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# Heavy Metal Contents in Topsoil of Selected Public Primary Schools Playground in Benin Metropolis, Nigeria

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**ABSTRACT:** This study was carried out to determine some physicochemical properties and heavy metals level in primary school playground located in Benin City, Southern Nigeria using standard methods. A total of 10 topsoil samples were collected from five primary school playgrounds from different locations in Benin metropolis, Southern Nigeria in February, 2017. The mean levels of pH and EC ranged from 5.53 to 7.02 and 200.05 - 410.00 µS/cm respectively. The mean concentrations for heavy metals ranged from 337.15±64.28 and 464.10±19.37 for Fe, 23.40±7.50 and 29.70±4.81 for Mn, 45.95±8.70 and 67.95±4.74 for Zn, 8.48±1.61 and 12.90±3.82 for Cu, 5.10±2.33 and 7.41±1.54 for Cd, 4.42±2.02 and 8.39±7.09 for Cr, 6.17±2.82 and 13.82±6.76 for Pb, 0.99±0.09 and3.24±3.73 for Ni respectively. Heavy metal concentrations were in the following order. In Ogiegbaen, Eresoyen and Ekosodin Primary schools (PS) playground, the order was Fe> Zn> Mn> Cu> Pb> Cd> Cr> Ni while the order in Agbado PS and Olua PS were Fe> Zn> Mn> Cu> Pb> Cr> Cd> Ni and Fe> Zn> Mn> Pb> Cu> Cd> Cr> Ni respectively. Enrichment factor (EF), Contamination factor (CF) and Geoaccumulation index (Igeo) were used to evaluate the pollution status of the soil.

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Soil parent material imparts a natural range of concentration of metals including heavy metals in soil. The soil of the urban environment receives higher load of metals than that of their rural environment from traffic and industries and, since metals are rather immobile once they reach the soil system, accumulation occurs resulting in levels that can be harmful to humans including children, upon repeated exposure (Thornton, 1991). As population increases in urban areas, good quality of soil is essential to the health of the urban inhabitants (Li *et al.*, 2001). Children in particular are more susceptible to the adverse health effects of soil metal pollution especially from the heavy metal due to their small body size, developing nervous system and high absorption rate (Li *et al*., 2001). Maddaloni *et al*., 1998 reported that ingested Pb that is absorbed in an adult's body is typically less than 5%, in contrast to that of children which is as high as 50% due to their less developed gastrointestinal tract. In recent years, environmental contaminants including heavy metals such as arsenic, lead and mercury, which can be quite harmful if ingested have become increasingly common in our surroundings (Miguel *et al*., 2007). Heavy metal which are among the more serious pollutants in the human environment because of their toxicity, persistence and bioaccumulation characteristics (Annao *et al*., 2008), have been implicated in the upsurge of liver and kidney diseases, pains in bones, mutagenic, carcinogenic and teratogenic effects (Alloway and Ayres, 2002; Orisakwe *et al*., 2012, Jaradat and Monani, 1999), neurological disorders, especially in the fetus and in children which can lead to behavioral changes and impaired performance in IQ tests (Alloway, 1995). Children have the propensity to explore the world through their mouth and are therefore exposed to heavy metals contamination via absorption through skin, food, ingestion of treated materials such as wood, contaminated soil and inhaling of contaminated air (Evelyn *et al*., 2015). Children also ingest more soil than adults via the hand-to-mouth pathway and when they put dirty hands and objects into their mouths (Lanphear and Roughmann, 1997; Schutz *et al*., 1997). Soil ingestion has been recognized as an equally important exposure route of contaminants to humans as water and food ingestion (McKone and Daniels, 1991), especially for children up to the age of six due to their hand-to-mouth behaviour (Mielke and Reagan, 1998). Soil ingestion and soil metal exposure are also dependent on the time spent outside and the location of the outdoor playing facilities. While some children in urban areas have

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private gardens for outdoor activities, others are confined to public playgrounds. In Benin City where the present study was carried out, children within the age bracket of 2–5 attend some type of day-care/nursery education center, while nearly all 6-year olds attend elementary classes at either private or public primary schools were they spend part of their outdoor time in the playground and in the process are exposed to biological, physical and chemical hazardous contents of the soil. Some of the educational centers in Benin City are situated close to high traffic area for sole purpose of easy accessibility thus the rate of accumulation of heavy metal in the soil via vehicle exhaust; industrial and other commercial activities are likely to be high. Few studies have investigated children's playgrounds in Nigeria (Evelyn *et al*., 2015). No report currently exist on the status of contamination of public schools playgrounds by heavy metals in Benin City in spite of the fact that these playgrounds present themselves as appropriate targets for the accumulation of heavy metals because of the bare nature of the soil. Comprehensive information about these metals is of primary importance to detect unusual concentrations, predict outbreaks of possible health problems and formulate preventive measures to curb possible health defects. The objective of this study is therefore to determine some physicochemical properties and heavy metals level in primary school playground in Benin City, Southern Nigeria.

