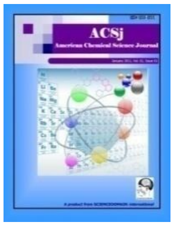

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# Determination of Pb in Ibadan Metropolis —An Indication of Environmental Pollution

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author JDO designed the study, performed the field work, wrote the protocol, and wrote the first draft of the manuscript. Author OO verified the field results and coordinated laboratory work, authors KJA and DAI analyzed laboratory results and managed the statistical analyses of the study. Author AMA managed the literature searches. Author ARA interpreted the results. All authors read and approved the final manuscript.*

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## ABSTRACT

This study determined the Pb pollution levels of lead (Pb) in Ibadan. Until 1970, Ibadan was the largest city in Sub-Saharan Africa and the current largest city in West Africa. Dust samples were randomly collected from selected sites, cleaned, air-dried and sieved. Pb level was determined in the samples by partial metal extraction. The average level of Pb in the house-hold dust of houses around heavy traffic areas was the highest followed by industrial area and then housing estate. It was observed that the Pb content decreased with increase in house distance from industrial area; there was rapid decrease in the level of Pb with distance. The result suggested that residential

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houses should be situated far away from industrial and heavy traffic areas and there should be authorized guidelines for placing industrial estates and major roads.

*Keywords: Household dust; lead; partial metal extraction; Ibadan; temperature.*

## 1. INTRODUCTION

The introduction of harmful substances into the environment has been shown to have many adverse effects on human health, agricultural products and natural ecosystem. Many of the chemical substances have been held culpable for the major or minor ills to which we are prone, they are pesticides and herbicides, preservatives, fertilizer-wastes and several metals including mercury, cadmium, Pb and most recently, aluminium all have their detractors. These are heavy metals which are grouped among pollutants that arouse public interest due to the potential health hazards they posed. Metals are naturally distributed in all phases of the environment, but as a result of technological processes, they often occur at much higher concentration or in different chemical forms other than those naturally present [1].

The notion that heavy metals like Pb in petrol is harmful to the health of the general populace and children in particular seems to have arisen from the knowledge that tetraethyl Pb (TEL), which is one of the principal anti-knock agents added to petrol to improve the octane number rating, is extremely toxic. Young children, who are undergoing physical and mental development, are more susceptible to the adverse health effects and more prone to be exposed to Pb-contaminated soil within the environment [2].

Pollution occurs as a result of anthropogenic activities which concentrate the emissions and discharges in settlement and work areas. Anthropogenic emissions and its waste charges increase as population increases and industries expand; and as people become more affluent, life styles and wastes increase [3]. Wastes which are pollutants sources can produce harmful effects of biological, chemical, physical, mechanical or psychological nature. Pb poison is not a by-product of our modern technology. Pb has been known to mankind since 2500 B.C. Pb toxicity was recorded by ancient Greek and Arab physicians [4].

Pb adversely affects a number of systems in the body. It gets into man through his diets and inhalation. Pb is a general protoplasmic poison that is cumulative, slow acting and subtle and produces a variety of symptoms. Pb inhibits the synthesis of haemoglobin and also shortens the lifespan of erythrocytes resulting in anaemia. The central nervous system is adversely affected by Pb. The symptoms include restlessness, dullness, irritability and memory loss. It can also cause muscular pain and headaches. In extreme cases, convulsion followed by coma and death may occur [5]. Pb causes discoloration of the teeth and mucous membrane of the mouth. A portion of the gums nearest the teeth assume a bluish or slate-grit colour. The effects of Pb poisoning after prolonged exposure are encephalopathy, renal tubular dysfunction, impairment of thyroid and adrenal function.

Ibadan is the Capital city of old Western State and at present capital city of Oyo State in Nigeria. It is the second largest city in Nigeria with current population estimated above 4 million. It is one of the urban settlements thought to be more susceptible to Pb pollution. The city is industrialized and her population resulted to heavy traffic jams in some significant areas. The aim of this study is to determine the level of Pb in the house-hold dust of selected houses around industrial areas, heavy traffic areas and isolated areas as an indicator of Pb pollution in Ibadan metropolis. This knowledge will be adopted by settlement developers to guide against Pb pollution.

## 2. MATERIALS AND METHODS

Seventy-five household dust samples were randomly collected in which twenty-five samples were collected from each of the three areas of study; industrial area, heavy traffic and housing estate area in Ibadan metropolis. Twenty-five houses were chosen from each sampling area to obtain samples that represent the region of contamination in the above mentioned areas. The samples were taken to the laboratory, air-dried at room temperature for 2 days. Objects such as sticks, papers, etc., were removed from the air-dried samples. The samples were sieved through a 0.15 mm aperture mesh. The sieved samples were then labeled and stored inside self-sealed nylon for subsequent analysis. Table 1, shows the areas representing the levels of Pb contamination of houses in Ibadan metropolis. Tables 2, 3 and 4, show the number of samples collected within the said areas.

