Short communication

Lead content of dried films of domestic paints currently sold in Nigeria

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Abstract

Children are at higher risk from lead exposure because their developing neural system is susceptible to its neurotoxic effects. We studied lead levels of paints manufactured in Nigeria in 2006. Lead levels in 5 colors of paints, each from different manufacturers were measured using flame-atomic absorption spectroscopy. We found that 96% of the paints had higher than recommended levels of lead. The mean lead level of paints ranged from 84.8 to 50,000 ppm, with mean of 14,500 ppm and median of 15,800 ppm. The main determinant of lead levels was color of the paint. As lead levels in paint sold in the past years in Nigeria are likely to be at least as high as that currently sold, it is likely that many existing houses contain dangerously high levels of lead. Efforts need to be undertaken to assess the presence of high lead levels in existing housing and if detected, intervention programs for eliminating risk of exposure should be developed in addition to measures to increase awareness and enforce regulations leading to the elimination of lead based domestic paint.

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1. Background

Exposure to environmental health hazards is a continuing threat to the health, particularly in developing countries though reducing environmental health hazards is one of the 8 aims of the United Nations’ Millennium Development Goals (MDG) (Briggs, 2003; Hrynkow et al., 2003; Meyer et al., 2003; Obasanjo, 2005; United Nations, 2005). For example, lead-exposure associated mental retardation is the 6th most important disease in terms of environmental contribution to total global burden of diseases measured in disability adjusted life years (Pruss-Ustun and Corvalan, 2006). Since economically-feasible technology has been available for more than one half century to produce paints without added lead, there is no plausible reason to continue to produce paints with any lead at all.

Exposure to lead in the domestic environment from potable water, dust, soil and paint is a particular health hazard for children. Though lead exposure is harmful to both adults and children, children are more susceptible
to the neurobehavioral toxicity of lead exposure because their nervous system is still developing, their absorption rates are higher, they have higher likelihood of engaging in hand-to-mouth practices and frequently spend time on the floor and on soil areas so they are more likely to be exposed to lead from paint, dust, soil and water in the domestic environment (Baghurst et al., 1992; Bellinger, 2004; Lidsky and Schneider, 2003; Needleman and Landrigan, 2004). Furthermore, their lack of involvement in the economic system limits their exposure from other sources, including occupational and leaded petrol which is still used in many countries (The Lead Education and Abatement Design Group, 2006). Previous studies in Nigeria have shown that 70% of children aged 6 to 35 months had blood lead levels greater than 10 μg/dL (Pfitzner et al., 2000) and that flaking house paint was an important determinant of this (Wright et al., 2005).

In a previous study, we have shown that emulsion and gloss types of paints currently manufactured and sold in Nigeria contained substantial levels of lead (Adebamowo et al., 2006a) but we could not compare our results with international studies because we had not prepared a dried film of paint. In this paper, we present our analysis of the lead level in dried films of paints manufactured and sold in Nigeria for domestic use and compare these with paints sold in some Asian countries.

2. Methods

In June 2006, we purchased at least 5 different colors of the most popular brands (based on our market survey) of new glossy paints, manufactured and sold in Ibadan — a city of about 2 million people mostly engaged in agriculture and the services industry in South Western Nigeria. To prepare each paint sample for analysis, we stirred the paint and applied it by brush to individual clean and unused wood blocks. Each stirring utensil and paintbrush was used only once. After drying by exposure to ambient environment, the blocks were packed in individual ziploc® bags and shipped to the Hematology and Environmental Laboratory of the University of Cincinnati, Ohio where the paints were removed from pre-measured areas on the wood surfaces using clean sharp paint scraper and care so as not to remove portions of wood.

