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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 ($\mu g/cm^2$) 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 $\mu g/cm^2$, 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.

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 (μg Pb/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 μg/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 μg Pb/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.

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).

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

reasons for any decline in lead content that may be observed. For each of these countries prior data documented that many brands of paint contained high concentrations of lead. In Brazil, Federal Law 11.762 (effective date when marketing of paint not meeting standard must stop August 1, 2009) limited the total lead concentration of new paint to a maximum of 600 ppm (Brazilian Federal Law, 2008). In analysis of 24 paints produced prior to the effective date of this regulation (Toxics Link/IPEN, 2009) four of six brands tested had concentrations exceeding 600 ppm with the maximum of 170,000 ppm. The average lead concentration in the paints was 15,000 ppm and 38% exceeded 600 ppm lead.

In India the lead content of new enamel decorative paints had been analyzed by several investigators beginning in 1999 (Van Alphen, 1999; Clark et al., 2006; Kumar and Gottesfeld, 2008; Clark et al., 2009; Toxics Link/IPEN, 2009; Johnson et al., 2009; Berne et al., 2011). The average lead concentration in the study with the largest number of paint samples from India (Clark et al., 2009) was 30,000 ppm total lead. Although India's Bureau of India Standards (BIS, 2004) limit of 1000 ppm, (recently lowered to 90 ppm BIS 2013) for the lead content of paint is only voluntary, Toxics Link and others have been actively advocating for a mandatory standard. Some major paint companies in India have indicated that they have eliminated or are in the process of eliminating the use of lead in enamel decorative paints. The latest sampling of many brands of paint prior to the current study still indicated high levels of lead. Analysis of more recent samples collected in this project was used to determine if any changes in lead concentration have occurred. Archival data was also examined to determine if other changes in lead concentrations had previously occurred.

Armenia and Kazakhstan were selected because data on the lead content of new enamel paint were not available in these countries or in other countries in the South Caucasus region of Eurasia and in Central Asia. Regulatory control of lead content of paints had not been established in these countries and member organizations of IPEN in each of these countries were available to participate in the project.

2.2. Collection and preparation of samples

An average of about twenty-five (25) enamel paint samples was collected from each country. Samples were collected during the time period from October 2010 to December 2011. The samples were analyzed during the period from September 2011 to February 2012. The samples were purchased at retail shops. The collected samples were from multiple brands and colors. Colors selected included those that had previously been found to contain high concentrations of lead, such as yellow, green and red, and lighter colored paints such as white, which usually have the lowest concentrations. The samples collected from Brazil and India included colors from popular brands with large market shares that had been previously tested and found to contain greater than 90 ppm lead (Clark et al., 2009; Toxics Link/IPEN, 2009; Johnson et al., 2009). Of the paint brands/colors collected in Brazil and India, ten and nineteen, respectively, had been previously tested. Efforts were also made to purchase some paints in Armenia and Kazakhstan that were from popular brands.

After the paint was obtained, the paint was thoroughly stirred in the can with a single-use clean stirrer. Using a single-use clean brush, a sample of the paint was applied carefully to the smooth side of two pre-numbered, clean, unused piece of black polycarbonate plastic (0.6 cm by 2.5 cm by 12 cm). The samples from an individual paint were allowed to dry at room temperature and then placed in individual unused plastic bags. Information on country where paint was manufactured, country of company headquarters, and the date the paint was manufactured was obtained if available from the labels of the paint cans. Information not provided on the label was supplemented from that available on the brand website. When all of the samples from a country had dried and been packaged, the samples were shipped to the H & E Laboratory at the University of Cincinnati for analysis of total lead content on a dry basis.