## MATERIALS AND METHODS

*Study Location Area:* This research was conducted in Benin City, Edo State ($6^{o}$20'00N, $5^{o}$37'20E) (Fig. 1). Criteria such as population activity, traffic density and road sections were considered while selecting the sample sites. The soil samples were collected and their geographic coordinates recorded with a global positioning system (GPS) at five different sites within Benin metropolis. Site 1: Eresoyen Primary School, Oluku, Ovia North East ($6^{o}$ 26' 55'' N $5^{o}$ 35' 50'' E), Site 2: Ekosodin Primary School, Ekosodin Ovia North East ($6^{o}$ 24' 31'' N $5^{o}$ 37' 36'' E), Site 3: Olua Primary School, Egor ($6^{o}$ 21' 43'' N $5^{o}$ 37' 5'' E), Site 4: Agbado Primary School, Oredo ($6^{o}$ 20' 22'' N $5^{o}$ 37' 49''E,) Site 5: Ogiegbaen Primary School, Ikpoba Okha ($6^{o}$ 20' 39'' N$5^{o}$ 41' 27'' E).

*Micro climate of the study area:* According to UNDP, (2006), the rain pattern is characteristics of the rainforest zone with mean rainfall of 3000mm (Agbaire and Emoyan, 2012) which is distributed between April to October, followed by marked dry season (of up to four months) November to February. The ranges of maximum and minimum temperatures are high and fairly constant throughout the year while the average monthly temperature for the warmest months ranged from 28ºC to 33ºC and the average monthly temperature for the coolest month ranges from 22ºC to 26ºC.

*Sample Collection:* Soil samplings were collected at random in the primary school playgrounds. Three discrete soil samples were collected from each of the selected point and pooled to form a composite sample. Two replicate samples were collected from each primary school playground, making it a total of 10 samples. The number of samples collected at each point was based on the circumstances that existed at the point of collection including the spots were the children played during breaks in the playground. About 100 g of topsoil was collected with a hand trowel into a polyethene bag and labeled before taken to the laboratory (Robertson, 2003). This method was used because it is easier and more readily available. Samples were collected once in the month of February, 2017.

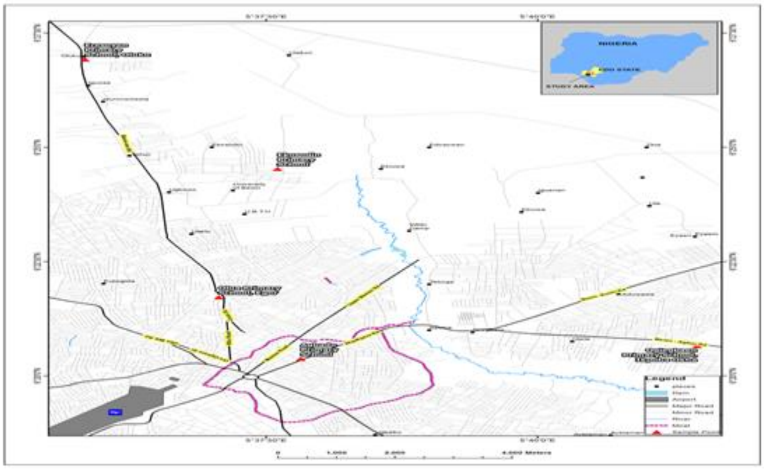

**Fig 1:** Map of Benin City showing the sampling sites

*Soil Sample preparation:* The soil samples collected were air-dried at room temperature $25^{o}$ C – $27^{o}$ C for two to three days, thereafter samples were crushed and sieved through a 2mm sieve and packed in well labelled sample cups for laboratory analysis. The samples were analysed for the following chemical properties using defined procedures. Soil pH was measured and Electrical conductivity were determined according to the method of Davey and Conyers (1988) and APHA (2005) respectively. Necessary precautionary quality assurance measures were observed to prevent sample contamination.

