Environmental health in minority and other underserved populations: benign methods for identifying lead hazards at day care centres of New Orleans

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This study tests the hypothesis that exterior sources of lead dust are more important than interior sources in the route of exposure of children. Benign field methods were used to distinguish between potential and actual lead exposure problems. Utilising hand wipe and surface wipe techniques, hand and environmental samples were obtained from selected day care centres at different locations within New Orleans. Previous research has shown that soil lead is determined by location within the city. Private and public day care centres were selected from inner and outer city areas to estimate the extent of hand lead exposure. To measure and identify the extent of environmental lead exposure, hand wipes were taken before and after playing outdoors. Results of preliminary findings show that outdoor lead dust is a more potent contaminant of hands than indoor lead dust. An association was found between the amount of lead on children's hands after playing outdoors and the lead content in the exterior dust and soil. Although two girls out of forty children had exceptionally high hand lead quantities after playing outdoors, in general, boys have higher hand lead levels than girls. The private inner-city day care centre had a severe contamination problem in its outdoor play area. By contrast, the outdoor play area of the public inner city day care centre is of such a high quality that the quantity of lead dust is independent of location in the city.

Keywords: lead dust, soil lead, hand lead, urban lead hazards, environmental health, primary lead prevention

Introduction

Excessive exposure to lead may be the main environmental health threat to children. Children absorb lead from many sources, including air, drinking water, food, housedust, play area soil and dust, interior and exterior paints and improperly glazed ceramics and toys (Chaney and Mielke, 1986). Children are more sensitive because they absorb and retain more lead (about 50%) in proportion to their body weight than do adults (Mushak *et al*., 1989). There is no safe lead level. From 1991, the Centers for Disease Control and Prevention (CDC) has recommened lowering the community blood lead intervention level from 25 μg dL^{-1} to 10 μg dL^{-1} (CDC, 1991).

As the most prevalent and publicised of home toxins, lead makes young children vulnerable to a variety of health problems. Blood lead levels as low as 10 μg dL^{-1}, previously thought to be safe, have been associated with developmental delays, deficits in intellectual performance and neurobehavioural disorders (Mushak *et al*., 1989). Based on the NHANES III phase 1 survey, approximately one in eleven, or an estimated 1.7 million children aged 1 to 5 years old in the USA have blood lead levels exceeding this threshold (Brody *et al*., 1994). Blood lead levels such as these can often be reached when children merely touch a lead dust contaminated surface and then sucks their thumbs on a regular basis.

Several pathways account for environmental lead exposure. Lead in surface dust and soil comes from many sources including weathering and chipping of lead-based paint, disturbance of old paint during renovations, combustion of leaded petrol, and factory emissions and industrial waste. Surface dust and soil contaminated with lead is a ubiquitous urban hazard (Mielke, 1993). Young children, who are undergoing physical and mental development, are both more susceptible to the adverse health effects and more prone to be exposed to lead-contaminated soil within the environment. The present study was undertaken to evaluate the extent of lead exposure in private and public day care centres and to identify specific areas of lead contamination. This information can then be used to understand better what steps should be taken to decrease lead exposure.

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Methodology

The research protocol for the children's hand wipe and environmental study included decisions about the subjects' ages, the number of subjects chosen for the research, and how the samples (hand, surface and soil) were to be obtained and analysed.

The Institutional Review Board at Xavier University approved the study based on guidelines from the Office for Protection from Research Risks of the US National Institutes of Health. The sample sites for this project were chosen from day care centres located in New Orleans. The four day care centres were defined according to management and location as follows: private inner and outer city (sites 1 and 2 respectively) and public inner and outer city (sites 3 and 4 respectively). At the selected sites, a sample size of 10 children was chosen. All subjects were African-American children, both boys and girls between the ages of 3 and 6 years old.

Field methods of sample collection

Pretreated, antibacterial, Nice'n Clean® (Nice-Pak Products, Inc., Orangeburg, NY) moist towelettes (13.75 cm × 20 cm), were used to collect the wipe specimens. Samples were obtained by wiping surfaces with a single towelette that was then placed into individually labelled 120 ml polypropylene specimen containers with polyethylene caps.

Disposable gloves were worn while testing hands. Background samples were obtained by wiping gloved hands before collecting hand samples. The test involved wiping the palm and fingers of both hands of each child. In addition, unused wipes (control blanks) were treated in the same manner as the test samples.

Interior surface areas which children commonly touch while playing were tested. The areas tested included doors, table tops, cribs, toys, window sills and floors. To collect a sample, a template with an area of 112.5 cm^2 was used. The template was laid on the area to be wiped. The wiping was done in a right to left and then up to down motion.