2.3. Sample analysis

Two methods were used to quantify the amount of lead in the samples; (1) analysis by a field portable X-Ray Fluorescence Analyzer (Niton XRF with an X-ray tube source- XL3t) in units of micrograms of lead per square centimeter of surface ($\mu g\ Pb/cm^2$) and, (2) Atomic absorption spectroscopy (AA) in units of parts per million (ppm). Quality Assurance procedures for the XRF Analyzer were followed as prescribed in the HUD Guidelines (2012). The Calibration check standard (NIST SRM 2579, 1.02 mg/cm^2) was analyzed before and after each work session (2–4 h) and whenever the instrument was turned off. XRF analysis was performed on two locations on each of the samples. Once the XRF analysis was performed, the paint was carefully removed from about 15 cm^2 of the painted polycarbonate surface by means of a clean sharp paint scraper using care to not remove any of the plastic. The paint scrapings were extracted with 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 of Inductively Coupled Plasma Emission Spectroscopy, EPA, PB92-114172, September 1991 U.S. Environmental Protection Agency (1991). Extracts were analyzed by flame atomic absorption spectroscopy using a Perkin-Elmer 5100 spectrometer. The H & E Laboratory was accredited by the American Industrial Hygiene Association as an environmental lead laboratory under the National Lead Laboratory Accreditation Program. The laboratory participated in the Environmental Lead Proficiency Analytical Testing (ELPAT) proficiency program. Strict quality control procedures were maintained according to the accreditation guidelines.

3. Results of analyses of total lead concentration (ppm)

Data and analysis from each of the selected countries are presented in two tables. In the first table data are presented for

Table 2
Total lead concentration (ppm) of new enamel decorative paints purchased in Armenia.

Sample no.	Brand no.	Brand headquarters	Country where paint manufactured	Date manufactured	Color	Lead concentration (ppm)
A-01	41	Emirates	Emirates	Not available	Blue	2100
A-02	41	Emirates	Emirates	Not available	Green	76,000
A-03	41	Emirates	Emirates	Not available	Red	83,000
A-04	41	Emirates	Emirates	Not available	White	< 9
A-05	41	Emirates	Emirates	Not available	Black	3300
A-06	42	Iran	Armenia	May 2011	Blue	< 9
A-07	42	Iran	Armenia	March 2011	Green	101,000
A-08	42	Iran	Armenia	Feb.2011	Red	36,000
A-09	42	Iran	Armenia	Sept.2011	White	5800
A-10	42	Iran	Armenia	July 2011	Yellow	130,000
A-14	43	Germany	Russia (importer)	Not available	White	< 9
A-16	44	Russia	Russia	June 2010	Dark blue	1210
A-17	44	Russia	Russia	July 2010	Dark green	1110
A-18	44	Russia	Russia	Aug.2010	Red	1240
A-19	44	Russia	Russia	Feb.2011	White	2100
A-20	44	Russia	Russia	Feb.2011	Yellow	38,000
A-21	45	Turkey	Turkey	June 2010	Dark blue	4000
A-22	45	Turkey	Turkey	June 2010	Yellow	45,000
A-23	45	Turkey	Turkey	June 2010	Dark green	22,000
A-24	45	Turkey	Turkey	June 2010	Red	1400
A-25	45	Turkey	Turkey	June 2010	Chocolate	3100
A-26	46	Turkey	Turkey	June 2011	Yellow	86,000
A-27	46	Turkey	Turkey	Feb.2011	White	< 9
A-29	47	Armenia	Armenia	Not available	Yellow	11,300
A-31	35	India	Emirates	Not available	White	41
A-32	35	India	Emirates	Not available	Snuff color	< 9

each sample and in the second they are presented by paint brand including the distribution of the results by percentages greater than 90 ppm, greater than 600 ppm and greater than or equal to 10,000 ppm. Ninety (90) ppm is the current regulatory limit in the United States; 600 ppm is the current limit in Brazil and the former limit in the US for the lead concentrations in new decorative paints. 10,000 ppm represents a very high lead concentration and paints with concentrations at this level and above are thought to contain lead pigments such as lead chromates and lead molybdate.