*Heavy metal analysis:* Heavy metals were analysed at the Ecotoxicology laboratory, University of Benin, Benin City. Sample digestion and the determination of the heavy metal concentration were carried out according to the method of the Association of Analytical Chemists, (AOAC, 2000). After the digested samples have been cooled, the mixture was diluted with distilled water to 100 ml and subsequently analysed by using Atomic Absorption Spectrophotometer (AAS Bulk Scientific 210 VGP) to determine the concentrations of Copper (Cu), Manganese (Mn), Lead (Pb), cadmium (Cd), Zinc (Zn), Iron (Fe), Chromium (Cr) and Nickel (Ni).

*Statistical analysis:* All the data obtained were subjected to descriptive analysis, (measure of central tendency and dispersion) to characterize the samples.The comparison of each study area was carried out to test for significant differences in the chemical conditions using parametric analysis of variance (ANOVA). If significant value (P<0.05) were obtained in the ANOVA, Duncan multiple range (DMR) test was performed to determine the location of significant difference. All data analyses including Enrichment Factor, Contamination Factor (CF), Pollution Load Index (PLI), and Geo-accumulation Index (Igeo), were done using SPSS 20.00 version and Microsoft excel (2003) windows application.

Assessment of soil contamination: The: Evaluation of Data – Risk Assessment: Enrichment Factor (EF)
The formula for enrichment factor (Levy *et al.,* 1992) is stated below

$$\mathrm{EF} = \frac{\left(\frac{\mathrm{X}}{\mathrm{Fe}}\right)_{\mathrm{soil}}}{\left(\frac{\mathrm{X}}{\mathrm{Fe}}\right)_{\mathrm{background}}}$$

Where EF = enrichment factor, $(X/Fe)_{soil}$ is the ratio of heavy metal (X) to Fe in the soil samples. According to Sutherland (2000), five categories are generally recognized on the basis of enrichment factor (EF).

When EF < 2 depletion of mineral enrichment or no enrichment; 2≤EF<5 moderate enrichment; 5≤EF<20 significant enrichment; 20≤EF<40 very high enrichment; EF>40 extremely high enrichment

*Pollution Load Index (PLI) and Contamination Factor (CF):* The contamination factor (CF) and pollution load index (PLI) are expressed as follows:

$$\mathrm{CF} = \frac{\mathrm{C}_{\text{metal concentration}}}{\mathrm{C}_{\text{background concentration of the metal}}}$$

It is assessed as the ratio obtained by dividing the concentration of each metal in the soil by baseline or background value (concentration in uncontaminated soil):

$$CF_{metal} = \frac{C_{metal}}{C_{background}}$$

According to Hakanson (1980), CF values were interpreted as follows: If CF < 1: it means that low contamination exists. If 1 < CF > 3: it means that moderate contamination exists. If 3 < CF < 6: it means that considerable contamination exists. If CF > 6: it means that very high contamination exists. While PLI can be expressed as

$$PLI\ of\ a\ study\ area = n\sqrt{C_f^i\ 1 \times C_f^i\ 2 \times C_f^i\ 3 \times C_f^i\ \ldots \times C_f^i\ n}$$

For assessing the level of heavy metal pollution this empirical index provides a simple, comparative means. When PLI > 1, it means that a pollution exists; otherwise, If PLI < 1, there is no metal pollution.

*The geo-accumulation index (Igeo)* is expressed by Muller, (1969) as:

$$\mathrm{I}_{\mathrm{geo}} = \frac{\log^2(\mathrm{C_n})}{1.5(\mathrm{B_n})}$$

Where $C_n$ is the metals concentration in soil samples and $B_n$ is the geochemical background concentration of the metal (n). Factor 1.5 is the background matrix correction factor due to lithospheric effects. The Igeo index consists of seven classes ranging from practically unpolluted to extremely polluted.

Class 0 (practically unpolluted): Igeo ≤ 0; Class 1 (unpolluted to moderately polluted): 0<Igeo<1; Class 2(moderately polluted): 1<Igeo<2; Class 3 (moderatelyto heavily polluted): 2<Igeo<3; Class 4 (heavily polluted):3<Igeo<4; Class 5 (heavily to extremely polluted):4<Igeo<5; Class 6 (extremely polluted):5>Igeo

