



Examination of lead concentrations in new decorative enamel paints in four countries with different histories of activity in lead paint regulation

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ABSTRACT

Paints with high lead concentrations (ppm) continue to be sold around the world in many developing countries and those with economies in transition representing a major preventable environmental health hazard that is being increased as the economies expand and paint consumption is increasing. Prior lead paint testing had been performed in Brazil and India and these countries were selected to examine the impact of a new regulatory limit in Brazil and the impact of efforts of non-governmental organizations and others to stop the use of lead compounds in manufacturing paints. Armenia and Kazakhstan, in Central Asia, were selected because no information on lead concentration in those regions was available, no regulatory activities were evident and non-governmental organizations in the IPEN network were available to participate. Another objective of this research was to evaluate the lead loading ($\mu\text{g}/\text{cm}^2$) limit determined by X-Ray Fluorescence (XRF) for areas on toys that are too small to obtain a sample of sufficient size for laboratory analysis. The lead concentrations in more than three-fourths of the paints from Armenia and Kazakhstan exceeded 90 ppm, the limit in the United States, and 600 ppm, the limit in Brazil. The percentages were about one-half as high in Brazil and India. The average concentration in paints purchased in Armenia, 25,000 ppm, is among the highest that has been previously reported, that in Kazakhstan, 15,700 ppm, and India, 16,600, about median. The average concentration in Brazil, 5600 ppm, is among the lowest observed. Paints in Brazil that contained an average of 36,000 ppm before the regulatory limit became effective were below detection (< 9 ppm) in samples collected in the current study. The lack of any apparent public monitoring of paint lead content as part of regulatory enforcement makes it difficult to determine whether the regulation was a major factor contributing to the decline in lead use in these paints. Using data from the current study and those available from other studies 24 of 28 paints from major brands in India decreased from high concentrations to 90 ppm or lower. Since lead concentrations in golden yellow paints from these brands were found to decrease to ≤ 90 ppm, it is possible that all 28 of these paints now contain ≤ 90 ppm since yellow paints usually have the highest lead concentrations. Other brands in Brazil and India that have been analyzed only one time had lead concentrations up to 59,000 ppm and 134,000 ppm, respectively. Less than one-third of the paints had notations on their labels with information about lead content and these were sometimes inaccurate. The label from one brand indicating “no added lead” contained paint with 134,000 ppm lead, the highest found in this study. Three percent (3 of 98) of the paints with surface lead loading that did not exceed $2 \mu\text{g}/\text{cm}^2$, the limit established by the Consumer Product Safety Improvement Act for small areas on toys, contained greater than 90 ppm lead and thus were false negatives. Of the new paint samples that contained ≤ 600 ppm, 88% contained ≤ 90 ppm. Of the samples that contained ≤ 90 ppm, 97% contained ≤ 45 ppm and 92% contained ≤ 15 ppm. Based on

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these data it appears to be technically feasible to manufacture paints containing ≤ 90 ppm and in many cases to produce paints that have lead concentrations that do not exceed 15 ppm.

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1. Introduction and background

Lead poisoning from the legacy of the use of lead-based paint in housing can be a continuing environmental health problem even after the use of lead compounds in the manufacturing of paint has ended. In the United States, for example, even after the use of lead was restricted much earlier in 1978, significant lead-based paint hazards still exist in over 20 million housing units (Jacobs et al., 2002). In a report on lead concentrations in new enamel decorative paints in twelve other countries (Clark et al., 2009) the average concentrations ranged from 7000 ppm to 32,000 ppm total lead. More than two-thirds of the paint companies had at least one sample with a very high lead concentration, greater than 10,000 ppm, more than one hundred times the current limit of 90 ppm in the United States (CPSIA, 2008) that went into effect in 2008. The previous limit was 600 ppm, which went into effect in 1978 (CPSC, 1997). Similar results have been reported by others: for example Toxics Link/IPEN (2009), Kumar and Gottesfeld (2008), Adebamowo et al. (2007), Ewers et al. (2011), Nganga et al. (2012) and Gottesfeld et al. (2013). Kumar and Clark (2008) found that almost one-half of the houses in Delhi examined had at least one floor or window sill lead dust wipe sample that exceeded the USEPA standard. In recent years concern over the detection of leaded paint on imported toys and other products has drawn increased attention in the United States and in other countries (APHA, 2007; CDC, 2012; Kumar, 2007; Lin et al., 2008; Weidenhamer and Clement, 2007).