## 2.1 Extraction of Pb

Samples were digested and extracted for heavy metals analysis using the method of Anderson [6], which estimates the ecologically significant fraction of soil metal. Pb level was determined in all the soil samples by partial metal extraction with 2 M – nitric acid. 2. 00 g of sieved dust samples was weighed and transferred quantitatively into digestion beaker with seal. The dust samples were extracted with 20 ml of 2 Molar $HNO_3$ for 2 hours in water bath at 100°C. The digested solution was removed after 2 hours, allowed to cool, filtered into 50 ml volumetric flask and rinsed with deionized water and transferred into transparent plastic reagent bottle. The blank was carried out using 2 Molar $HNO_3$ without dust sample for quality assurance, for every 25 samples.

## 2.2 Determination of Pb by Atomic Absorption Spectrophotometry

Pb in the extract was determined using a bulk scientific model 200A atomic absorption spectrophotometer with an air-acetylene flame (HGA 600, model 3300 Perkin Elmer).

## 3. RESULTS AND DISCUSSION

The levels of Pb in relation to the study areas are shown in Table 5. The T-test analysis of the Pb levels for Heavy Traffic Area and Industrial Area with respect to control areas are as shown in Tables 6a and 6b respectively. While the levels of Pb at different sampling zone for Heavy Traffic Areas are shown in Table 7 that of industrial area in relation to proximity to industrial area is shown in Table 8.

Since t Stat is greater than t Critical, that is (t Stat (4.28) > t Critical (2.01)) and P value < Alpha value, that is (8.84977E-05 < 0.05). We reject the null hypothesis that the means are the same. Since we are not accepting the hypothesis of equal means, we can conclude that there is statistically significant difference between Heavy Traffic Area and Isolated Area (Control) in their Pb concentration.

Since t Stat is greater than t Critical, that is (t Stat (3.014) > t Critical (2.01)) and P value < Alpha value, that is (0.00411 < 0.05). We reject the null hypothesis that the means are the same. Since we are not accepting the hypothesis of equal means, we can conclude that there is statistically significant difference between Heavy Traffic Area and Isolated Area (Control) in their Pb concentration.

Generally, high level of Pb was observed (Table 5). for Industrial and Heavy Traffic areas compared to Control area. T-Test was used to analyze the difference in Pb level between house-hold dust around heavy traffic areas and industrial areas with respect to control areas. The results pointed to a statistically significant Pb level pollution (Tables 6a and 6b).

The Pb level in different heavy traffic areas are shown in Table 7. The average Pb levels in the household dust of houses around Gate, Beere, Ojoo and Sango are 181.61µg/g, 154.71 µg/g, 225.33 µg/g and 218.00 µg/g respectively. The highest average Pb level was obtained from Ojoo (225.33 µg/g) and the least average Pb level was from Beere Area (154.71 µg/g). This difference in Pb levels is due to difference in traffic density.

There have been reports of higher levels of Pb in household dust of houses around commercial and heavy traffic areas. Average Pb level of (1600 –2400) mg/kg was reported in mid-western cities in U.S.A. [7], 1514 µg/g in Caracas, Venezuela [8] and 1040 – 1440 µg/g in Cincinati, Ohio [9]. In industrial area, the levels of Pb declined rapidly with distance of the houses and were below the background levels obtained at the control area.

**Table 1. Study areas and their location**

| Industrial areas | Heavy traffic areas | Housing estates |
|---|---|---|
| Oluyole Industrial Estate | Gate, Beere, Ojo and Sango | Akobo Estate, Bodija Estate, Jericho quarters and Agodi G.R.A. |

**Table 2. Number of samples collected in industrial areas**

| Distance from industrial site | Number of samples |
|---|---|
| 50 – 100 m | 7 |
| 100 – 200 m | 6 |
| 200 – 500 m | 6 |
| > 500 m | 6 |

**Table 3. Number of samples collected in heavy traffic areas**

| Areas | Number of samples |
|---|---|
| Gate | 7 |
| Ojoo | 6 |
| Beere | 6 |
| Sango | 6 |

The average Pb levels in the house-hold dust of houses at distance (50–100 m) was 601.78 µg/g, while its average level at distance (100 – 200 m) from the industrial area was 169.13 µg/g. There is about 73.26% reduction in Pb level at a distance (100 – 200 m) from the industrial area.

**Table 4. Number of samples collected in isolated areas (Estate)**

| Estate | Number of samples |
|---|---|
| Agodi GRA | 7 |
| Bodija | 6 |
| Akobo | 6 |
| Jericho | 6 |

Its levels had reduced by 95.4 and 99.5% respectively at a distance (200 – 500 m) and above 500 m from the industrial area compared to distance (50 - 100 m) in Table 8.