Exterior surfaces were tested in the primary outdoor play areas. The areas tested included slides, swings, jungle gyms, benches, asphalt and cement surfaces. The template was used as described above.

Soil was not present at all day care centres. Notably, the public centres often had exterior play areas that were free of it. When soil was present, approximately 50–75 g of surface soil sample was collected (top 2.5 cm) and placed into a labelled polyethylene field bag.

Laboratory Methods

The moist towelettes were treated with 25 ml Trace Metal Grade (TMG) (Fisher Scientific) 1 M HNO_3 extraction solution and then shaken on an Eberbach Reciprocal Shaker for 2 h at room temperature. The extracts were filtered into polyethylene vials. Samples were then analysed for lead and other trace metals using a Spectro® Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) equipped with an ultrasonic nebuliser. The results of the hand wipe samples were divided by two and reported as lead per hand.

Five grams of air dried soil sample were placed into a labelled 120 ml sample cup. They were treated with 25 ml of 1 M HNO_3 (TMG) extraction solution and agitated on an Eberbach Reciprocal Shaker for 2 h at room temperature. The extracts were filtered through Fisher Scientific P4 filter paper into polyethylene vials. The soil extracts were diluted with 1 M HNO_3 (TMG) resulting in a dilution factor of 50.

Results

Table 1 shows the results of soil and surface lead for all sites. The exterior soil and surface samples for the private inner city day care centre have a relatively high lead content. In the case of site 1, which is a private inner-city day care centre, 75% of the soils exceed the EPA standard of 400 mg kg^{-1}. Note also that 60% of the exterior wipes exceed the HUD standard of 100 μg Pb ft^{-2} (1076 μgPb m^{-2}) for lead dust loading of interior floors. Sites 2–4 do not exceed EPA or HUD standards.

Table 1. *Lead results for exterior soil, exterior wipe samples and interior wipe samples for selected day care centres in New Orleans.*

	Exterior soils mg kg^{-1}				Exterior wipe samples μg ft^{-2}				Interior wipe samples μg ft^{-2}			
Site	*n*	Range	Median	% > 400	*n*	Range	Median	% > 100	*n*	Range	Median	% > 100
1	4	287–1878	498	75	5	44–690	412	60	5	16–68	34	0
2	4	4.9–17.7	11.5	0	4	2.2–8.0	3.3	0	4	0.8–1.4	0.95	0
3		NA			5	8–33	10.9	0	5	9–16	11.7	0
4		NA			5	9.5–18.4	10.5	0	4	9.9–115	11.3	0

Figure 1 *Private inner city daycare*

Figure 2 *Private outer city daycare*

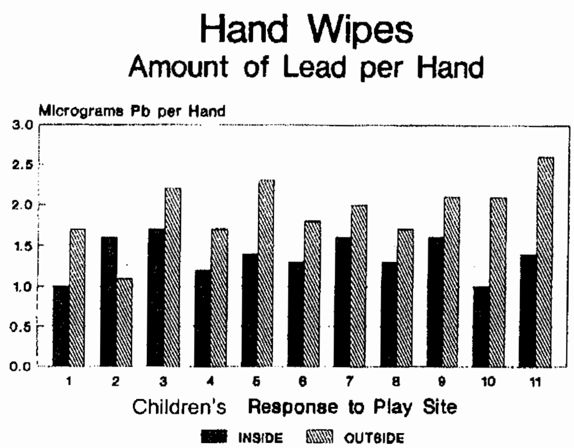

Figure 3 *Public inner city daycare*

Figure 4 *Public outer city daycare*

Figures 1–4 show the before and after hand lead results for the project. There were 40 children tested by the handwipe procedure, 52.5% boys and 47.5% girls.

Figure 1 shows data from site 1, a private inner-city day care centre. Here, 100% of the children tested showed increases of hand lead exposure after playing outdoors. Note that after playing outdoors, 70% of the children had over 20 μg Pb per hand. Two children had over a 15-fold increase in hand lead after playing outdoors. The average level before playing outdoors was 3.6 μg Pb per hand. Afterwards, it increased to 27.6 μg Pb per hand. This resulted in an average increase of 760%.

Figure 2 shows data for site 2, a private outer-city day care centre. Here, 80% of the children tested had an increase in hand lead exposure after playing outdoors. Note however, that the initial average exposure of 2.7 μg Pb per hand was lower than at the first site. Also, the average from 2.7 to 3.6 μg Pb per hand was a comparatively small increase, of 33%.