3.1. Armenia

Of the twenty-six (26) samples from eight brands of enamel decorative paints purchased in Armenia, 10 samples had lead concentrations above 10,000 ppm (Table 2). The highest lead concentration was 130,000 ppm (over 13% lead). The average lead concentration was 25,000 ppm. The two highest lead concentrations, 101,000 ppm and 130,000 ppm total lead, were from paints manufactured in Armenia by a company that had its headquarters in Iran. Of the five samples with lead less than 90 ppm, four were below detection (<9 ppm) and the other had a concentration of 41 ppm. The dates that the paints were manufactured, where available, were between June 2010 and September 2011.

The distribution of lead concentrations by brand and country of brand headquarters for paints purchased in Armenia is presented in Table 3. Seventy-seven (77) percent of the samples had lead concentrations greater than both 90 ppm and 600 ppm. At least one sample from each of six of the eight brands tested had a lead concentration greater than 10,000 ppm. Only one of eight brands of paint purchased in Armenia had its headquarters located in Armenia. The single sample of this brand had a concentration of 11,300 ppm. The other seven brands had headquarters located in six other countries: UAE, Germany, India, Iran, Russia and Turkey (two brands). Only two brands of paint were manufactured in Armenia.

3.2. Kazakhstan

In Kazakhstan, 26 paints samples were analyzed. The samples were manufactured in five different countries (Table 4). The headquarters of the companies were located in four different countries. None of the paint can labels provided information on the lead content of the paint. Single samples of yellow paint collected from brands whose headquarters are located in Poland and Slovenia had lead concentrations of <9 ppm (less than detection) and 310 ppm, respectively.

The average concentration in the 26 samples collected in Kazakhstan was 15,700 ppm (Table 5). Seven of the eight brands had at least one sample with a lead concentration above 90 ppm. Six of the brands had at least one sample with a lead concentration greater than 2000 ppm and five had at least one sample above 25,000 ppm. Four of the brands had one sample with low lead concentration (<90 ppm). Four of the seven (57%) paints from Iran and six of seventeen samples (35 %) from Russia had lead concentrations greater than or equal to 10,000 ppm. Four samples had concentrations <90 ppm; two were below detection (<9 ppm) and the others were 35 ppm and 73 ppm. The dates the paints were manufactured, when available, were from April 2008 to June 2010.

3.3. Brazil

Twenty (20) samples of new enamel decorative paints were collected in Brazil from December 8 to 12, 2011. Each of the paint samples was purchased after the date the regulatory limit was in effect. The paints were all manufactured in Brazil and the headquarters were also in Brazil. The dates of manufacture, where provided, were from June 2010 to December 2011. As shown in Table 6, each of the ten paints found to have high lead concentrations levels before the regulatory limit went into effect (Toxics Link/IPEN, 2009), had concentrations at the detection limit (<9 ppm) after the effective date of the regulation. The largest decrease observed was in a yellow paint where the concentration decreased from 170,000 ppm to <9 ppm. Another sample (BRZ-54) from one of the brands tested earlier (51) but from a color not tested earlier, contained only 91 ppm; the other four colors of this brand decreased in concentration from a range of 57 ppm to 61,000 ppm to <9 ppm. The other nine samples collected in the current study were from four brands not previously tested. The lead concentration in five of these samples ranged from 1470 ppm to 59,000 ppm, with an average of 22,000 ppm. Two samples collected from one of these four brands (black and white) contained <9 ppm as did a white sample from another brand in this group. The remaining sample contained 520 ppm. Of the 13 samples with less than 90 ppm lead, all were below detection (<9 ppm).

The distribution of the lead concentrations (ppm) by brand of paints for those colors that were purchased in Brazil before (Toxics Link/IPEN, 2009) and after (current study) the regulatory limit of 600 ppm went into effect is summarized in Table 7. For five of the total of eight brands tested, all samples met the regulatory limit of 600 ppm. For the other three brands, five of the seven paints exceeded 600 ppm.

The distribution by brand of lead concentrations in paints not tested previously (Table 8) shows two brands with very high concentrations, one with moderately high concentrations and one below detection.

