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EVALUATION OF LEAD CONCENTRATION LEVELS OF CHILDREN'S PLAY GROUND IN KADUNA STATE SCHOOLS

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ABSTRACT
Leaded paint and lead from exhaust of vehicle have been observed to be the major contributors of lead contamination, resulting to soil contamination. African infants by way of culture have direct contact with contaminated soil. The study investigated, lead contamination of soil in children's playgrounds of some selected schools in Kaduna State with emphasis on the premises of nursery/primary schools in the State An Energy Dispersive X-ray Fluorescence (EDXRF) was the technique used in the investigation. The results obtained from exterior showed some variations from the background lead levels. Schools such as LK-II, HCPS, SPS, showed high variation from background study. HCPS recorded interior mean lead concentration of 137.5±24.6 (127.0-174.0)ppm and exterior mean lead concentration of 145.8±25.0(26.0-348.7)ppm while the established background lead concentration level is within the range of 23.5-38.9ppm.

Keywords: Lead concentration, Contamination, background, EDXRF, Children playground, leaded paint, flakes, debris, building foundation, Kaduna State.

INTRODUCTION

Lead components are usually introduced into domestic paints as major ingredient and subsequently as pigments and drier. When painted walls flake and peel off, they become a source of potential hazard to any pica child, (Ibeanu *et-al*, 1997).

Pica-children have been observed to experience high blood lead level (Ruddock, 1924).As early as 1904, it was recognized that accidental ingestion of paint dust and flakes, associated with mouthing of hands, posed a serious health hazard to young children. (Gibson,1904). In the intervening half-century, thousands of children were identified with clinical lead poisoning attributed to paint, (Guinee,. 1972). A survey in a part of Ahmadu Bello University main campus and academic environment revealed that lead levels were found to range from 400 800ppm by dry weight.(Ibeanu *et al*, 1997).

The peeling and chipping of the painted walls of the deteriorated schools necessitates their renovation. During the renovation, paint flakes spread all over the building sites. These flakes contain large quantities of lead, which is the major element in paint.

United States environmental protection agency, (USEPA, 1995) defines lead based paint as "paint with a lead concentration of one milligram per square centimeter (1 mg/cm^2) or 5000ppm by weight (dry or wet weight). The Department of Health and Social Security (DHSS,1980) reported that the greatest risk among sources of lead is that associated with the presence of old lead-based paint and primers on surfaces in and around houses, or other premises and playgrounds to which young children may have access.

For an African child, sitting on the bare floor, and playing with sand/dust is a normal routine. Children are exposed to lead primarily by ingesting lead-contaminated dust and soil through normal hand-to-mouth activity. For example, pica children may play with toys on a dusty floor and then put them in their mouths. Similarly, they may play in dirty outdoors and then eat snacks without washing their hands. Some children may directly ingest lead-based paint chips from flaking walls, windows and doors. According to USEPA (1998), lead-based paint is considered to be in "poor condition" and therefore a hazard under any of the following conditions.

(i). More than two square feet (1860cm^2) of deteriorated paint on interior compounds with large surface areas, such as inside walls, ceilings, floors and doors.

(ii). More than 10 square feet (9300 cm^2) of deteriorated paint on exterior compounds with large surface area, such as outside wall.

(iii). Deteriorated paint of more than 10 percent of the total surface area of interior or exterior components with small surface area, such as windowsills, baseboards, and trims.

Lead based paint hazards arise from three sources:
(i) Lead – based paint (in poor condition)
(ii) Lead – contaminated dust.
(iii) Lead – contaminated soil.

Environmental protection principles demand that man and his immediate environment be adequately protected. Lead in paint presents greater and more immediate threats to the health of school children by its significant contribution to play ground dust/soil because lead is easily absorbed into their growing bodies. Thus the work aims at analyzing the lead concentration in and outside the classes in Kaduna state schools.

