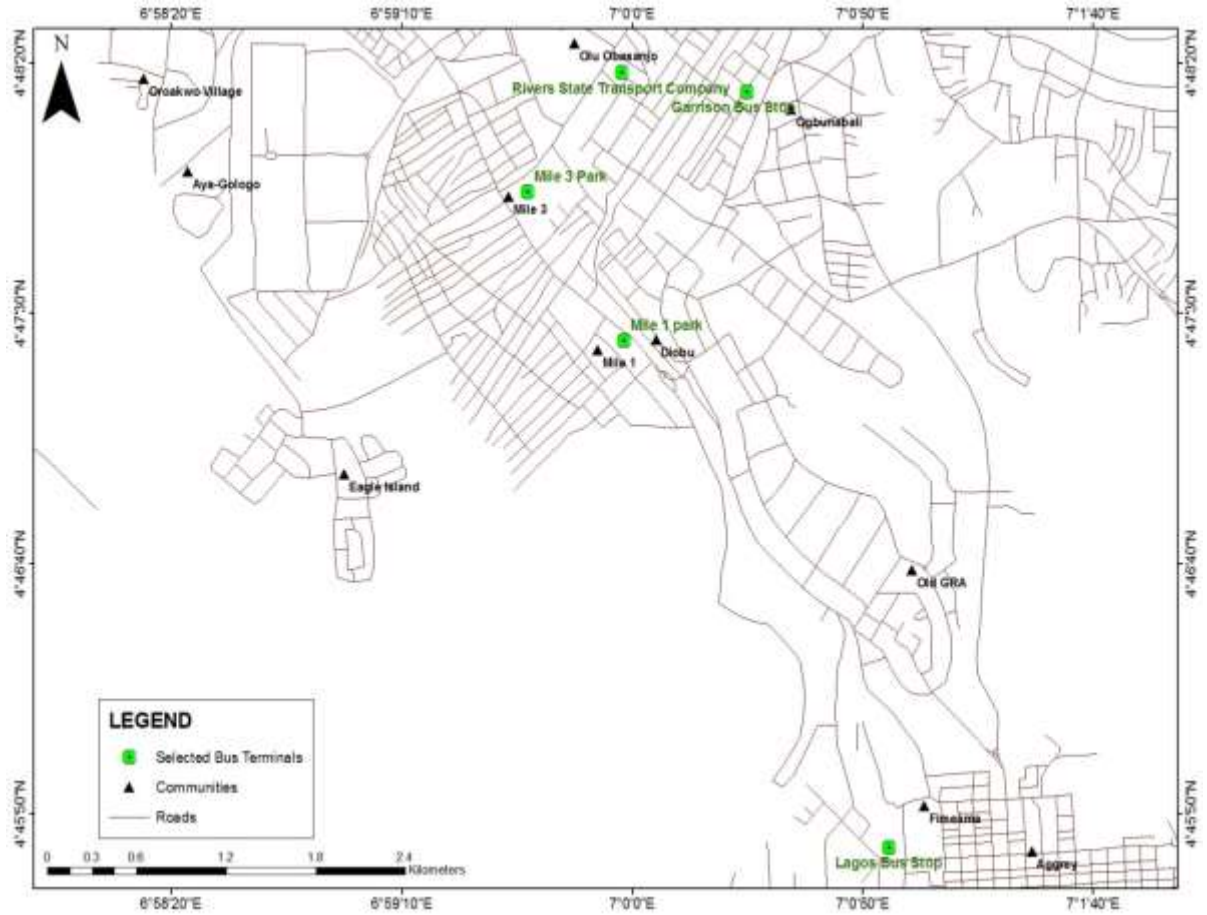

Figure 1: Map showing the selected bus terminals in Port Harcourt City.