Documentation of the continued presence of high lead concentrations in new enamel decorative paints in many countries throughout the world, and the concern that this has raised, has led to the formation of the Global Alliance to Eliminate Lead Paint by the World Health Organization and the United Nations Environmental Program (UNEP, 2013a). Efforts are under way in many countries to increase awareness of the health hazards of paints containing lead and to prohibit the use of lead in paints. In Sri Lanka, legislation restricting the lead content of paints became effective January 1, 2013 (Center for Environmental Justice, 2013). The European Union has funded a three-year project (2012–2015) through IPEN (2013), an international network of non-governmental organizations working towards a toxic-free environment, to eliminate the use of lead in paints in seven Asian

countries including India. This multi-faceted project will include two rounds of paint lead testing. IPEN also recently completed a nine-country paint testing project for UNEP (2013b).

The available data on the lead concentration of latex (water-based) paints (e.g. Kumar and Gottesfeld, 2008; Toxics Link/IPEN, 2009) indicates that these paints usually have very low lead concentrations; they were therefore not sampled in this study (University of Cincinnati, 2013).

Data on the lead concentration in paints where lead compounds have not intentionally been used in formulating the paints are important in programs to determine compliance with regulations limiting lead concentration. Such data can be obtained by examining the lead concentration of paints expected to contain very low levels of lead or where use of lead compounds in producing the paint has been discontinued. In an examination of the distribution of lead concentrations ≤ 600 ppm in samples of new decorative enamel paints collected in several previous studies (e.g. Clark et al., 2009; Ewers et al., 2011; Clark et al., 2014) it was found 66 percent (69 of 105) of the paints with concentrations that did not exceed the former US limit of 600 ppm were also less than the current US limit of 90 ppm (Table 1). Of the 69 samples with concentrations that did not exceed 90 ppm, 71% (49 of 69) did not exceed 45 ppm and 45% (31 of 69) did not exceed 15 ppm, suggesting that when lead compounds were not deliberately used in manufacturing paint, lead concentrations are often less than 15 ppm.

The surface lead loading ($\mu\text{g Pb}/\text{cm}^2$) was also determined for the samples collected in this study. These data permitted an examination of the US Consumer Product and Safety Improvement Act (CPSIA) of 2008 (CPSIA, 2008) that permitted the use of portable X-Ray Fluorescence (XRF) lead paint analyzers, which measure lead in units of $\mu\text{g}/\text{cm}^2$, to determine the lead content in areas of toys that are too small to obtain a sufficiently sized sample for laboratory determination of lead concentration (ppm). Although technically lead loading and lead concentration can only be equated if the density and thickness of a paint layer are known, the use of lead loading is permitted under the CPSIA and also is commonly used in lead paint inspections in existing housing in the United States (HUD, 2012). The allowable limit in the CPSC limit for small areas on toys is $2 \mu\text{g Pb}/\text{cm}^2$.

In this study lead concentrations in new enamel decorative paints were determined in four countries: two of which have either a mandatory (Brazil) or voluntary limit (India) on the lead concentration and two that do not, Armenia and Kazakhstan. In the first two countries the lead concentrations are compared with those from earlier analyses to determine whether concentrations had decreased from the high levels previously detected. Prior data on the concentration of lead in new enamel decorative paints were not available in Armenia and Kazakhstan.

2. Materials and methods

2.1. Selection of countries

Two of the countries were selected for the potential to document decreases in the lead content of new paint that may have occurred [in part because of recent regulations, (Brazil) or efforts to promote the need for regulations (India)]. The apparent lack of governmental monitoring of the lead content of paint as part of the regulatory enforcement program in Brazil makes it difficult to determine the

Table 1
Distribution of lead concentration (ppm) of new enamel decorative paints containing less than or equal to 600 ppm.^a

Lead concentration interval (ppm)	# Of total samples in interval	Percent (%) of samples in interval	Cumulative % of samples
Less than or equal to 15 ppm	31	30	30
Greater than 15–45 ppm	18	17	47
46–90 ppm	20	19	66
91–100 ppm	3	3	69
101–150 ppm	9	9	78
151–300 ppm	15	14	92
301–450 ppm	5	5	97
451–600 ppm	3	3	100
Total	105	100	100

^a Samples from database ($n=538$) at University of Cincinnati including those in Clark et al. (2009, 2014) and Ewers et al. (2011).

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