Table 1.0 Limit for lead

Medium	Limit	Source
Air	2 µg/m^3	Directive 82/844/EEC
	2000 µg/l	
Water	50 µg/l	Directive 80/778/eec WHO circular 33/82-trigger level
	100 µg/l	
Food	1ppm	Lead in food regulation 1979
Canned		
food	2ppm	Lead in food regulation 1979
Adult	0.2ppm	
Children		
Soil		
Gasoline	500ppm	ICRCL guidance note
Parks	2000ppm	Recommendation
Dust	500ppm	Greater London council 1981
Paint		
General	10000ppm	Voluntary agreement to restrict use. Directive 77/728/EEC (should carry specific warning level).
	600ppm	US Safety Revolution/.1974
Toys	2500ppm	Toys (safety) regulation 1974
Pencils	250ppm	Pencil and graphic instruments (safety) regulation 1974.
Petrol	0.4-0.15g/l	Directive 77/312/EEC

Source: Page R.A. (1984)

MATERIALS AND METHODS

Preliminary sample collections were conducted for background concentration of lead in soil at areas free from sources of lead contaminations from all the 12 sample local government Areas. Controlled samplings from unpainted buildings were also used as background. Background sample study will also help the researcher to verify if Kaduna state soil falls within 16 ppm of mean concentration of lead (Waldron and Stofan, 1974). The soil sample collection protocol established two major standard locations for sampling interiors of the buildings (classrooms where children sits and play most of the time) and the exteriors, which were supposed to be the playground of the children.

The samples were made into pellets, irradiated and analysed using conventional EDXRF machine that uses isotopic source of annular Cd-109 as the excitation source and lithium-drifted silicon detector to separate the x-rays according to their energy, coupled to a computer controlled adc-card. Peak searching and evaluation of the measured x-ray spectrum was accomplished off-line using the IAEA developed formats conversion from trump to axil software package. The axil instrument software then translates this information into the type and concentration of each element present in the sample (Benasconi *et al,* 1996).

RESULTS AND DISCUSSION

Table 2.0 shows the mean background concentration of 12-sampled Local Governments of Kaduna state. The results obtained are within the range of 23.5-38.9ppm. All the results are without much difference, which is an indication that all the results obtained, are free from source of lead contamination.

At the time of visit, most of the children were found sitting on the bare floor or on mats inside their classrooms. These environments form a natural environment to an African child. Table 3.0 shows the mean indoor lead concentration levels. All the results show concentrations that are within, slightly different or highly different from background levels. Schools like LK-11, HCPS, SPS, have high variation from background study. These variations are as a result of flaking of paintwork from within the building. Schools which have values within the background levels explain the observation that the school had been properly cleaned after the renovation.

Outdoor sample areas are the immediate environments that the children come into contact with. The child can introduce contaminated dust into the interior classroom through his feet or shoes from exterior foundation or playground. Table 3.0 also shows the mean outdoor lead concentration levels. The mean exterior results from MPSS, HCPS, SPS, LK-2, shows high variation from background levels which is an indication that the source of lead must be coming from either, within the building or outside the building, depending on either the concentration is found to be decreasing, increasing from the sources of lead, or the source unknown when the results shows an even distributions of lead concentration with distance.

A histogram of relative frequency against mean lead concentration of indoor results is shown in fig1.the graph is asymmetrical with a skew to the right. This is due to high variability in the mean lead concentration in samples which is as a result of flaking of paint from the walls and ceilings of the school building.

The majority of samples fall within 30-40ppm. LPSG should form a site of interest because, all the children were found sitting on bare floors, and with time, the concentration levels will build up, forming a potential hazard area.

An outdoor analysis of the sampled areas carried out was plotted as shown in figs. 1- 3. These sampled areas were found to explain the observations made about the concentration of lead in relation to the distance from the source.

Fig.2 is a plot of concentration of lead decreasing with distance from the exterior foundation of the buildings of SPS and ACLPS schools. From the foundation lead concentrations of 131.61ppm from SPS and 124.49ppm from ACLPS were measured. It is observed that the lead concentration decreases with distance without a background value. The observed trend indicates the source of lead from such sampled areas to be the renovated painted buildings.