METHODOLOGY

Data collected includes the concentration of Pb on white bread in the selected bus terminals, Pb concentration in Premium Motor Spirit collected from the refinery in Port Harcourt, vehicular counts in each bus terminal and the size of each bus terminals. Representative sample of Premium motor spirit (PMS) was randomly collected between July and September 2013 in tightly screwed amber glass sample bottles from Port Harcourt Refinery Company in accordance with practice D4057 American Society for Testing and Materials (ASTM) standard. Ten samples were collected in each month and total samples were thirty samples. The sampled white bread loaves from the same bakery were purchased directly from food vendors at bus terminals namely Rivers State Bus Terminal (RSTB) along Olu-Obansanjo road at waterlines; Mile 3 Park, Garrison bus stop, Flyover Mile 1 Park and Lagos bus stop all in Port Harcourt City. These loaves of bread have similar dimensions in terms of length, breadth and weight. The length was 17.5cm, breadth was 8.3cm and the weight was about 5kg. They are very busy bus terminals to various parts of the city and out of the city. They have influx of patronage with high volumes of traffic. The food vendors normally purchase the bread from commercial bakeries for sale at the terminals. Ten loaves of white bread were exposed to air in each bus terminals on Mondays and Fridays in the morning (7am-9am), afternoon (12pm-2pm) and evening (4pm-6pm) for four weeks. This shows that thirty

loafs of bread were used per day and sixty per week because two days (Mondays and Fridays) were selected for the study. A total of two hundred and forty loaves of bread were used in each study location. This means that a total of one thousand two hundred loaves of bread were for used and analyzed in the laboratory for Pb concentrations in the entire study. Vehicles were counted at a point in the morning, afternoon and evening on Mondays and Fridays at each bus terminal. Both inflow and outflow vehicular movements were counted simultaneously at a point with the aid of Field assistants.

The size of bus terminals was determined by determining the length and breadth of each bus terminal and using the formula for calculating the area (Sq. m) to determine the size. The formula is:

Area = Length (m) x Breadth (m)

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A test specimen of about 25ml gasoline was transferred into a 250ml separatory funnel containing 50ml iodine monochloride reagent and 25ml heavy distillate. The separatory funnel was immediately stopped and shaken for 60seconds. The funnel was allowed stand for twenty minutes after which the content separated into phases. The lower aqueous phases run into a 500ml Erlenmeyer flask made of borosilicate glass. The gasoline was washed by shaking with three separated 20ml portions of distilled water then added to the Erlenmeyer flask. Several glass beads were placed in the flask the mouth was covered with small ribbed watch glass and heated on the hotplate until the volume of the solution is reduced to 15-20ml five (5) ml concentration of nitric acid was added down the side of flask while still on the hotplate. The content of the flask were evaporated to almost dryness to oxidize any organic material present. The process of nitric acid treatment was repeated and evaporated to almost dryness until a white residue is left indicating the complete removal of all organic matters. The solution was evaporated to dryness and the flask removed from hot plate to cool the content. The residue was then reconstituted with 200ml of distilled water, 5 drops of bromthymol blue indicator was added and titrated with (1+1) ammonia solution until the colour changes to blue, 10ml of sodium acetate-acetic acid buffer solution and 5 drops of xylenol orange indicator solution was also added. The solution was turned to a rose colour due to the presence of lead. The solution was titrated with 0.005m standard EDTA solution, the colour then changed from orange to a permanent bright lemon yellow. The litre was noted, and a blank determination of the reagents was carried out without addition of heavy distillate and the extraction stages. All chemicals that were used was of analytical grades and all the glassware were properly washed with liquid soap, rinsed with water, soaked in dilute distilled water before use. The metal standard solution was prepared from 1000-ppm stock solution of the metal. Flame atomic absorption spectrometer (AAS), pye unicorn Philips model PU900x was employed in the determination of the Pb concentration in the bread samples. The sample loaves of white bread were air dried for about 2-3 days in a clean laboratory environment and further dried in the oven at $100^{O}C$ for about 24hours. The dried sample was pulverized in a clean and acid rinsed (10% HNO_3) agate mortar. The samples were digested using the procedure described by Puchyr and Shapiro (1986). 10g of the homogenized samples were weighed into 250ml Erlenmeyer flask and 20ml of the acid mixture (HCL-HNO_3) 9 +1) was also added. The flask was then be heated on a hot water bath at $90^{O}C$ for about 30mintues. The digested sample was allowed to cool and then filtered using what man filter NO 542 into 50ml standard flask. The Erlenmeyer flask was rinsed twice with

