The lead content of currently available new residential paint in several Asian countries

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Abstract

Worldwide prohibitions on lead gasoline additives were a major international public health accomplishment, the results of which are still being documented in parts of the world. Although the need to remove lead from paints has been recognized for over a century, evidence reported in this article indicates that lead-based paints for household use, some containing more than 10% lead, are readily available for purchase in some of the largest countries in the world. Sixty-six percent of new paint samples from China, India, and Malaysia were found to contain 5000 ppm (0.5%) or more of lead, the US definition of lead-based paint in existing housing, and 78% contained 600 ppm (0.06%) or more, the limit for new paints. In contrast, the comparable levels in a nearby developed country, Singapore, were 0% and 9%. In examining lead levels in paints of the same brands purchased in different countries, it was found that some brands had lead-based paints in one of the countries and paints meeting US limits in another; another had lead-free paint available in all countries where samples were obtained. Lead-based paints have already poisoned millions of children and likely will cause similar damage in the future as paint use increases as countries in Asia and elsewhere continue their rapid development. The ready availability of lead-based paints documented in this article provides stark evidence of the urgent need for efforts to accomplish an effective worldwide ban on the use of lead in paint.

Keywords: Lead-based paint; Housing; Childhood lead poisoning; Globalization and the environment; International public health

1. Introduction and background

The phasing out of lead from gasoline is regarded as a critical first step in reducing worldwide blood lead concentrations and is considered a major international public health achievement (Falk, 2003). The phase out has been accomplished by actions in many countries, Western countries such as the United States, countries in the former Soviet Union, in Asia (Michaelowa, 1997; Lovei, 1999), Africa (Montgomery and Mathe, 2005), and elsewhere.

The percentage of children aged 1–5 years in the US with blood lead levels 10 µg/dL or higher has reduced from 77.8% to 4.4% from the period 1976–1980 to 1991–1994 and further reduced to 0.7% in the period 1999–2002 (MMWR, 2005). These dramatic reductions are due in part to the reduction of air lead and in part to efforts to control exposures from lead-based paints in older housing (Falk, 2003). The estimated number of US housing units containing lead-based paint was reduced from 64 million in 1990 to 24 million in 2000 through demolition, rehabilitation, lead hazard control, and other factors (Jacobs et al., 2002). Public health awareness of the dangers to the health of children and others from lead-based paint increased in the United States in the middle of the 20th century, although a US regulation of the lead content in new paint for residential use was not in effect until 1978 when a limit
of 600 ppm became effective (US CPSC, 1977). For existing housing, US regulations now require that the paint contain less than 5000 ppm or 1.0 mg/cm² of lead (US HUD, 1995; US EPA, 2001a). Decades earlier the International Labour Organization promulgated a convention on the prohibition of the use of lead-based residential paint (ILO, 1921). Some other countries have established limits on the lead content of paint; Singapore, for example, has a limit of 600 ppm in new paints (Singapore NEA, 2004). In many countries, however, there are apparently still no regulations on the lead content of either new paint or paint in existing housing.

In many developing countries lead exposure from smelters and battery-recycling operations are considered to be major sources of lead poisoning for children and adults (Falk, 2003; Hashim et al., 2000; Nriagu et al., 1996; Shen et al., 1996). Little is known, however, about the lead content of paint in many developing countries and thus about exposures to children from lead-based paint.