## RESULT AND DISCUSSION

*Physical and chemical characteristics of Soil*: The results of the chemical characteristics including pH, electrical conductivity and the heavy metals concentrations of soil samples obtained from the selected primary schools (PS) playgrounds within Benin Metropolis (in mean and standard deviation for each parameter) are given in Tables 1. Continual urbanization and industrialization induces heavy metals emissions into our environment which may greatly affect human health. Pollution of surface soil with toxic heavy metals has become a major global concern due to growing health risks to the public (Ahmed and Ishiga, 2006; Khashman, 2007). The pH of a soil is one of the most frequently measured parameters due to the importance of pH in regulating numerous processes. The pH gives an indication of the acidity or alkalinity and this makes it valuable for soil characterization. Many chemical reactions are pH dependent and knowledge of the pH can be useful in predicting the extent and speed of chemical reactions (Radojevic and Bashkin, 1999). The pH value obtained at Olua primary school was alkaline in nature having a pH of 7.02 while other primary school playgrounds were slightly acidic with a range of 5.53 at Ekosodin PS to 6.89 at Agbado PS. The slightly acidic nature of the soils could affect the solubility and greater retention of metals in the soils (Mirjana *et al*., 2009). The pH of the soil samples to some extent maintained clear significant difference between Olua PS and other primary school playgrounds in this study. Acidic soil was obtained from Ekosodin Primary School. No strong correlations were found between heavy metal contents as similar observation was opined by Ljung *et al*., (2006). Electrical conductivity measurements are not as widely applied in soil analysis compared to pH (Radojevic and Bashkin, 1999). Soil electrical conductivity can be used as a measure of total soluble ions in a given soil sample. The electrical conductivity of the soil across the various primary schools were relatively similar, thus no significant difference (p>0.05) was obtained. The electrical conductivity showed significant and positive correlation with zinc, thus increase in the level of zinc would in turn influence the electrical conductivity positively.

**Table 1:** Summary of the spatial variations in the parameters characterized in the top soil samples from the selected primary school playgrounds

| **Parameters** | **Primary Schools** | | | | | |
|---|---|---|---|---|---|---|
| | **Ogiegbaen** $\bar{x}$**±SD** | **Agbado** $\bar{x}$**±SD** | **Olua** $\bar{x}$**±SD** | **Eresoyen** $\bar{x}$**±SD** | **Ekosodin** $\bar{x}$**±SD** | **p-value** |
| **pH** | 5.72±0.01 [c] | 6.89±0.06 [a] | 7.02±0.13 [a] | 6.37±0.33 [b] | 5.53±0.16 [c] | p<0.01 |
| **EC (µS/cm)** | 206.50±19.09 | 410.00±0.71 | 292.50±153.44 | 234.50±106.77 | 200.50±13.44 | p>0.05 |
| **Fe (mg/kg)** | 391.60±6.65 | 464.10±19.37 | 347.40±79.48 | 408.25±19.59 | 337.15±64.28 | p>0.05 |
| **Mn (mg/kg)** | 27.55±0.64 | 29.70±4.81 | 23.40±7.50 | 29.20±1.84 | 28.35±11.81 | p>0.05 |
| **Zn (mg/kg)** | 58.80±5.80 | 67.95±4.74 | 60.75±6.72 | 56.35±17.04 | 45.95±8.70 | p>0.05 |
| **Cu (mg/kg)** | 12.90±3.82 | 12.50±0.85 | 11.50±1.70 | 9.74±2.21 | 8.48±1.61 | p>0.05 |
| **Cd (mg/kg)** | 7.41±1.54 | 6.66±3.91 | 9.31±3.95 | 5.10±2.33 | 5.82±0.13 | p>0.05 |
| **Cr (mg/kg)** | 6.43±1.34 | 8.39±7.09 | 7.79±3.69 | 4.42±2.02 | 5.05±0.11 | p>0.05 |
| **Pb (mg/kg)** | 9.28±2.30 | 10.01±7.49 | 13.82±6.76 | 6.17±2.82 | 7.04±0.16 | p>0.05 |
| **Ni (mg/kg)** | 1.76±0.37 | 0.99±0.09 | 3.24±3.73 | 1.21±0.55 | 1.38±0.03 | p>0.05 |

*p<0.01 – Highly significant difference* *p>0.05 – No significant difference*

**Table 2** shows the enrichment factor (EF) in the Study area.

| **Heavy Metals** | **Primary Schools** | | | | |
|---|---|---|---|---|---|
| | **Ogiegbaen** | **Agbado** | **Olua** | **Eresoyen** | **Ekosodin** |
| **Mn** | 0.61 | 0.56 | 0.59 | 0.62 | 0.73 |
| **Zn** | 0.84 | 0.82 | 0.98 | 0.77 | 0.76 |
| **Cu** | 0.87 | 0.71 | 0.87 | 0.63 | 0.66 |
| **Cd** | 5.31 | 4.02 | 7.52 | 3.50 | 4.84 |
| **Cr** | 3.74 | 4.12 | 5.11 | 2.47 | 3.41 |
| **Pb** | 5.84 | 5.31 | 9.81 | 3.72 | 5.15 |
| **Ni** | 2.28 | 1.08 | 4.72 | 1.50 | 2.07 |