A plot of lead concentration against distance shown in fig3 from the sampled area HCPS with a measured foundation concentration value of 46.075ppm was observed to increase to about 300ppm with distance, while the LM school also with a similar trend was observed to increase from 57 to 465ppm at foundation with distance. The exterior concentrations of lead at the foundation for the two graphs found to increases with distance could be indications that the renovated building were cleaned and dumped around the premises to now serve as the source of the lead. More importantly those schools were also found close to a busy street hence the source of lead could be from the burnt fuel of vehicles.(Ndiokwere, 1984)

Fig. 4 is a plot of lead concentration against distance from the CPSHB and LADPS schools. The lead concentrations at the foundation are 28.29ppm for CPSHB and 37.6ppm for LADPS. The observed trend was found to be almost constant with distance as such does not follow or take any particular pattern, meaning, the source of lead is uncertain. Could it be due to the poor clean up and left out paint flakes around the building?. The exterior source could also be due to the same dumping effect coupled with the proximity of the school to an un-tarred street. Similar work carried out by Ndiokwere and his collaborators on heavy metal pollution from vehicles indicated the existence of lead contamination in vegetables and crops in Kaduna state and also concluded that the State's primary schools could be highly leaded. (Ndiokwere, 1984; Ndiokwere and Ezihe, 1990)

The results from the interior have shown that the schools like LK-II, HCPS, and SPS have fairly elevated lead concentration levels, which indicates, the source of lead to be from the interior of the buildings.

Exterior lead concentration analysis indicates that schools like SPS and ACLPS sourced their lead concentration levels from the flaking of paints from the walls, while schools like HCPS and LM shows an indication of their lead concentration from sources far from the buildings probably from debris dumped from the renovated buildings coupled with ejections from vehicle exhaust. Schools like CPSHB and LADPS with their sources uncertain could at best be explained in relation to the location of the sample from the street and to poor cleaning of the renovated lead chips. Otherwise could be said the problem existed before the renovation.

CONCLUSION

Almost all the results obtained falls below the EPA guideline recommended levels of 400ppm. This is because, at the time of visit, most of the schools which were newly renovated had their debris completely cleared or partially cleared. Some schools that were not cleared well had their concentration almost at the threshold levels indicating that the lead contamination problem existed before the schools were renovated and that Kaduna State primary schools are highly leaded

Recommendations

Further studies on lead concentration levels should be conducted in other parts of the country and there should be adequate supervision of children especially of infant age.

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Table 2.0: Background lead concentration of 12 sampled L.G.A's of Kaduna state.

S/N	Sample Location	L.G.A	Mean Measured Pb Concentration (PPM)	Range ppm
1.	Gayan	Birnin	25.3± 2.8	22.7-30.8
2.	Jibril Maigari	Gwari	27.9±3.6	23.9-30.0
3.	Kujama	Chikun	30.3±2.7	26.8-34.8
4.	Giwa	Giwa	30.3±2.7	26.8-34.8
5.	Rigasa	Igabi	28.4±2.8	23.7-31.4

6.	Unguwar Dosa	Kaduna	30.5±1.7	27.8-32.4
7.	Hayin Banki	North	30.5±1.7	27.8-31.2
8.	Makera	Kaduna	26.7±4.3	23.7-30.4
9.	Ung. Maichibi	South	29.2±2.2	26.9-31.4
10.	Maraban Kajuru	Kajuru	30.1±1.7	27.3-31.4
11.	Pambegua	Kubau	23.5±1.9	20.6-26.4
12.	Hunkuyi		28.2±3.3	22.4-31.2
13.	Makarfi	Makarfi	28.4±3.8	23.6-32.3
14.	Basawa	Sabon-	31.1±2.2	26.9-33.6
15.	Samaru	Gari	31.1±2.1	26.9-34.7
16.	Tudun Sarki		28.9±1.8	26.3-31.0
17.	Kufena	Zaria	38.9±4.2	32.4-43.7
18.	Tudun Wada	Zaria	36.9±5..3	29.8-41.7
19.	Wusasa		35.7±3.2	31.2-42.6
20.	Zaria City		38.6±5.4	32.3-41.1