Reports on the paint lead levels in housing in Asia and Africa are very few. In China, painted surfaces of classroom desks, pencils and toys are reported to contain hazardous levels of lead (Shen et al., 1996). Over 60% of houses of a population of children in Venezuela with elevated blood lead were found to have paint lead levels above the regulatory limit (Rojas et al., 2000). Lead chromate has been reported to be unregulated in most African countries (Nriagu et al., 1996). In a recent report on lead paint levels in South Africa (Montgomery and Mathe, 2005), it was stated that a voluntary agreement has been in place among some industry stakeholders since the 1970s to limit the use of lead in paint but that a regulatory limit had not been established. In their survey of 239 homes, 20% were found to contain at least one surface with lead-based paint as defined by the US. Paint is considered to be a source of lead for children in Malaysia but levels of lead were not provided (Hashim et al., 2000). Lead-based paint was found in the homes of 3 of 10 children with blood leads of at least 40 μg/dL in India (Kuruvilla et al., 2004). Several years ago, an examination of samples of 24 new paints purchased in India (Van Alphen, 1999) revealed that 4 (17%) had a lead concentration exceeding 0.5% by weight, 3 (13%) were higher than 1% and 1 (5%) exceeded 10%. In a recent study of new paint in India, field-portable X-ray fluorescence (XRF) analyzers were used to determine the lead content (mg/cm²) of surfaces with a single coat of new paint and three coats of new paint. Three coats were used to simulate surfaces in older housing, which typically receive multiple coats over time; 14% of surfaces with one coat of paint and 28% of surfaces with three coats of new paint, respectively, had lead levels greater than or equal to the US limit of 1.0 mg/cm² for existing housing (Clark et al., 2005).

It is very important to know the content of lead in paint in existing housing so that the necessary poisoning prevention efforts can be implemented. Equally important for future generations is whether lead-based paints for domestic use are currently available and are continuing to be applied in housing. If lead-based paints are still available, then major action is needed to promote their effective banning to curb the growth of future cases of lead poisoning, an entirely preventable disease.

2. Objective and methods

In an effort to determine the extent to which lead-based paint is currently available for purchase in selected Asian countries, new paint samples were obtained in China, India, Malaysia, and Singapore. In each of the study countries, new paints were purchased from retail shops readily accessible to the public. Paints were selected with assistance of coauthors and others in the countries involved using two criteria: multiple brands and a variety of colors. The colors selected included those sampled earlier by Van Alphen (1999)—black, blue, green, orange, red, and white. To prepare each paint sample, the paint was stirred and applied by brush to individual wood blocks. Each stirring utensil and paintbrush was used only once. The paint was carefully removed from a premeasured area on the painted wood surface using a clean sharp paint scraper, using care not to remove portions of the wood. The scraping was done in the Hematology and Environmental Laboratory at the University of Cincinnati, which also analyzed the removed paint for lead. Paint scrapings were 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 (US EPA, 2001b). 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 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.

3. Results

A total of 80 samples of paint were obtained from four countries: 9 were obtained in Shanghai, China; 17 were obtained in India from Vallabh Vidyanagar, Gujarat and in the Territory of Diu; 32 were from Johor Bahr and Kuala Lumpur, Malaysia; and 22 were from Singapore. A wide range of paint lead concentrations were observed (Fig. 1) with paints from China, India, and Malaysia.
generally having much higher concentrations of lead than those from Singapore. Concentrations of 10% and higher were found in some samples from India and Malaysia. The percentages of paint samples with lead concentrations exceeding the US limit of 600 ppm for new paints were 100%, 72%, 56% and 9% for India, Malaysia, China, and Singapore, respectively; and the percentages of which would be defined as lead-based paint in existing US housing (5000 ppm) were 82%, 62%, 44%, and 0%, for India, Malaysia, China, and Singapore, respectively (Table 1). One of the new paints from Malaysia (143,000 ppm) had also recently been applied to an existing home; the label from this paint indicated that its producer was a Korean company.

Sixty-six percent of new paint samples from China, India, and Malaysia combined were found to contain 5000 ppm (0.5%) or more of lead and 78% contained 600 ppm (0.06%) or more. In contrast, the comparable levels in a nearby developed country, Singapore, were 0% and 9%.