**Table 3**: The concentration factor and the pollution load index of the Study area

| Primary School | Contamination Factor | | | | | | | | PLI |
|---|---|---|---|---|---|---|---|---|---|
| | Fe | Mn | Zn | Cu | Cd | Cr | Pb | Ni | |
| Ogiegbaen | 4.29 | 2.63 | 3.60 | 3.73 | 22.80 | 16.06 | 25.07 | 9.78 | 7.79 |
| Agbado | 5.09 | 2.84 | 4.16 | 3.62 | 20.48 | 20.96 | 27.04 | 5.47 | 7.81 |
| Olua | 3.81 | 2.23 | 3.72 | 3.33 | 28.63 | 19.48 | 37.35 | 17.97 | 8.90 |
| Eresoyen | 4.48 | 2.79 | 3.45 | 2.82 | 15.68 | 11.04 | 16.66 | 6.72 | 6.26 |
| Ekosodin | 3.70 | 2.71 | 2.81 | 2.45 | 17.91 | 12.61 | 19.03 | 7.67 | 6.23 |

Results from this study which was restricted to topsoil of selected primary school playground in Benin metropolis shows that the playground are polluted with Cd, Cr, Pb and Ni and other metals which can arise from atmospheric and anthropogenic deposition. It is a common practice to compare mean concentrations of heavy metals in urban soils from different urban settings. Putting this into consideration, the concentrations of all the heavy metals analyzed in this study showed no significant difference (p>0.05) across the primary schools playgrounds. The result of this study showed that Fe was the most abundant heavy metal in soil samples obtained across the various schools. This observation contradicted the record of Verla *et al*. (2015a) which had zinc as the dominant heavy metal in playgrounds of public schools within Owerri Metropolis, Imo State. This difference can be attributed to spatial and geological compositional differences in the soil. Generally, Ni was the least concentrated of all the heavy metals analyzed in this study. In ranking of the heavy metals in order of decreasing concentration, slight differences were observed. In Ogiegbaen, Eresoyen and Ekosodin primary schools, the order was Fe> Zn> Mn> Cu> Pb> Cd> Cr> Ni while the order in Agbado and Olua primary schools were Fe> Zn> Mn> Cu> Pb> Cr> Cd> Ni and Fe> Zn> Mn> Pb> Cu> Cd> Cr> Ni respectively. Fe is found everywhere in the environment i.e. from debris, waste from automobiles, household waste, brake wheels etc. are built up in the environment and was seen to be the most abundant heavy metal recorded (Kanu *et al.,* 2015). The concentration of Fe at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 391.60, 464.10, 347.40, 408.25 and 337.15 (mg/kg) respectively. Lower concentrations were recorded Ekosodin PS followed by Olua PS. High level of variability was recorded at Olua PS and this can be attributed to the large landmass which happened to be the highest among the various primary schools investigated. This factor increased the distance for composite sample collection thus the reduction in sample homogeneity. The highest concentrations of Fe was recoded at Agbado PS. Statistical analysis showed no significant difference (P>0.05) on the concentration of Fe in the soil when compared to other primary schools playground soils. The concentrations of Fe found in the various soil samples were low when compared to the value of 22,991 mg/kg and 8522 mg/kg obtained by Ng *et al*. (2003) and Miguel *et al*. (2007) in playground in Hong Kong and Madrid, Spain respectively.

**Table 4**: Igeo of heavy metal contamination in the study areas

| **Heavy** | **Primary Schools** | | | | |
|---|---|---|---|---|---|
| **Metals** | **Ogiegbaen** | **Agbado** | **Olua** | **Eresoyen** | **Ekosodin** |
| **Fe** | 1.52 | 1.76 | 1.34 | 1.58 | 1.30 |
| **Mn** | 0.81 | 0.92 | 0.58 | 0.89 | 0.85 |
| **Zn** | 1.26 | 1.47 | 1.31 | 1.20 | 0.91 |
| **Cu** | 1.32 | 1.27 | 1.15 | 0.91 | 0.71 |
| **Cd** | 3.93 | 3.77 | 4.25 | 3.39 | 3.58 |
| **Cr** | 3.42 | 3.80 | 3.70 | 2.88 | 3.07 |
| **Pb** | 4.06 | 4.17 | 4.64 | 3.47 | 3.67 |
| **Ni** | 2.70 | 1.87 | 3.58 | 2.16 | 2.35 |