Paint scrapings were first extracted using nitric acid and hydrogen peroxide according to the method: Standard Operating Procedures for Lead in Paint by Hotplate or Microwave-based Acid Digestions and Atomic Absorption or Inductively Coupled Plasma Emission Spectroscopy, EPA, PB92-114172, September 1991. Extracts were analyzed by flame-atomic absorption spectroscopy using a Perkin-Elmer 5100 spectrometer. This laboratory is accredited by the American Industrial Hygiene Association as an industrial hygiene laboratory and as an environmental lead laboratory under the National Lead Laboratory Accreditation Program. Consequently, the laboratory participates in the Proficiency Analytical Testing (PAT) and Environmental Lead Proficiency Analytical Testing (ELPAT) proficiency programs. Strict quality control procedures are maintained according to the accreditation guidelines. The laboratory is also a recognized facility through the National Environmental Laboratory Accreditation Conference and participates in the New York proficiency program for environmental sample analytes including lead. We analyzed the data with MS Excel® and STATA 8.2® (STATA Corporation, College Station,
TX). We performed chi-squared nonparametric test of the equality of medians (Mann-Whitney) because of non-normality of distribution of the data. We set the level of statistical significance at 0.05.

3. Results

We analyzed paints of 5 different colors from 5 different manufacturers in Nigeria. Because some colors were not available from some of the manufacturers at the time of the market survey, we could not ensure that we obtained the same range of colors from all the manufacturers. Our analysis showed that 96% of the paints had higher than the recommended 600 parts per million [ppm] and the mean lead levels was 14,500 ppm while the median was 15,800 ppm. The lowest level was 84.8 ppm while the highest was 50,000 ppm. Only one out of the 25 samples (4.0%) had a level less than the 600 ppm recommended by the US EPA and Consumer Product and Safety Commission for new paint (Environmental Protection Agency, 2001; US Consumer Products Safety Commission, 1977).

Fig. 1 shows the lead levels of paint according to manufacturers. Pearson $\chi^2$ for comparison of median lead level of paints was 2.56 with a $p$-value of 0.63. Fig. 2 shows the lead levels according to color of paint. Pearson $\chi^2$ for comparison of median lead levels according to paint color was 22.0 with a $p$-value of 0.003 indicating that the main determinants of different lead levels were the colors. With regards to the manufacturer whose white paint had lead below the recommended level, other paint from the same manufacturer had high lead levels with a mean (SD) of 17.000 (16,600) ppm if the sample with low lead level was excluded.

We compared the lead level of paints in this analysis with published and unpublished data on the level of lead

<table>
<thead>
<tr>
<th>Color</th>
<th>Country</th>
<th>Median</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Nigeria</td>
<td>40,515</td>
<td>42.271 (5393)</td>
</tr>
<tr>
<td>Red</td>
<td>India</td>
<td>24,457</td>
<td>23.784 (15,877)</td>
</tr>
<tr>
<td>Green</td>
<td>Malaysia</td>
<td>12,216</td>
<td>15.976 (9410)</td>
</tr>
<tr>
<td>White</td>
<td>Singapore</td>
<td>4110</td>
<td>30.35 (1864)</td>
</tr>
<tr>
<td>Blue</td>
<td>China</td>
<td>3615</td>
<td>34.57 (1729)</td>
</tr>
</tbody>
</table>

Table 1

Lead level in parts per million of different colors of paint sold in Nigerian and selected Asian countries, Ibadan, 2007

Fig. 2. Lead level in parts per million (ppm) in domestic paint in Nigeria according to color, Ibadan, 2006.
in paints sold in 2004 in India, Singapore, China, Malaysia and India (Clark et al., 2006). As shown in Table 1, the level of lead in the paints sold in all these countries was high with the exception of Singapore. We also found that the level of lead varied with color. In general, yellow paint had the highest amount of lead in each country followed by red, green, blue and white. Even in Singapore where all except two of the paints tested had lead below the recommended level, the highest mean amount of lead was found in yellow paint. Furthermore, the median lead level of Nigerian paints did not substantially differ from those of these Asian countries (15,800 ppm compared to 16,500 ppm; p-value 0.16) (Clark et al., 2006). The highest lead level found in Nigeria was in yellow paint with 50,000 ppm of lead compared to 187,000 ppm found in the Indian yellow paint sample which was the highest found in Asia. While 96% of Nigerian paints had lead levels above 600 ppm, only 78% of Asian paints were above this level. Furthermore, 52% of Nigerian paints had lead levels above 5000 ppm compared to 66% of Asian paints.