small portions of doubly distilled water filtered into the 50ml standard flask. Blank determination using the same procedure was carried out to digest the samples analysed on the AAS. Triplicate digestion of each sample was analyzed. Due to unavailability of standard Reference material (SRM) in the laboratory, standard addition method of the metal was used for the validation of the analytical protocol. The food sample (white bread) was spiked with 1mg of the metal standard and then taken through the chemical analysis as described above. Three replicate analyses of the recovery tests were also carried out.

One way analysis of variance (ANOVA) test was used to examine the spatial and temporal variation in Pb concentration among the bus terminals while relationship between the Pb concentration in bread and size of bus terminals; and volume of vehicular counts was statistically analyzed using a simple linear regression

The ANOVA model states that:

$$SS_{total} = \sum (\bar{X} - X..)^2 \quad (2)$$

$$SS_{between} = \sum \bar{n}_j (\bar{X}_j - X)^2 \quad (3)$$

$$SS_{error\ or\ within} = \sum_j \sum_i (\bar{X}_{ij} - X_j)^2 \quad (4)$$

$$SS_{total} = \sum X^2 - (\sum X)^2/N \qquad (df_{total} = N-1) \quad (5)$$

$$SS_{between} = (\sum X_1)^2/n_1 + (\sum X_2)^2/n_2 + \ldots + (\sum X_a)^2/a - (\sum X)^2/N \qquad (df_{between} = a-1) \quad (6)$$

$$SS_{error/within} = SS_{total} - SS_{between} \qquad (df_{error/within} = N-a) \quad (7)$$

$$s^2 = SS/df = MS \quad (8)$$

$$F = MS_{between}/MS_{error/within} \quad (9)$$

Where
SS is the sum of squares
X is the variable
N is the total number of population
df is the degree of freedom
s^2 is the variance
MS is the mean squares
$\sum$ is the sum

The linear regression model is $Y = a + bX$ (10)

Where,
Y is the dependent variable
a is the gradient or slope
b is the regression coefficient

X is the independent variable

RESULT AND DISCUSSION OF FINDINGS

Result showed that Pb concentration in RBTC, Olu Obasanjo, Flyover Bus Terminal in Mile 1 (FBT), Mile 3 Park, Garrison Bus stop and Lagos Bus Stop in the morning (7am-10am) was 0.235µg/g, 0.464 µg/g, 0.314 µg/g, 0.193 µg/g and 0.147 µg/g respectively. This result is also depicted in Figure 4.1 which shows that highest Pb concentrations was observed in the FBT. The Pb concentration was highest in the Garrison Bus Stop with 0.306 µg/g and followed by FBT with 0.305 µg/g in the afternoon. RBTC had 0.227µg/g, while Mile 3 Park and Lagos Bus Stop had 0.226 µg/g and 0.174 µg/g respectively. The analysis also reveals that Pb concentrations in the evening in RBTC in Olu Obasanjo, Flyover Bus Terminal in Mile 1 (FBT), Mile 3 Park, Garrison Bus stop and Lagos Bus Stop was 0.184 µg/g, 0.339µg/g, 0.302µg/g, 0.185µg/g and 0.164µg/g respectively. The concentration of Pb in the evening was more in FBT and Mile 3 Park.