**Table 5:** Summary of the Correlation Table for Test of Relationship among the Parameters Characterized in the Top Soil Samples from the various Schools

| | pH | EC | Fe | Mn | Zn | Cu | Cd | Cr | Pb | Ni |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 1.000 | | | | | | | | | |
| EC | 0.526 | 1.000 | | | | | | | | |
| Fe | 0.290 | 0.214 | 1.000 | | | | | | | |
| Mn | -0.175 | -0.114 | **0.659** | 1.000 | | | | | | |
| Zn | 0.410 | **0.716** | 0.512 | 0.102 | 1.000 | | | | | |
| Cu | 0.192 | 0.485 | 0.311 | -0.018 | **0.828** | 1.000 | | | | |
| Cd | 0.336 | -0.347 | 0.109 | -0.169 | 0.015 | 0.197 | 1.000 | | | |
| Cr | 0.365 | -0.103 | 0.368 | -0.135 | 0.231 | 0.281 | **0.870** | 1.000 | | |
| Pb | 0.445 | -0.204 | 0.190 | -0.171 | 0.141 | 0.235 | **0.981** | **0.916** | 1.000 | |
| Ni | 0.272 | -0.477 | 0.081 | 0.115 | -0.196 | -0.106 | 0.772 | 0.461 | **0.734** | 1.000 |

*Bold Figures – Significant Correlation*

The concentration of Mn recorded at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 27.55, 29.70, 23.40, 29.20 and 28.35 (mg/kg) respectively. Mn is a micro nutrient required by plants and man and it is found in the organic matter in the soil (Orhue and Usi, 2015). Lower concentrations were recorded at Olua PS while Agbado PS had the highest concentration. However the concentrations of Mn recorded in this study were high but showed no significant difference (P>0.05) on the concentration of Mn in the soil when compared to other primary schools playground soils. Other researchers have reported similar concentration of Mn and attributed the level of Mn to anthropogenic sources especially when the primary schools were located along traffic zones and other industrial activities which could have increased the level in the playground soils (Kanu *et al.,* 2015)