3.4. India

Twenty-six (26) new enamel decorative paint samples were purchased in India and analyzed for total lead concentration (ppm)

Table 3
Distribution of lead concentration (ppm) by brand and brand headquarters of new enamel decorative paints purchased in Armenia.

Brand	Brand headquarters	# Of samples	Average ppm	% > 90 ppm	% > 600 ppm	% ≥ 10,000 ppm	Maximum ppm
No. 35[a]	India	2	23	0	0	0	41
No. 41	Emirates	5	33,000	80	80	40	83,000
No. 42	Iran	5	55,000	80	80	60	130,000
No. 43	Germany	1 (White)	<9	0	0	0	<9
No. 44	Russia	5	8700	100	100	20	38,000
No. 45	Turkey	5	15,100	100	100	40	45,000
No. 46	Turkey	2	43,000	50	50	50	86,000
No. 47	Armenia	1 (Yellow)	11,300	100	100	100	11,300
Overall		**26**	**25,000**	**77**	**77**	**38**	**130,000**

[a] Manufactured under license from a company in Dubai, UAE, which is an indirect subsidiary of Brand no. 19 located in India (Information supplemented by the company website).

Table 4
Lead concentration (ppm) of new enamel decorative paints purchased in Kazakhstan (Information on lead content not indicated on any of the paint can labels).

Sample #	Brand no.	Brand headquarters	Country where paint manufactured	Date manufactured	Color	Lead concentration (ppm)
KZ-01	42	Iran	Iran	April 2008	Brown	9000
KZ-02	42	Iran	Iran	Jan. 2008	Blue	9300
KZ-03	42	Iran	Iran	Feb.2010	White	< 9
KZ-04	42	Iran	Iran	May 2008	Green	71,000
KZ-05	57	Iran	Iran	March 2009	Blue	11,800
KZ-06	57	Iran	Iran	Not available	Brown	39,000
KZ-07	57	Iran	Iran	Aug. 2009	Red	48,000
KZ-08	58	Russia	Russia	March 2009	Yellow	50,000
KZ-09	58	Russia	Russia	April 2010	White	73
KZ-10	54	Russia	Ukraine	July 2009	Yellow	39,000
KZ-11	54	Russia	Ukraine	May 2010	White	1120
KZ-12	54	Russia	Ukraine	Sept.2009	Red	16,300
KZ-13	54	Russia	Ukraine	May 2010	Brown	2100
KZ-14	54	Russia	Ukraine	June 2009	Green	12,100
KZ-15	54	Russia	Ukraine	May 2010	Blue	1140
KZ-16	54	Russia	Ukraine	March 2010	Green	5400
KZ-17	54	Russia	Ukraine	April 2010	Yellow	56,000
KZ-18	60	Slovenia	Slovenia	Not available	Yellow	310
KZ-19	61	Poland	Poland	Not available	Yellow	< 9
KZ-20	62	Russia	Russia	May 2010	Blue	2500
KZ-21	62	Russia	Russia	June 2010	White	1940
KZ-22	63	Russia	Russia	Not available	Green	4900
KZ-23	63	Russia	Russia	Not available	Yellow	26,000
KZ-24	63	Russia	Russia	Not available	Blue	2800
KZ-25	63	Russia	Russia	Not available	Red	2400
KZ-26	63	Russia	Russia	Not available	White	35

Table 5
Lead concentration (ppm) by brand and brand headquarters of new enamel decorative paints purchased in Kazakhstan.

Brand no.	Brand headquarters	Samples (#)	Average (ppm)	> 90 ppm (%)	≥ 600 ppm (%)	≥ 10,000 ppm (%)	Maximum (ppm)
42	Iran	4	22,000	75	75	25	71,000
54	Russia	8	16,600	100	100		000
57	Iran	3	33,000	100	100	100	48,000
58	Russia	2	25,000	50	50	50	50,000
60	Slovenia	1	310	100	0	0	310
61	Poland	1	< 9	0	0	0	< 9
62	Russia	2	2200	100	100	0	2500
63	Russia	5	7200	80	80	20	26,000
Overall		**26**	**15,700**	**81**	**77**	**38**	**71,000**

Table 6
Total lead concentrations (ppm) in new enamel decorative paints purchased in Brazil before and after regulatory limit went into effect.