Result of the spatial and temporal concentrations of Pb in the study locations showed that the concentration of Pb was 0.248 µg/g, 0.103µg/g and 0.105µg/g in the morning, afternoon, and evening respectively on Mondays at RSTB Olu Obasanjo Road while the mean value of Pb concentration was highest in the afternoon with 0.351µg/g on Fridays at RSTB Olu Obasanjo. It is also revealed that the highest mean value of Pb concentrations was 0.562µg/g in the morning on Mondays and 0.367µg/g in the afternoon on Fridays at Flyover Terminal Bus Mile 1 Park. However, at Mile 3 Park, the highest mean value of Pb concentrations was observed in the morning on Mondays with a value of 0.317µg/g and also highest in the morning on Fridays with a value of 0.310µg/g. The highest mean value of Pb concentration was 0.416µg/g in the afternoon on Mondays and 0.225µg/g in the evening on Fridays in Garrison Bus stop. In the Lagos Bus Stop, the highest mean value of Pb concentration on white bread was observed in the evening with a value of 0.240 µg/g on Mondays and in the afternoon on Fridays with a value of 0.171µg/g. In addition and generally, the mean value of Pb concentration on bread was higher in the morning, afternoon and evening on Mondays than Fridays in Lagos Bus stop. The ANOVA of the spatial and temporal Pb concentration in bread is shown in tables 1and 2 respectively.

Table 1: ANOVA of Pb concentrations in bread among the bus terminals in Port Harcourt

	Sum of Squares	df	Mean Square	F-calculated	F-critical	Sig.
Between Groups	5.922	4	1.480	10.451	2.38	0.000
Within Groups	169.284	1195	0.142			
Total	175.206	1199				

The spatial variation of Pb concentration among the bus terminals indicates that F calculated was 10.451 while the F critical was 2.38. This means that the F calculated was higher than the F critical suggesting that there is significant variation in the Pb concentrations among the bus terminal examined in this study.

Table 2: Temporal Variation of Pb concentrations on bread among the bus terminals in Port Harcourt city.

	Sum of Squares	df	Mean Square	F-calculated	F-critical	Sig.
Between Groups	6.128	4	1.532	10.788	2.38	0.000
Within Groups	169.180	1195	0.142			
Total	175.308	1999				

Using the ANOVA, table 2 indicates that the F calculated was 10.788 while the F critical was 2.38. This means that there is significant temporal variation in the Pb concentrations on bread in among the bus terminals during the morning, afternoon and evening periods. Findings showed that Pb concentration in white bread varied among the selected bus terminals at different time of the day. This is confirmed in the study of John et al (2004) stating that contaminant varies from one source to another source and region to region in a city. The difference may be due to the different volumes of vehicles that ply the bus terminal at different time of the day.

The concentrations of Pb on bread on Mondays and Fridays among the bus terminals showed that the mean values of 0.152µg/g, 0.383µg/g, 0.290µg/g, 0.257µg/g and 0.211µg/g was experienced in RSTB, Flyover Terminal Mile 1, Mile 3 Park, Garrison Bus stop and Lagos Bus stop respectively on Mondays while on the mean values of Pb concentrations on bread on Fridays in RSTB, Flyover Terminal Mile 1, Mile 3 Park, Garrisson Bus Stop and Lagos Bus stop was 0.279µg/g, 0.355µg/g, 0.271µg/g, 0.200µg/g and 0.112µg/g respectively. It is therefore discovered that the highest mean value of Pb concentrations both on Mondays and Fridays was recorded in the Flyover Terminal Bus stop.

The mean concentrations of Pb on bread in the entire study area revealed that Pb concentration on bread in the morning, afternoon and evening was 0.271µg/g, 0.247µg/g and 0.235µg/g. This shows that the concentration was highest in the morning while the least was experienced in the evening in the study area.