The concentration of Zn recorded at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 58.80, 67.95, 60.75, 56.35 and 45.95 (mg/kg) respectively. The highest concentration was recorded at Agbado PS while the lowest concentration was recorded at Ekosodin PS. Statistical analysis showed no significant difference (P>0.05) on the concentration of Zn in the soil when compared to other primary schools playground soils. EL- GAmmal *et al.*, (2005) and Kamani *et al.*, (2015) reported high levels of zinc in soils close to traffic areas and attributed it to wear and tear of automobile tire. However, the prevalence of Zn, though the least toxic among all heavy metals (Ladipo and Doherty, 2011) is indicative of the significance of zinc in our ecosystem (Olukanni and Adeoye, 2012). The health implications of elevated levels of zinc ($Zn^{2+}$) are severe vomiting, diarrhoea, bloody urine, liver and kidney failure and anaemia (Fosmire, 1990). The concentration of Cu recorded at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 12.90, 12.50, 11.50, 9.74 and 8.48 (mg/kg) respectively. Statistical analysis showed no significant difference (P>0.05) on the concentration of Cu in the soil when compared to other primary schools playground soils. The lowest concentration of Cu was recorded at Ekosodin PS while the highest concentration was recorded at Ogiegbaen PS. Excess intake of soluble copper compounds can result in the accumulation of Cu in the liver and may lead to an alteration of liver function to handle copper and to arrange for its use and elimination from the body. Consequently copper can be released into the blood stream producing haemolysis (El-Gammal *et al.*, 2005). Overall, the average concentrations of Mn, Zn and Cu obtained in the soil samples from the various primary schools playgrounds were low when compared with the values of 75.79 mg/kg, 124.98 mg/kg and 32.91 mg/kg respectively obtained by Verla *et al*. (2015a) in playgrounds of public schools within Owerri Metropolis, Imo State, Nigeria. The concentration of Cd and Cr recorded at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 7.41, 6.66, 9.31, 5.10 and 5.82 (mg/kg) for Cd and 6.43, 8.39, 7.79, 4.42 and 5.05 (mg/kg) for Cr respectively. The highest concentration of Cd and Cr were recorded at Olua PS and Agbado PS while the lowest concentrations of Cd and Cr were recorded at Eresoyen PS. Statistical analysis showed no significant difference (P>0.05) on the concentration of Cd and Cr in the soil when compared to other primary schools playground soils. It was observed that the concentration of Cd and Cr in Eresoyen PS was lower than that of Ekosodin PS. Ekosodin PS is located at Ekosodin village and it is the only primary school that is not along the road in this study. However, the high concentrations of Cd and Cr recorded in Ekosodin PS can be attributed to the fact that Ekosodin PS is sitting on a sloppy landmass according to the geography of the area. Therefore, the high concentration recorded can be attributed to runoffs of soils deposits which end up towards Ekosodin PS playground. Cadmium can also be emitted into the environment from agricultural discharge, zinc, lead or copper smelters and through incineration of municipal waste materials (ATSDR, 1997). Long term exposure to cadmium is associated with renal dysfunction, anaemia, bone marrow disorder, cancer, bronchitis, liver and brain disorders (Dara, 2000; Koji *et al.*, 2004). The concentration of Pb and Ni recorded at Ogiegbaen PS, Agbado PS, Olua PS, Eresoyen PS and Ekosodin PS are 9.28, 10.01, 13.83, 6.17 and 7.04 (mg/kg) for Pb and 1.76, 0.99, 3.24, 1.21 and 1.38 (mg/kg) for Ni respectively. The highest concentration of Pb and Ni were recorded at Olua PS for both heavy metals while the lowest concentrations of Pb and Ni were recorded at Eresoyen PS and Agbado PS respectively. Statistical analysis showed no significant difference (P>0.05) on the concentration of Pb and Ni in the soil when compared to other primary schools playground soils. It has been reported that roadside soils near traffic are polluted by Pb and other metals (Wong and Mak, 1997). Conversely, in this study, the concentration of Pb recorded at Ekosodin PS which is located far away from traffic was higher than values recorded at Eresoyen PS which is located along Benin-Lagos high way. However, this can be attributed to the high runoff of soil particles that end up in Ekosodin PS playground. Lead poising ($Pb^{2+}$) has been found to be the major cause of haemoglobin synthesis, dysfunction in the kidney, hypertension, impairment of central nervous system, damage to gastro-intestinal system, mental retardation in children, abnormalities in fertility and pregnancy, cardiovascular systems and other respiratory problems in adults (Olade, 1987; Dara, 2000; Ferner, 2001; Ikenaka *et al.*, 2010). It has been reported that children are more susceptible to Pb toxicity because intestinal absorption of Pb is five times greater in children than in adults (Ikenaka *et al.*, 2010). Cd, Cr, Pb and Ni recorded low levels of variations; however the levels would continue to increase due to increasing anthropogenic or natural inputs. The soil samples obtained from Olua and Agbado primary playground recorded the highest levels of Cd, Cr, Pb and Ni as this can be attributed to high vehicle usage of the roads positioned close to these schools and often time high traffic congestion along those roads. Thus Cd, Cr, Pb and Ni input can be associated to input from the vehicle exhaust and other industrial and commercial activities. It was observed that the concentration of Mn, Cd, Cr, Pb and Ni was high in Ekosodin PS due to runoff of soil particles which can lead to bioaccumulation of metals in soils of Ekosodin PS playgrounds. Generally, the values obtained for the selected primary school playground in Benin metropolis clearly indicated that these playgrounds have been polluted by anthropogenic emissions except for Ekosodin primary school that has been attributed to other sources of metal pollution. Various studies have shown that heavy metals such as Cd, Cr, Pb and Ni amongst others are responsible for certain diseases that have lethal effects on man and animals, and due to their accumulation and long-time retention by plants and animals, these metals are very dangerous (Popescu, 2011) in Olukanni and Adeoye, (2012).

*Correlation matrixes for chemical properties and heavy metals in soils of selected primary school playgrounds:* The correlation between the concentrations of some geochemical parameters can establish influencing factors and indicate potential sources of pollution (Robertson *et al.*, 2003; Crosby, 2012) in Otari and Dabiri, (2015). The result of the correlation analysis between the parameters showed that there was a positive correlation between the elements with regards to their sources and origin. Considering the sample size, the critical level of correlation coefficient is 0.632. pH recorded no significant relationship with any of the parameters characterized in this study while EC showed a significant and positive correlation with Zn (r= 0.717). Fe recorded significant and positive correlation with Mn (r= 0.659) while Zn showed the same pattern of relationship with Cu (r=0.828). Cd recorded significant and positive correlations with Cr (r=0.870) and Pb (r=0.981) while Pb showed similar pattern of relations with Cr (r=0.916) and Ni (r=0.734). These positive correlations indicates Fe, Mn, Cu, Cd, Cr, Pb and Ni may have originated from common sources, preferably from different industrial and commercial activities as well as contribution from auto-exhaust.