Sample #	Brand[a] no.	Label notations regarding lead content (current study)	Date[b] manufactured	Color	Before regulation (Toxics Link/IPEN, 2009) (ppm)	After regulation (current study) (ppm)
BRZ-35	48	Does not contain heavy metals	Aug. 2014[c]	Yellow	66,000	< 9
BRZ-36	48	Does not contain heavy metals	Aug. 2015[c]	Red	21,000	< 9
BRZ-37	49	Does not contain heavy metals	March 2011	Yellow	170,000	< 9
BRZ-38	49	Does not contain heavy metals	Dec. 2010	Red	5600	< 9
BRZ-39	50	No information	Sept. 2011	Black	4400	< 9
BRZ-40	50	No information	Aug. 2011	White	3900	< 9
BRZ-41	51	No lead	June 2013[c]	Orange	61,000	< 9
BRZ-42	51	No lead	April 2014[c]	Green	7700	< 9
BRZ-43	51	No lead	Sept. 2013[c]	Blue	570	< 9
BRZ-44	51	No lead	Nov. 2013[c]	Red	19,100	< 9
BRZ-54	51	No lead	March 2013[c]	Yellow	Not tested	91
BRZ-45	52	No information	Sept. 2012[c]	Black	Not tested	< 9
BRZ-46	52	No information	Aug. 2012[b]	White	Not tested	< 9
BRZ-47	53	No lead	Oct. 2014[b]	White	Not tested	< 9
BRZ-48	53	No lead	April 2013[b]	Green	Not tested	1470
BRZ-49	53	No lead	April 2013[b]	Blue	Not tested	2100
BRZ-50	55	No information	March 3011	Red	Not tested	59,000
BRZ-51	68	No information	June 2010	Green	Not tested	48,000
BRZ-52	55	No lead	Nov. 2010	Silver	Not tested	1910
BRZ-53	55	No information	Sept. 2010	Sand	Not tested	520

[a] All paints were manufactured in Brazil and all brand headquarters were based in Brazil.
[b] Refers to paint collected for current study.
[c] Date of manufacture not provided; date of expiration was provided and is shown in parenthesis.

Table 7
Distribution of lead concentration (ppm) by brand[a] of new enamel decorative paints purchased in Brazil after regulation (current samples) compared with distribution of concentration in samples collected prior to regulation.

Brand	Number of samples	Average (ppm)	> 90 ppm (%)	> 600 ppm (%)	≥ 10,000 ppm (%)	Maximum (ppm)
Suvinil: before regulation	2	44,000	100	100	100	66,000
Suvinil: after regulation	2	4.5	0	0	0	< 9
Renner: before regulation	2	88,000	100	100	50	170,000
Renner: after regulation	2	4.5	0	0	0	< 9
3RM: before regulation	2	4200	100	100	0	4400
3RM: after regulation	2	4.5	0	0	0	< 9
Dacar: before regulation	4	22,000	100	75	50	61,000
Dacar: after regulation samples	4	4.5	0	0	0	< 9
Overall-before regulation	10	36,000	100	90	50	170,000
Overall- after regulation	10	4.5	0	0	0	< 9

[a] All paints were manufactured in Brazil and all brand headquarters were based in Brazil.

Table 8
Distribution of Total Lead Concentration (ppm) in New Enamel Decorative Paints Purchased in Brazil After Effective Date of Regulation that Were Not Also Purchased Before Regulation.