Table 3: Spatio-temporal concentration of Pb in the study area

Locations	Time of the Day	N	Minimum (µg/g)	Maximum (µg/g)	Mean (µg/g)	Std. Deviation
RBTC Olu Obasanjo	Morning (7am-10am)	80	0.002	0.800	0.235	0.284
	Afternoon (12pm-2pm)	80	0.001	0.800	0.227	0.281
	Evening (5pm-7pm	80	0.001	1.500	0.184	0.319
	Morning (7am-10am)	80	0.005	3.500	0.464	0.649

Flyover Bus Terminal, Mile 1 Park	Afternoon (12 pm-2pm)	80	0.004	1.000	0.305	0.324
	Evening (5pm-7pm	80	0.001	2.000	0.339	0.484
Mile 3 Park	Morning (7am-10am)	80	0.003	1.000	0.314	0.326
	Afternoon (12pm-2pm)	80	0.010	1.500	0.226	0.321
	Evening (5pm-7pm	80	0.001	0.900	0.302	0.303
Garrison Bus Stop, Aba Road	Morning (7am-10am)	80	0.001	2.000	0.193	0.390
	Afternoon (12pm-2pm)	80	0.001	2.500	0.306	0.505
	Evening (5pm-7pm	80	0.001	2.000	0.185	0.397
Lagos Bus Stop	Morning (7am-10am)	80	0.001	0.900	0.147	0.279
	Afternoon (12pm-2pm)	80	0.003	1.000	0.174	0.280
	Evening (5pm-7pm	80	0.002	0.800	0.164	0.265
Total		1200				

The mean values of Pb concentrations on bread on Mondays and Fridays showed that it was 0.258μg/g and 0.243μg/g respectively. The temporal analysis of Pb concentrations on bread on Mondays and Fridays showed that Pb concentrations was 0.310μg/g, 0.236μg/g and 0.228μg/g in the morning, afternoon and evening respectively on Mondays, while for Fridays the mean values of Pb concentrations on bread in the morning, afternoon and evening was 0.231μg/g, 0.258μg/g and 0.241μg/g respectively.

The temporal and spatial analysis of daily vehicular counts indicates that 301 vehicles were recorded at RBTC Olu Obasanjo in the morning on Mondays while 392, 312, 310 and 306 vehicles were recorded in Flyover Mile 1, Mile 3 Park, Garrison Bus Stop and Lagos Park respectively at the same time on Mondays. It is also observed that 214, 345, 315, 309 and 302 vehicles were recorded in the morning on Fridays at RBTC Olu Obasanjo, Flyover Mile 1, Mile 3 Park, Garrison Bus Stop and Lagos Park respectively. However, Flyover Mile 1 recorded the highest average vehicle count in the afternoon on Mondays and Fridays while the least was discovered in RBTC Olu Obasanjo. The average daily vehicular count in the evening at all selected bus terminals was observed to be lower than that of morning and afternoon on Mondays and Fridays but the highest was still found in Flyover Mile 1 Park with 210 and 237 vehicles on Mondays and Fridays respectively. Generally, the highest average vehicular count was discovered in Flyover Mile 1 Park with 843 and 847 vehicles on Mondays and Fridays respectively while the least was discovered in RBTC Olu Obasanjo with 568 and 454 vehicles on Mondays and Fridays respectively. Considering the spatial variation among the time of the day (morning, afternoon and evening), it is observed that an average total of 3106, 1935 and 1629 vehicles were recorded in the morning, afternoon and evening at the selected bus terminals in the study area.

Relationship between Pb Concentration In Bread And Volume Of Vehicular Counts

The analysis of the volume of vehicular counts and Pb concentration in bread indicates that the regression coefficient (R) was 0.440 and the R square was 0.194. However with the coefficient of determination of 19.4% means that the volume of vehicular counts in the study area can explain 19.4% of the Pb concentrations in bread. This suggests that there are many other sources of Pb in the area which may include industries. The regression model explaining the relationship between the volume of vehicular counts and Pb concentrations in bread is giving in equation 1:

$$Y_{\text{Pb conc in bread}} = 0.056 + 0.001_{\text{Volume of vehicular counts}} \quad 11$$

The scatter diagram shows that a direct relationship exists between Pb concentration in bread and volume of vehicular counts (Fig. 1), though the relationship was moderate. The implication of the direct relationship existing between Pb concentration in bread and volume of vehicular counts in the selected bus terminals showed that the higher the volume of vehicular flow at the terminals, the higher the Pb concentrations in bread (fig.1)