Table 3.0: Indoor and Outdoor measured lead concentration levels (ppm) from the 12 sampled L.G.A's in Kaduna State

S/No	Sample code	L.G.A.	Interior mean concentration (ppm)	Exterior Mean concentration (ppm)
1.	LPSG	Birnin Gwari	49.6±5.3	29.0±7.7
2.	LSPJMG		48.6±5.1	30.3±6.8
3.	LK.2	Chikun	104.2±18.1	85.0±13.9
4.	LPSR	Igabi	58.5±1.3	33.0±9.3
5.	MPSG	Giwa	48.5±6.7	38.8±9.3
6.	MPSS		53.8±4.0	175.9±95.5
7.	LPSHB		58.9±13.1	42.9±2.53
8.	LADPS	Kaduna north	38.6±1.9	39.6±9.5
9.	LMPS		48.4±7.4	27.7±7.3
10.	LBDPS	Kaduna south	42.4±4.1	48.4±3.23
11	LSYPS		42.6±6.1	46.9±2.31
12	LUM-1		50.1±5.9	41.4±13.2
13	LUM-11		50.1±5.8	31.8±7.5
14	LSGPS		49.6±5.3	25.9±7.7
15	KM-11	Kajuru	36.5±4.3	50.9±14.9
16	LMKPS		57.1±3.6	46.0±14.4
17	ACLPS	Kubau	30.7±0.8	73.0±12.9
18	CPSPB		54.4±11.1	29.5±3.8
19	HCPS	Kudan	137.5±24.6	145.8±25.0
20	LSPSM	Makarfi	55.3±6.6	37.5±6.6
21	LM	Sabon gari	60.8±1.5	74.7±7.14
22	SPS		102.7±8.5	90.7±12.0
23	LT		59.6±15.2	36.0±12.5
24	AMP	Zaria	36.1±4.8	32.3±6.2
25	NBSS		64.8±16.8	52.7±20.1
26	LITPS		36.4±5.7	52.9±11.2
27	WLPS		75.9±42.9	52.0±12.7