Brand	Number of samples	Average (ppm)	% > 90 ppm	% > 600 ppm	% ≥ 10,000 ppm	Maximum (ppm)
51	**1**	**91**	**100**	**0**	**0**	**91**
52	**2**	**4.5**	**0**	**0**	**0**	**< 9**
53	**3**	**1180**	**67**	**67**	**0**	**2000**
55	**3**	**20,000**	**100**	**67**	**33**	**59,000**
68	**1**	**48,000**	**100**	**100**	**100**	**48,000**
Overall	**10**	**11,300**	**70**	**50**	**20**	**58,000**

(Table 9). Nineteen (19) of the paints were selected because the lead concentration in previously collected samples was greater than 90 ppm (Clark et al., 2009). These 19 samples were from four of five of the most popular brands in India, as measured by market share of decorative paints (Asian, Berger, Nerolac and Shalimar). Paints from the other brand in the top five in market share (ICI Dulux) were not collected because the lead concentrations were consistently low. The other seven samples were from three brands not previously tested (Brand nos. 65, 66, 67). Two of these brands (nos. 65 and 66) are considered to be from the "informal paint sector" and thus represent small and medium-sized (SME) facilities. The lead concentrations in the six Asian Paint samples decreased from their previously high levels (average of 33,000, maximum 122,000 ppm) to an average of only 37 ppm and a maximum of 143 ppm. Although the concentration in three of four of the Berger paints decreased to less than 90 ppm, the fourth color (golden yellow) was found to contain 3400 ppm lead; this concentration was much lower than the prior value (41,000 ppm) but still higher than the voluntary limit of 1000 ppm and the goal of 90 ppm. A more recent sample (Rajankar et al., 2013) manufactured on October 2012 had a concentration less than 9 ppm. Three of the four Nerolac paints with previously high lead concentrations (up to 85,000 ppm) contained less than 90 ppm in the current testing; one contained 380 ppm, which is higher than the prior 200 ppm. Three of the five Shalimar paints had high concentrations of lead in the samples collected (9500–97,000 ppm), the other two decreased to less than 90 ppm, indicating that the use of lead compounds in their production had ended. A more recent sample of the paint that contained 97,000 ppm (golden yellow) was found to contain 18 ppm (Rajankar et al., 2013). Of the 15 samples containing less than 90 ppm lead, seven had below detection levels (< 9 ppm) and the other eight contained less than 45 ppm.

The distribution of lead concentrations for major brands with data from current study and an earlier one (Table 10) shows substantial decreases in lead concentration: the average concentration has decreased to about one-seventh of the previous level, the percent of samples with very high concentrations of 10,000 ppm or higher decreased from 58 to 11 and the percentage exceeding 90 ppm decreased from 100 to 32. Thirteen of the nineteen paints now met the goal of 90 ppm while none did earlier.

Lead concentrations for the other paints that were not previously analyzed (Table 11) were very high for the two brands: maximum concentrations 93,000 ppm and 134,000 ppm. For one of these brands even the white paint sample had a high concentration (3800 ppm). Five of the total of seven paints from these brands exceeded 90 ppm and 600 ppm.

Using data from previously reported lead paint analyses it was possible to document decreases in total lead concentration from greater than 90 ppm to less than or equal to 90 ppm in nine other paints from the Asian, Berger and Nerolac brands (Table 12). The distribution of total lead concentration by brand for these samples is summarized in Table 13.

Combining data from Tables 9 ($n=19$) and 12 ($n=9$) reveals that 86% (24 of 28) paints of Asian, Berger, Nerolac and Shalimar brands that had lead concentrations greater than 90 ppm in their earlier samples had less than or equal to 90 ppm in the most recent available sample (Table 14).

3.5. Combined data for new paints from Armenia, Brazil, India and Kazakhstan

A comparison of the lead concentrations (ppm) and distributions for the four countries where samples were analyzed (Table 15) revealed that the percentage of samples that exceeded 90 ppm and 600 ppm was highest for the two countries from which samples had not previously been analyzed (Armenia and Kazakhstan) and lowest in the country where a lead regulation is in place (Brazil). Thirty eight percent of samples exceeded 10,000 ppm in Armenia and Kazakhstan. In India, concentrations of lead in many paints for larger paint companies have decreased

Table 9
Total lead concentration (ppm) of new enamel decorative paints purchased in India compared with concentrations in prior samples.