Table 4: Model Summary of the relationship between vehicular flow and Pb concentration in bread at the bus terminals

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.440[a]	0.194	0.093	0.08051

a Predictors: (Constant), Volume of vehicular count

Table 5: Coefficients[a] of vehicular flow and Pb concentration in bread at the bus terminals

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.056	0.143		0.395	0.703
	Volume of vehicular counts	0.001	0.001	0.440	1.386	0.203

a. Dependent Variable: Pb Concentration in Bread

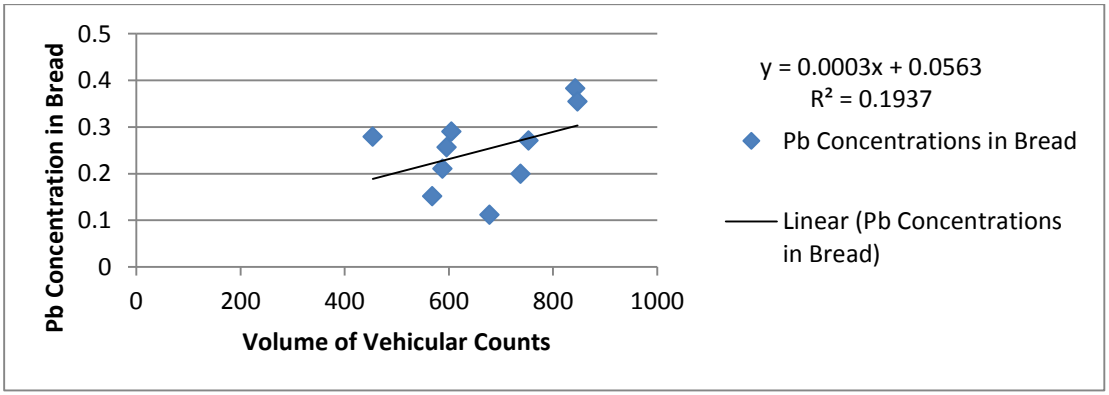

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Fig. 1: Scatter diagram of the relationship between Pb concentration in bread and volume of vehicular count.

There was a direct relationship between the volume of vehicular counts and Pb concentrations in bread. This shows that the higher the volume of vehicular counts the higher the Pb concentrations in bread. According to Suruchi and Khanna (2011), the lead emissions from motor vehicles contribute significant quantities of airborne lead in the ambient air near highways. In the same manner, the accumulation of Pb is closely related to traffic volume, vehicle type, topography and vegetation cover (Smith, 1976 cited in Sinegani, 2007).

The low coefficient of determination (19.4%) existing between Pb concentration in bread and volume of vehicular counts signified that there are other sources that contribute to the concentration of Pb in bread and the entire environment. According to John et al (2004), the categorical aspects of pollutants (inorganic and organic) come from different source of industrial activities and vehicle based emission. Inorganic pollutants and its compounds come from vehicle pollution and industrial emission. John et al (2004) confirmed in their study that lead concentrations were found to be highest in the industrial and densely vehicle traffic area. According to Suruchi and Khanna (2011), as human activities increases, especially with the increases in the modern technologies, pollution and contamination of the human food chain has become inevitable. The concentration of Pb on bread signified that food substance can act as interception for metal accumulation. Metal accumulation rate from atmospheric deposition in road side dust depends on sedimentation, interception and impaction (Kenworthy, 2004).