*Enrichment Factor:* The findings from this study reveal high levels of Cd, Cr, Pb and Ni contamination in the soil which is in line with the findings of Zhang and Liu, (2002), Salah *et al.*, (2012) who reported that both lithogenic and anthropogenic sources may have a significant role in the enrichment of Zn, Pb, and Cd and attributed these sources to urbanization, industrialization and runoff (Kanu *et al.*, 2015; Kamani *et al.*, 2015). The findings revealed high levels of Cd, Cr and Pb contamination in the soil. Thus, it is possible that these metals are increasing due to anthropogenic activities of man while stating the obvious of incomplete combustion of vehicular emissions which can increase the level of heavy metals in theses soils.

*Contamination Factor (CF):* The contamination factor indicated a considerable contamination of Fe in all the study areas as CF for Fe is $3 < CF < 6$. There is a moderate contamination of Mn in all the study area as CF for Mn is $1 < CF > 3$. There is a moderate contamination of Zn at Ekosodin PS while other study areas recorded a consideration contamination of Zn. There was a moderate contamination of Cu at Eresoyen PS and Ekosodin PS while other PS recorded considerable contamination in soils of their playgrounds. There was a very high contamination of Cd, Cr and Pb ($CF \geq 6$) in all the study areas while to Ni recorded a considerable contamination ($3 < CF < 6$) at Agbado PS. Ogiegbaen PS, Olua PS, Eresoyen PS and Ekosodin PS had a very high contamination of metals as CF value was $CF \geq 6$ in the primary school playgrounds respectively. Nwaogu *et al.,* (2014) and Sripathy *et al.,* (2015) reported similar result and attribute the contamination level in soils to anthropogenic sources that normally go on soil through human activities.

*Pollution Load Index (PLI):* In this study, PLI value across all the study areas indicates that all the sampled areas were all polluted ($PLI > 1$) by heavy metals. This is in line with various studies carried out in traffic areas which showed that the soil samples have been contaminated by the anthropogenic activities in study locations (Olukanni and Adebiyi, 2012; Otari and Dabiri, 2015) respectively.

*Geoaccumulation Index (Igeo):* All the soils of the study area fell within the seven classes of risk assessment based on Muller's interpretation. In relation to Fe, the soil samples obtained from the study areas were moderately polluted as Igeo values were ($1<Igeo<2$). In relation to Mn, the soil samples obtained from all the study areas was practically unpolluted ($Igeo \leq 0$). In relation to Zn, the soil samples obtained from Ogiegbaen PS, Agbado PS, Olua PS and Eresoyen PS were moderately polluted as Igeo values were ($1<Igeo<2$) while the soil sample obtained from Ekosodin PS was practically unpolluted ($Igeo \leq 0$). The soil samples obtained for Cu from Ogiegbaen PS, Agbado PS and Olua PS were moderately polluted as Igeo values were ($1<Igeo<2$) while the soil sample obtained from Eresoyen PS and Ekosodin PS were practically unpolluted ($Igeo \leq 0$). In relation to Cd, the soil samples obtained from Ogiegbaen PS, Agbado PS, Eresoyen PS and Ekosodin PS were heavily polluted ($3<Igeo<4$), while the soil sample obtained from Olua PS was heavily to extremely polluted ($4<Igeo<5$) with Cd. In relation to Cr, the soil samples obtained from Ogiegbaen PS, Agbado PS, Olua PS and Ekosodin PS were heavily polluted ($3<Igeo<4$), while the soil sample obtained from Eresoyen PS was moderately to heavily polluted (2<Igeo<3). In relation to Pb, the soil samples obtained from Ogiegbaen PS, Agbado PS and Olua PS were heavily to extremely polluted (4<Igeo<5), while the soil sample obtained from Eresoyen PS and Ekosodin PS were heavily polluted (3<Igeo<4). In relation to Ni, the soil samples obtained from Agbado PS was moderately polluted (1<Igeo<2), the soil samples obtained from Ogiegbaen PS, Eresoyen PS and Ekosodin PS were moderately to heavily polluted (2<Igeo<3), while the soil sample obtained from Olua PS was heavily polluted (3<Igeo<4) with Ni. Similar findings were reported by Otari and Dabiri (2015) as soils were significantly contaminated by Cr and Ni with anthropogenic origin from mining activities. Similar Igeo value was reported by Zakir *et al.,* (2015) which further is in agreement with the report of Howari *et al.,* (2004), who opined that soils collected at industrial and commercial areas close to traffic locations were moderately contaminated with Cd, Pb and Ni.

*Conclusion:* Heavy metals concentrations were low when compared with the values obtained elsewhere in the world, however, they can accumulate to constitute health hazards. The present data can help in the assessment and establishment of future monitoring programs focusing on metal contamination in the environment. It is also needful to constantly monitor concentrations in order to detect any possible chance of risk to full exposure.

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