Sample #	Brand	Brand headquarters	Date Manufactured (current study)	Label notations regarding lead content (current study)	Color	Lead concentration (ppm) (previous Study)	Lead Concentration (ppm) (current Study)
I-100	Asian	India	Jan. 2011[a]	No added Pb	Imperial crimson red	6800[b]	18.7
I-101	Asian	India	Apr. 2011[a]	No added Pb	Gray	2400[b]	< 9
I-102	Asian	India	May 2011[a]	No added Pb	Phirozi blue	340[b]	< 9
I-103	Asian	India	Apr. 2011[a]	No added Pb	Lemon yellow	122,000[b]	10.2
I-104	Asian	India	Jan. 2011[a]	No added Pb	Brown	11,000[b]	41
I-105	Asian	India	Sept. 2010[a]	No added Pb	Bus Green	55,000[b]	140
I-106	Berger	India	May 2011	No added Pb	Black	9,600[b]	15.2
I-107	Berger	India	Jan. 2010	No information	Oxford blue	22,000[c]	20
I-108	Berger	India	July 2011	No added Pb	Snow white	15,200[c]	13.7
I-109	Berger	India	May 2010	No information	Golden yellow	41,000[c]	3400 (Note a)
I-110	Nerolac	Japan	Apr. 2011	No added Pb	Phirozi blue	3,900[b]	9.1
I-111	Nerolac	Japan	Apr. 2011	No added Pb	Black	4,800[b]	10.1
I-112	Nerolac	Japan	Jan. 2010	No added Pb	Golden brown	200[b]	380
I-113	Nerolac	Japan	Aug. 2010	No added Pb	Tractor orange	85,000[b]	< 9
I-114	Shalimar	India	Apr. 2011	No added Pb	Black	14,900[d]	< 9
I-115	Shalimar	India	Not available	No information	Bus green	35,000[d]	30,000
I-116	Shalimar	India	March 2011	No added Pb	Dazzling white	3500[d]	14.4
I-117	Shalimar	India	May 2010	No information	Golden yellow	290,000[d]	97,000 (Note a)
I-118	Shalimar	India	Apr. 2011	No added Pb	Deep orange	185,000[d]	9500
I-119	65	India	March 2011	No information	Phirozi blue	No previous sample	4300
I-120	65	India	Feb. 2011	No information	Bus green	No previous sample	57,000
I-121	65	India	Oct. 2010	No information	Golden yellow	No previous sample	93,000
I-122	65	India	Aug. 2010	No information	White	No previous sample	3800
I-123	66	India	Nov. 2010[a]	No information	White	No previous sample	< 9
I-124	67	India	Aug. 2009	No added Pb	Golden yellow	No previous sample	134,000
I-125	67	India	Apr. 2011	No added Pb	Ultra white	No previous sample	< 9

[a] Packaging date.
[b] Clark et al. (2009).
[c] Toxics Link/IPEN (2009).
[d] Rajankar et al. (2013), Concentration < 90 ppm.

Table 10
Comparisons of distributions of lead concentration (ppm) in major brands[a] of new enamel decorative paints purchased in India in current study with concentrations in samples previously analyzed.

Brand no.	Samples (#)	Average (ppm)	> 90 ppm (%)	> 600 ppm (%)	≥ 10,000 ppm (%)	Maximum (ppm)
Asian: prior samples	6	33,000	100	100	50	122,000
Asian: current samples	6	44	17	0	0	143
Berger: prior samples	4	22,000	100	100	75	41,000
Berger: current samples	4	864	25	25	0	3410
Nerolac: prior samples[b]	4	23,000	100	75	25	85,000
Nerolac: current samples	4	101	25	0	0	380
Shalimar-prior samples	5	106,000	100	100	80	290,000
Shalimar-current samples	5	27,300	40			97,300
Overall-prior samples	19	48,000	100	95	58	290,000
Overall-current samples	19	7400	21	10		97,000

[a] All brand headquarters in India except for Nerolac brand which is in Japan.
[b] In more recent samples Ranjankar et al. reported that paint that was at 3410 ppm was now < 9 ppm and that paint that was at 97,300 ppm was now 18 ppm.