4. Discussion

This is the first report of an examination of the lead levels in new paint in Africa and we found almost all the paints tested had lead above the recommended level. We also found that while these levels varied significantly by color — with the highest levels occurring in bright colorful paints like yellow, red and green, they did not vary by manufacturer suggesting that all manufacturers were producing paint with above recommended lead levels and the main determinant of varying lead level was use of lead pigments to enhance colors in paint.

The health hazards of exposure to lead in the domestic environment have been understudied in developing countries though its importance as a source of morbidity is widely recognized (Nriagu et al., 1996). Previous studies in Nigeria have shown that over 70% of children have lead above 10 μg/dL and that flaking paint was an important determinant of this (Pfitzner et al., 2000; Wright et al., 2005). Lead exposure is associated with a wide variety of effects (Agency for Toxic Substances and Diseases Registry, 1999). Recent studies show that even once thought safe blood lead levels are associated with increased risk of death from many causes (Menke et al., 2006). Adults tend to be exposed to lead through occupations and inhalation of fumes from combustion of leaded petrol, children are less likely to be exposed in this manner because they are not yet members of the workforce. Exposure to lead in the domestic environment is therefore a particular hazard for them.

Many countries have legislation setting the permissible limits of lead in domestic paints but these are often poorly enforced. Comparison of our data with that of some countries in Asia (India, Malaysia and China) show similarly high levels of lead in the paint sold in these countries while paint sold in a developed Asian country — Singapore — where regulations are enforced generally contained lower or no lead levels (Clark et al., 2006). Recent economic recovery in Nigeria may lead to increased activity in the building industry and Nigeria like other African countries is increasing trade with Asia, particularly with China. It is therefore important that an international regulatory regime should be in place to supplement local efforts to ensure that paints have lower than recommended lead levels, with the ultimate goal of eventually eliminating all lead from paint. Increasing globalization and outsourcing of manufacturing increases the likelihood that products with higher than permissible levels of lead may be traded across borders into countries with effective regulation of local paint industry (Anon, 2007). One of the brands of paint tested in Nigeria is manufactured by a corporation that also produces paint in Asia. While its brand in Nigeria and India contained high levels of lead, the brand sold in Singapore did not.

Lead in paints can be replaced by the use of other additives such as titanium dioxide or barium sulfate and their durability can be improved by adding silicon or aluminum oxides. The increase in cost resulting from these is relatively small and cannot be compared with the human cost of continued exposure to lead. In a recent report from South Africa, 20% of the houses tested had at least one surface containing a hazardous level of lead (Mathée et al., 2003). High lead levels have recently been reported in new residential paints sold in China, India and Malaysia but not in a nearby country with an enforced lead regulation (Singapore) (Clark et al., 2006). Previously, high lead levels had been reported in new paints in India (Clark et al., 2005; Van Alphen, 1999).

Our cross country analysis of lead content of paint also show that in all countries, paints of the color yellow, red and green were most likely to contain the highest lead levels — even in countries with lead content within permissible levels while colors like white and blue have generally lower lead contents. Banning the sale of leaded paints is clearly an immediately achievable public health goal that will benefit the present and future generations of children and adults. This is made more urgent by studies that show that there is no safe lead...
level (Canfield et al., 2003; Lanphear et al., 2000). In the interim, the use of bright colors such as yellow, red and green should be avoided by consumers in these countries because of the high risk that they contain non-permissible levels of lead.

5. Conclusion

There is a need to increase awareness of the harmful effects of lead in the domestic environment, in household paints, similar to what has been done for leaded petrol (Adebamowo et al., 2006b,c; Thomas et al., 1999). A public health agenda leading to elimination of lead in paint should be formulated and systematically prosecuted (Clark et al., 2006). There is an urgent need to determine the extent of leaded paints in existing housing stock in Nigeria and other developing countries, its effect on children’s blood lead levels, and to develop programs to reduce the risk of exposure.

References