Relationship between Pb Concentration in Bread and Size of Bus Terminals

Table 6 presents the analysis of the size of bus terminals and Pb concentration in bread in the bus terminals. The Pb concentration in bread was the dependent variable (Y) while the size of bus terminals was the independent variable (X). Tables 7 and 8 explain the model summary and the coefficient respectively. The regression coefficient (R) was 0.775 and the R square was 0.600. Thus, the coefficient of determination was 60.0%. This shows that size of bus terminals in the study area can explain 60.0% of the Pb concentrations in bread. The regression model between the size of bus terminals and Pb concentrations in bread was:

$$Y_{\text{Pb conc in bread}} = 0.129 + 0.001_{\text{Size of bus terminals}} \qquad 12$$

The scatter diagram shows that a direct relationship existed between Pb concentration in bread and size of bus terminals in the study area (Fig. 2). The direct relationship proves that the larger the size of bus terminals the higher the Pb concentrations in bread.

Table 6: Size of bus terminals and Pb concentration in bread

SN	Size (Area (m^2)) X	Pb Concentrations in Bread Y
1	121.2	0.152
2	403.2	0.383
3	400	0.29
4	203.2	0.257
5	122.4	0.211
6	121.2	0.279
7	403.2	0.355
8	400	0.271
9	203.2	0.2
10	122.4	0.112

Source: Researcher's Fieldwork, 2013

Table 7: Model Summary of size of bus terminal and Pb concentration in bread

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.775[a]	0.600	0.550	0.05668

a Predictors: (Constant), Size of the bus terminal

Table 8: Coefficients[a] of size of bus terminal and Pb concentration in bread

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.129	0.039		3.266	0.011
	Size of the bus terminal	0.001	0.001	0.775	3.466	0.008

a. Dependent Variable: Pb Concentration in Bread

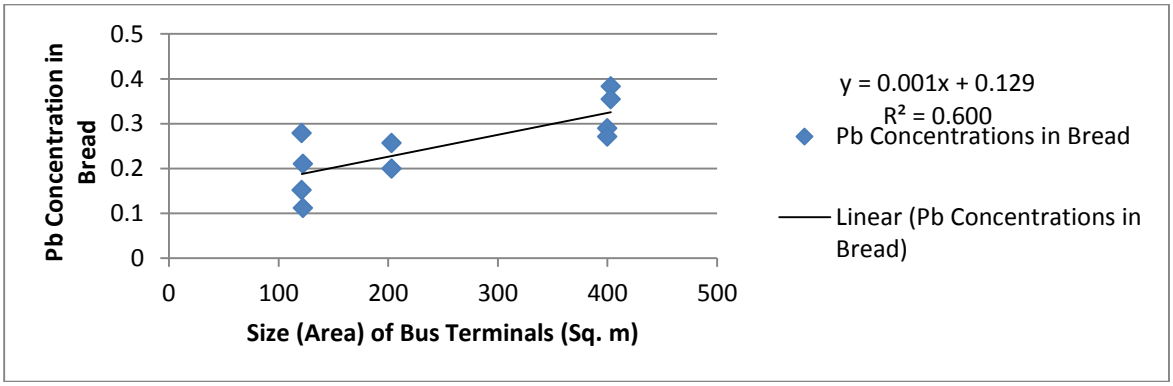

Fig. 2: Scatter diagram of the relationship between Pb concentration in bread and size of the bus terminals.

Results indicate that in most of the bus terminals, Pb concentration on white bread was higher in the morning (7-9am). This may be due to low speed of wind during this time because the calmness of the wind might make the Pb pollutant to be precipitated at the source of the pollution. Ogba and Utang (2009) stated that that 53 percent of the wind speeds in Port Harcourt is less than 3.1 m/s, suggesting generally low pollutant diffusion. The landuse which is predominantly built up area may cause the low wind speed and according to Ralph (1967), high building to land ratio (ratio of the area covered by buildings to the area of the plot) and high floor area ratio (ratio of total building square footage to the area of the plot) result in high aerodynamic surface roughness which can cause a weak wind speed; hence low pollutants diffusion. More importantly, Hung et al (2005) and Tsai et al (2004) stated that in case of wind speed below $2ms^{-1}$, the concentration of pollutants increase and becomes uniformly distributed around areas within the source zones, while stagnant weather conditions with low wind speed contributes to accumulation of pollutants at ground level (Jacobs et al, 2002, in Hung et al, 2005).