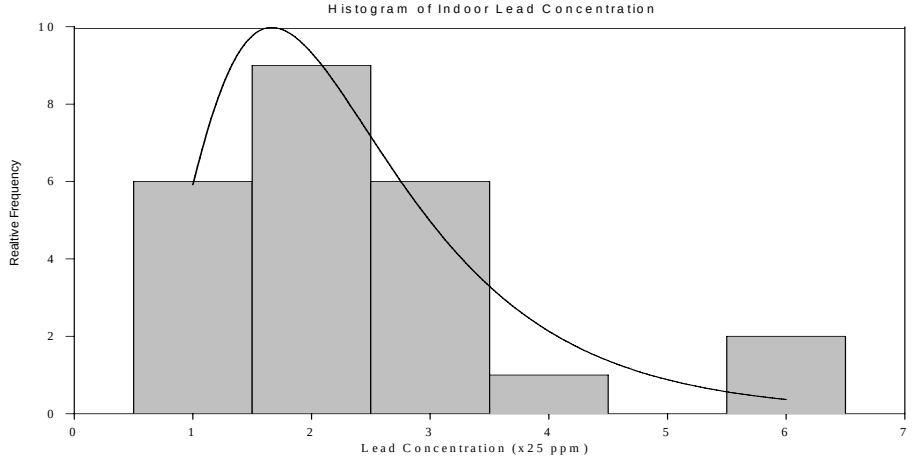

Fig. 1 Histogram of interior lead concentration

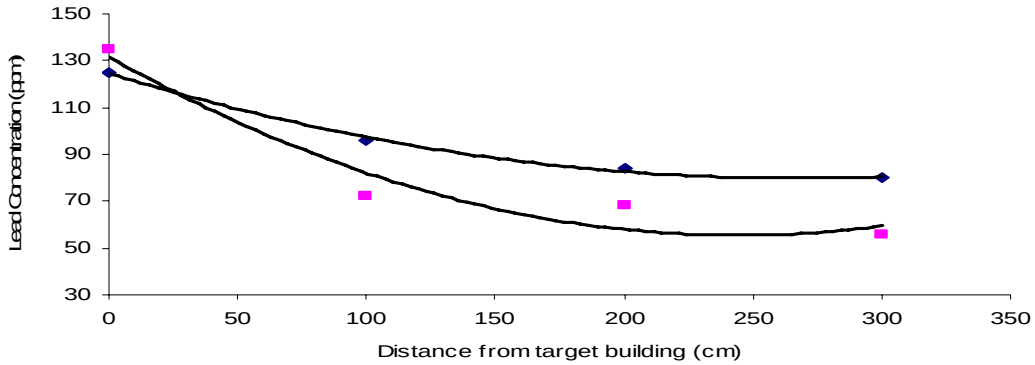

Fig.2 Variation of outdoor lead concentration w ith distance from SPS and ACLPS

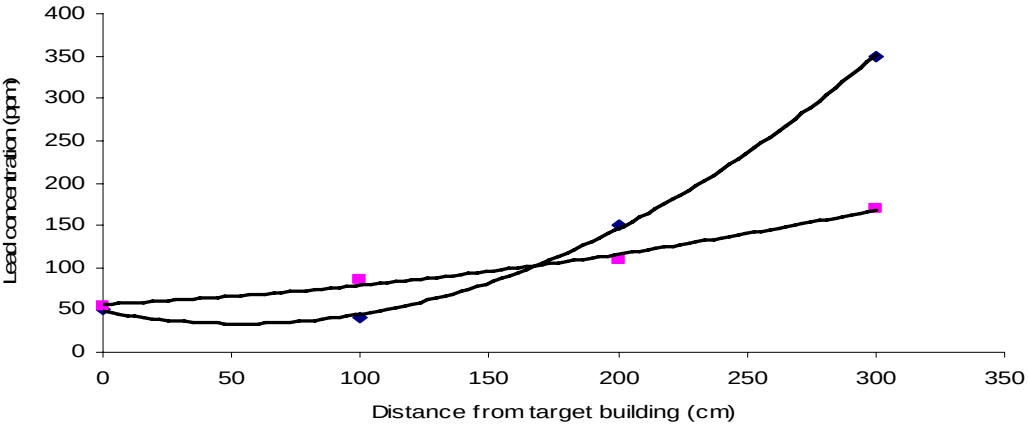

Fig. 3 Variation of outdoor concentration w ith distance from HCPS and LM

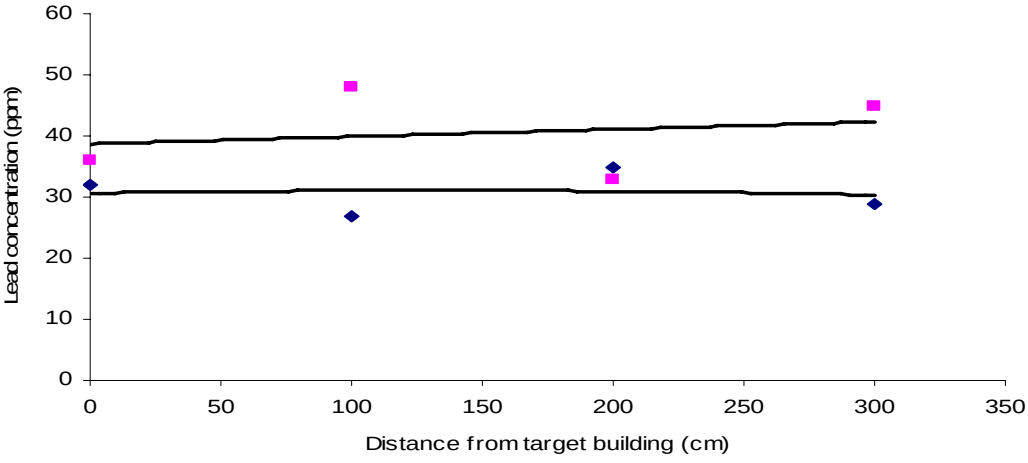

Fig.4 Variation of outdoor concentration w ith distance from CPSHB and LADPS