Figure 3 shows data for site 3, a public inner-city day care centre. Here 91% of the children had increases in hand lead after playing outdoors. It is important to note however that the children started with an average of 1.4 μg Pb per hand and afterwards it was 1.9 μg Pb per hand or a 36% increase. The children at this centre showed the lowest hand lead of the centres tested.

Figure 4 shows data for site 4, a public outer-city day care centre. Here 90% of the children showed increases in hand lead after playing outside. The average increase was from 2.1 – 2.7 μg Pb per hand, an average of 0.6 μg Pb per hand. This is a 28% increase.

The data set provides information concerning the role that sex plays in hand lead. Overall, boys (2.8 μg Pb per hand) had dirtier hands than girls (1.9 μg Pb per hand) before playing outdoors. Afterwards, girls (10.2 μg Pb per hand) had dirtier hands than boys (6.7 μg Pb per hand). The situation changes however, if the results of two girls from site 1 with exceptionally dirty hands (52.9 and

59.2 μg Pb per hand respectively) were removed from the data set. With this adjustment, boys (6.7 μg Pb per hand) had dirtier hands after playing outdoors than girls (4.8 μg Pb per hand).

Discussion

These findings are preliminary but they indicate some interesting relationships and suggest the usefulness of the wipe method for directly identifying lead hazards. First, the hypothesised relationship between environmental lead dust and the lead contamination of hands has been supported. The children at the day care centre with the highest outdoor lead dust sources exhibited the highest hand lead levels. For example, environmental data from soil samples showed a significant soil lead content ranging from 200 to 1358 mg kg^{-1}. The lead in the soil contributes directly to the lead found on the children's hands after outdoor play. Previous research on the relationship between soil lead and hand lead found similar results (Sayre *et al.*, 1974).

Second, public day care centres exhibited lower hand lead exposure than private ones. Site 3 was located in a lead dust contaminated inner-city community (as described by Mielke (1993, 1994)) but the children exhibited the lowest hand lead exposures of the centres measured. The playgrounds of public day care centres had well-maintained equipment and all play areas were completely covered with rubberised asphalt or concrete. The play area was free of soil. Consequently, the surface lead found on the outside play areas were extremely low. The exterior surface lead measurements of site 3 ranged from 8.2 to 33.3 μg ft^{-2} and the interior surface lead measurements ranged from 9.1 to 16 μg ft^{-2}. These findings demonstrate that an inner-city public day care centre can have play areas that have a lead dust content independent of inner-city lead dust contamination problems. The playgrounds that had bare soil and old or rusted equipment, high soil lead and surface lead dust contamination were associated with high hand lead content.

Third, private day care centres are usually in ordinary residential housing. On these properties, the amount of lead dust in soils is similar to the content of the lead dust of the surrounding housing (Mielke, 1994). Where traffic has historically converged towards the inner city there is a disproportionate accumulation of lead dust compared with equally old, but outer-city urban communities (Mielke *et al.* 1989; Mielke, 1993, 1994). Unless special efforts are taken to clean up or encapsulate the lead dust, the soils of the play areas remain contaminated with lead dust. As demonstrated by the results, soil is a major reservoir of lead dust. The lead dust is easily transferred to the hands during common play activities. These children can easily ingest the lead from their hands during ordinary hand mouthing and thumb and finger sucking activities that are associated with young children. These combined urban and behavioural processes probably explain why excessive lead exposure remains a problem especially for those disproportionately represented by minority and low-income people that live in the inner city (Brody *et al.*, 1994, Pirkle *et al.*, 1994).

The principle regulatory measures for lead exposure prevention is being directed at lead-based paint. The applicability of this has been questioned for day care centres (Dungy *et al.*, 1993). Only limited regulatory action has been specifically directed at controlling lead in dust and soil (Mushak and Crocetti, 1989). This study suggests that to achieve primary prevention in the group with highest lead risk, lead dust contamination in outdoor play areas must be controlled.

Conclusion

The use of handwipe and surface wipe techniques provides a benign and inexpensive measurement of lead. The technique is particularly useful for primary prevention because it focuses on the environmental sources and hand-to-mouth route of exposure of lead. In this study, four day care centres were selected, private and public, one each located in inner and outer New Orleans. Children's hands were wiped before and after playing outdoors. The results support the hypothesis that exterior sources of lead dust are more important than interior ones in transferring lead from the environment to the hands of children. The private day care centre located in the inner city had a severe contamination problem. In contrast the inner city public centre exhibited the lowest lead measurements in this study. The results of this study suggest that for primary lead prevention of the most exposed group of children, the play area guidelines of public day care centres should be extended to private day care centres.

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