The general higher mean value of Pb concentration on bread in Flyover Mile 1 and Mile 3 could also be attributed to the higher volume of vehicular counts observed in these bus terminals. It could also be attributed to the bigger size of these bus terminals. The vehicular counts on Mondays and Fridays in Flyover Mile 1 and Mile 3 Park were higher. The higher Pb pollutant on bread in the morning could also be justified by the higher vehicular count experienced in the morning. The study further revealed that the premium motor spirit contained Pb with a mean value of 0.82 mg/l. This is quite higher than the World Health Organization (WHO) standard between 0.0000005mg/l and 0.000001mg/l (WHO, 2005). This shows that the level of lead in the PMS was injurious to the environment and the residents in the city of Port Harcourt are in serious health risk. Sinegani (2007) affirmed that lead is widely used as an intermediate for tetra-alkyl lead antiknock additives for motor fuels. This usage introduces large amount of lead into the atmosphere (Navas-Acien, 2007) which accumulates in the upper layer of soil (0-5 cm) (Wild, 1993).

Specifically, this study revealed that the concentration of Pb was observed in the bread used for the study in different study locations at different times of the day. The mean values of Pb concentrations in bread was highest in Flyover Mile 1 Park in the morning, afternoon and evening with a value of 0.464 μg/g, 0.305μg/g and 0.339μg/g while the least concentration in the morning, afternoon and evening was observed in Lagos Bus Stop with a mean value of 0.147μg/g, 0.174μg/g and 0.164μg/g respectively. Generally, the Pb concentration in bread was highest in the morning and least in the evening with a value of 0.271μg/g and 0.235μg/g. On the selected days for the study (Mondays and Fridays), it was discovered that generally, Pb concentrations in bread was higher on Mondays than Fridays though it was a slight variation. The volume of vehicular count was highest in Flyover with a total of 843 vehicles on Mondays and 847 vehicles on Fridays. Similarly, the volume of vehicular counts was highest in the morning with a total count of 3106 vehicles and least in the evening with a total count of 1629 vehicles. However, the size of the bus terminals also differs with the largest being observed in the Flyover Mile 1 Park with a value of 403.00 sq m while the least was discovered in RBTC Olu Obasanjo with a value of 121.20 sq. m. It equally showed that a direct relationship existed between the concentration of Pb in bread in bus terminals and volume of vehicular counts but the R square was 0.194. Similarly, the relationship between the concentration of Pb in bread and the size of bus terminals was a direct relationship with R square of 0.600. This implies that the size of the bus terminal accounted for 60% of the

variation in the concentration of Lead on bread. Similarly, the study revealed that the larger the size of the bus terminals, the higher the Pb concentration on bread.

IMPLICATIONS TO RESEARCH AND PRACTICE

Based on the findings of this study, the following are the implications of the research in practical terms.

1. Government should promulgate laws that will stop the sales of bread at the bus terminals.
2. There should be proper monitoring team that can control the activities of bread sellers at the bus terminals
4. The use of leaded petrol should be discouraged totally in Port Harcourt city
5. The octane rating of the petrol should be improved but not with lead additives.
6. There should public enlightenment campaigns to discourage people from consuming bread sold at bus terminals.
7. There is need for regular monitoring of bread in the area.
8. People should always go for medical test periodically at most six months interval.

CONCLUSION

It can be concluded that the study has revealed the spatial and temporal variations of Pb concentration in bread in different bus terminals in Port Harcourt metropolis. The study however showed that both size of the bus terminal and the volume of vehicular counts have influence on the concentration of Pb in bread. It is clear now that this study represents an eye opener to various food items exposed by the road side or bus terminals because of the possible deposition of heavy metals such as Pb on such food. Once consumed, it is good to seek the attention of medical practitioner for proper treatment.

FURTHER RESEARCH.

Further research should be encouraged in the area of identifying the level of Lead on the blood samples of Port Harcourt residence to unravel the presence of this silent killer.

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