Some brands of paint sampled were marketed in two or more countries (Table 2). In examining lead level, of the same brand in different countries, it was found that some of the paints were lead-based paints in one of the countries and not in another. Samples of one brand were obtained in India and Singapore; the samples from India contained from 1.10% to 15.9% lead while in the samples from Singapore the levels ranged from less than 0.005% lead to 0.04%. Paint samples of another brand contained 2.4–14.9% lead in Malaysia and about 0.004% in Singapore. A third brand of paint, for which the containers state that no lead was added, contained less than detectible levels of lead (less than 9 ppm (0.0009%) in Malaysia and Singapore.

4. Discussion and conclusions

In the first known study of the lead levels in new paints in several Asian countries, the lead levels in the three countries which did not have regulatory limits greatly exceeded levels in the regulations in place in the US and elsewhere. In the fourth country where paint samples were collected, and which had a regulatory limit, concentrations were markedly lower. Some brands of paint marketed in two or more countries had lead-based paint in one country and low-lead paint in the country that had a regulatory limit. One of the brands of yellow paint analyzed in this study, marketed with a label statement that it contains no added lead, contained a low level of lead, <9 ppm, in the country that contained a regulatory limit (Singapore) and in one that did not (Malaysia). In a third country (India) the level of lead in yellow paint from this brand was found, by XRF analysis in a previous study (Clark et al., 2005), to contain 0.00 mg/cm². In unpublished data from new paint

<table>
<thead>
<tr>
<th>Color</th>
<th>Brand</th>
<th>India</th>
<th>Malaysia</th>
<th>Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow A</td>
<td>159,200&lt;sup&gt;b&lt;/sup&gt;</td>
<td>—</td>
<td>408</td>
<td></td>
</tr>
<tr>
<td>Green A</td>
<td>39,200</td>
<td>—</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Brown A</td>
<td>10,980</td>
<td>—</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Yellow B</td>
<td>—</td>
<td>149,100</td>
<td>47&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Green B</td>
<td>—</td>
<td>24,200</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Yellow C</td>
<td>&lt;9</td>
<td>&lt;9</td>
<td>&lt;9</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Paint lead levels determined by atomic absorption.
<sup>b</sup>Average of two samples (187,200 and 131,300 ppm).
<sup>c</sup>Average of two samples (86.8 and <9 ppm).
<sup>d</sup>As described under Discussion and conclusions, using unpublished data, the yellow paint in India from brand C was estimated to contain less than or equal to 1328 ppm lead.
samples analyzed first by XRF and then by atomic absorption (AA), of 28 paint samples measured by XRF as 0.00 mg/cm², the corresponding AA values ranged from <9 to 1328 ppm. Thus it is likely that the brand marketed in India as having no added lead, and measured as 0.00 mg/cm² by XRF, contained less than or equal to 1328 ppm lead. One of the countries where high lead levels were frequently found (Malaysia) is adjacent to the country with low lead levels and a regulatory limit, Singapore. In general, it appears that the lead levels of many brands of paint depend on whether an enforceable regulatory limit exists in the specific country where the paint is marketed.

Lead-based paint was readily available for purchase in three of the four countries where samples were obtained. It is also possible that these lead-based paints could be exported to other countries, including the United States, as it has on jewelry, miniblinds, and other consumer products. As paint use in housing increases in these countries, a very likely result of increasing development, it is only a matter of time before childhood lead poisoning becomes an even greater public health issue. Substitutes for lead pigments have been available for many years and are indeed used in at least one paint brand marketed in three Asia countries where samples were obtained. Therefore, preventing future poisonings of children and others exposed to paint is a clearly achievable public health goal. This goal urgently calls for worldwide action, similar to that which occurred for gasoline lead additives. With the increased attention being given to globalization issues, including the environmental conditions of workers and families involved, consideration should be given to the inclusion in agreements and treaties of bans on the use of lead in paints so that this preventable disease does not increase.

Acknowledgments

Paint samples were analyzed in the Hematology and Environmental Laboratories of the University of Cincinnati Department of Environmental Health by Jim Bucha-

References