The rapid decrease in the levels of Pb with distance from the industrial area was an indication that industrial emissions play a significant role in the levels of Pb in the house-hold dust.

**Table 5. Pb levels in the House-hold dust of Houses around Heavy**

| S/N | ID (µg) | CD (µg) | HV (µg) | |
|---|---|---|---|---|
| 1 | 313.25 | 71.00 | 202.00 | (G) |
| 2 | 211.25 | 145.25 | 253.00 | (G) |
| 3 | 102.00 | 53.75 | 197.00 | (B) |
| 4 | 95.75 | 43.75 | 428.50 | (B) |
| 5 | 112.75 | 77.25 | 207.00 | (J) |
| 6 | 84.00 | 163.25 | 183.25 | (J) |
| 7 | 212.50 | 43.75 | 315.25 | (J) |
| 8 | 342.25 | 68.75 | 240.50 | (S) |
| 9 | 345.75 | 77.50 | 184.00 | (S) |
| 10 | 382.00 | 219.50 | 418.75 | (S) |
| 11 | 109.25 | 46.25 | 92.25 | (B) |
| 12 | 116.75 | 33.75 | 230.75 | (G) |
| 13 | 134.25 | 26.25 | 118.50 | (B) |
| 14 | 207.00 | 63.75 | 304.25 | (J) |
| 15 | 145.50 | 72.50 | 217.00 | (S) |
| 16 | 35.25 | 68.75 | 259.25 | (G) |
| 17 | 85.75 | 50.00 | 276.75 | (J) |
| 18 | 378.00 | 65.00 | 154.75 | (S) |
| 19 | 102.25 | 30.00 | 198.25 | (G) |
| 20 | 401.75 | 101.11 | 17.50 | (B) |
| 21 | 313.25 | 133.50 | 67.50 | (J) |
| 22 | 39.50 | 81.25 | 61.25 | (G) |
| 23 | 182.00 | 151.00 | 75.00 | (B) |
| 24 | 1141.00 | 47.00 | 96.00 | (S) |
| 25 | 106.25 | 284.25 | 67.50 | (G) |
| Mean | 227.97 | 88.72 | 194.63 | |
| SD | 222.44 | 61.21 | 104.61 | |

*Traffic areas (HV), industrial areas (ID) and isolated areas/control (CD)*

**Table 6a. T-test (two samples assuming equal variances)**

| | Variable 1 | Variable 2 |
|---|---|---|
| Mean | 194.63 | 88.7044 |
| Variance | 11399.63604 | 3904.826776 |
| Observations | 25 | 25 |
| Pooled variance | 7652.231409 | |
| Hypothesized mean ifference | 0 | |
| df | 48 | |
| t Stat | 4.281164265 | |
| P(T<=t) one-tail | 4.42489E-05 | |
| t Critical one-tail | 1.677224196 | |
| P(T<=t) two-tail | 8.84977E-05 | |
| t Critical two-tail | 2.010634758 | |

*Heavy traffic area (variable 1) versus control area (variable 2)*

The average levels of Pb at different control areas are shown in Table 9. The range of level of Pb in Akobo estate, Bodija estate, Jericho quarters and Agodi G.R.A. areas are: 30 – 145.25 µg/g, 43.75 – 284.25 µg/g, 26.25 – 72.50 µg/g and 47.00 – 219.50 µg/g, respectively. Also the average Pb levels in the same order are: 70.17 µg/g, 113.96 µg/g, 52.50 µg/g and 121.51µg/g. This shows that average Pb level in Jericho quarters was the least while that of Agodi G.R.A. was the highest.

**Table 6b. T-test (two samples assuming equal variances)**

| | Variable 1 | Variable 2 |
|---|---|---|
| Mean | 227.97 | 88.7044 |
| Variance | 49479.96521 | 3904.826776 |
| Observations | 25 | 25 |
| Pooled Variance | 26692.39599 | |
| Hypothesized mean difference | 0 | |
| df | 48 | |
| t Stat | 3.013735137 | |
| P(T<=t) one-tail | 0.002056347 | |
| t Critical one-tail | 1.677224196 | |
| P(T<=t) two-tail | 0.004112694 | |
| t Critical two-tail | 2.010634758 | |

*Industrial area (variable 1) versus control area (variable 2)*

The high value of Pb in Bodija estate and Agodi was due to its closeness to traffic areas while Akobo Estate and Jericho Quarters have low concentration of Pb because of their distance to high density traffic.

**Table 7. Pb (Pb) levels (µg/g) at different sampling location in heavy traffic areas**

| S/N | G | B | J | S |
|---|---|---|---|---|
| 1 | 202 | 197 | 207 | 184 |
| 2 | 253 | 428 | 183.25 | 418.75 |
| 3 | 230.75 | 92.25 | 313.25 | 240.5 |
| 4 | 198.25 | 118.5 | 304.25 | 217 |
| 5 | 259.25 | 17.5 | 276.75 | 154.75 |
| 6 | 61.25 | 75 | 67.5 | 96 |
| 7 | 67.5 | | | |
| Mean | 181.61 | 154.71 | 225.33 | 218 |
| S.D | ± 77.15 | ± 133.46 | ± 85.26 | ± 100.70 |

*S.D implies standard deviation*

**Table 8. The levels of Pb µg/g in relations to distance from industrial area and percentage reduction in the Pb level from the industrial area**

| Sample no. | Distance | | | |
|---|---|---|---|---|
| | 50 - 100 (m) | 100 – 200 (m) | 200 – 500 (m) | > 500 m |
| 1 | 1141.00 | 313.25 | 27.75 | 6.25 |
| 2 | 1327.50 | 62.25 | 34.00 | 2.00 |
| 3 | 378.00 | 382.00 | 10.50 | 1.25 |
| 4 | 342.25 | 109.00 | 39.00 | 2.81 |
| 5 | 39.50 | 116.75 | 35.25 | 2.00 |
| 6 | 382.40 | 31.50 | 27.75 | 1.75 |
| Mean | 601.78 | 169.13 | 29.04 | 2.68 |
| Standard deviation | 465.32 | 130.90 | 9.21 | 1.66 |
| Percentage reduction | | 73.26 | 95.4 | 99.56 |

**Table 9. levels of Pb (µg/g) at the control area**

| | Akobo estate | Bodija estate | Jericho quarters | Agodi G.R.A. |
|---|---|---|---|---|
| | 71 | 163.25 | 33.75 | 219.5 |
| | 145.25 | 43.75 | 26.25 | 101.11 |
| | 53.75 | 68.75 | 63.75 | 133.5 |
| | 43.75 | 77.5 | 72.5 | 151 |
| | 77.25 | 46.25 | 68.75 | 47 |
| | 30 | 284.25 | 50 | 65 |
| | | | | 133.5 |
| Mean | 70.17 | 113.96 | 52.5 | 121.51 |
| Standard deviation | ± 37.12 | ± 85.94 | ± 17.50 | ± 53.34 |

## 4. CONCLUSION

This study shows that, the average Pb level in the house-hold dust of houses around both industrial and heavy traffic areas (227.97 and 144.63) µg/g are in contaminant level (100 - 400) µg/g. In industrial area, the houses situated between (50 – 100) m to the industrial area are in danger. This is because the average Pb level 601.78 µg/g is beyond the contaminant level (100 - 400) µg/g which is the critical concentration at which pollution occurs.

It can be concluded from this study that vehicle Pb-based emission and gasoline related sources are major contributors to the elevated levels of Pb compared to their baseline in the control site. Therefore, there is an urgent need for the phasing out of Pb additives in fuel and its removal from gasoline as soon as practicable to prevent an environmental health calamity caused by Pb and to safeguard the safety of the public. In the case of residential houses around industrial area, the industrial emissions render the immediate environment around industrial area unsafe. The results also suggest that residential houses should be sited far away from both heavy traffic and industrial areas and there should be approved guidelines for placing structures. There should be room for more isolated areas to safeguard the next generation from a growing carcinogenic environment.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Forstner U, Wittman GTU. Metal pollution in the aquatic environment. Springer Verlag, Berlin; 1979.
2. Centers for Disease Control (CDC). Preventing Pb poisoning in young children. US Dept. of Health and Human Services, A report to Congress US Public Health, Atlanta, Georgia; 1991.
3. Odiette WO. Environmental physiology and animals pollution. Diversified Resources Ltd. 1999;(169):181-192.
4. Ademoroti CMA. Environmental chemistry and toxicology. 2nd edition. Foludex press limited. Ibadan; 1996.
5. Crusselin E, Robert R, Smith P, Harold CH. Clinical toxicology of commercial products. Williams and Wilkins Balhmore, 5th Edition. 1984;7–111.
6. Anderson A. On the determination of ecologically significant fractions of heavy metals in soils. Swedish J. Agric Res. 1976;6:19-25.
7. Washington DC. National Academy of Sciences, (NAS). Airborne Pb in Perspective; Natural Research Council. 1972;289:1016-1052.

8. Garcia-Miragaya J, Castro S, Paolini J. Pb and zinc levels and chemical fractionation in road side of caracas, venezuela. Water, Air and Soil Pollution. 1981;15:285-297.

9. Que Hee SS. Evolution of efficient methods of sample Pb sources, such as house dust and hand dust in the homes of children. Environ Res. 1985;8:77–95.



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