Table 11
Distributions of lead concentration (ppm) in new enamel decorative paints collected in current study by brands in India not previously sampled.

Brand	Number of samples	Average (ppm)	% > 90 ppm	% > 600 ppm	% > 10,000 ppm	Maximum (ppm)
65	**4**	**40,000**	**100**	**100**	**50**	**93,000**
66	**1**	**4.5**	**0**	**0**	**0**	**< 9**
67	**2**	**67,000**	**50**	**50**	**50**	**134,000**
Overall	**7**	**42,000**	**71**	**71**	**43**	**134,000**

(Tables 10, 12–14). Other paint companies in India, including one of the larger ones, were found to have samples with lead concentrations exceeding 10,000 ppm. The average concentration was lowest in Brazil and highest in Armenia; the averages were similar in India and Kazakhstan.

3.6. Comparison of lead content information on paint can labels with measured lead concentration (ppm)

Information pertaining to the lead content was indicated on the labels of 32 of the 98 paints purchased. These labels were only from paints purchased in Armenia, Brazil and India and none are from Kazakhstan paints. A summary of the cans containing lead content information (Table 16) revealed lead concentration of 75% of these paints (24 of 32) was less than 90 ppm. However, the lead concentrations in the other eight paints containing more than 90 ppm were: 91, 143, 380, 948, 1470, 2050 and 134,000 ppm. The latter concentration was the highest detected in the new samples analyzed for this project and was in a can with a label claiming "no added lead". Another brand from India with a similar label had a paint containing 9500 ppm. The concentrations of lead exceeded 600 ppm in two of 12 of the paints from Brazil (1470 ppm and 2000 ppm) that contained a label indicating that the paint contained "no lead". In Armenia, where only one brand had a label that referred to the lead content ("no added lead…"), the label notation was consistent with the lead concentration of the two paints sampled which were <9 ppm and 41 ppm.

Table 12
Use of results from previous analyses to determine changes in lead concentration (ppm) in new enamel decorative paints of other colors of major brands in India.

Brand	Color	Lead concentration (ppm) First available sample[a]	Lead concentration (ppm) Most recent available sample
Asian	PO Red	5300	7.5[b]
Asian	Bright White	173	23[c]
Asian	Golden Yellow	187,000	90[b]
Berger	Bus Green	39,000	70[a,b]
Berger	PO Red	3600	70[b]
Nerolac	PO Red	33,000	70[b]
Nerolac	Golden Yellow	90,000	12.3[b]
Nerolac	Bus Green	24,000	80[b]
Nerolac	White	450	11.1[c]

[a] Clark et al. (2009). Paint manufactured or purchased from 2001 to 2006.
[b] Berne et al. (2011).
[c] Toxics Link/IPEN (2009).

3.7. Results of comparison of lead loading ($\mu g/cm^2$) and lead concentration (ppm)

The logarithms of the lead loadings determined by the XRF analyzer and the lead concentration determined by atomic absorption for the ninety-eight (98) samples were strongly correlated (Pearson correlation coefficient 0.96) with a p value <0.0001.

Using the correlation between loading and concentration, the predicted lead concentrations at various lead loadings ranging from 0.5 $\mu g/cm^2$ to 2000 $\mu g/cm^2$ were estimated and are presented in Table 17.

At the CPSIA lead loading limit of 2.0 $\mu g/cm^2$ for areas on toys too small to obtain a sample adequate for laboratory analysis, the geometric mean lead concentrations were estimated to be 85 ppm, very close to the limit of 90 ppm. However, the upper confidence limit of 740 ppm is more than eight times the 90 ppm limit.

Using the relationship between loading and concentration, estimates were made of the XRF loading values for which there were 95% and 99% certainties that the concentration was 90ppm (Table 18). The lowest lead loading reading observed for the ninety-eight samples tested was 0.03 $\mu g/cm^2$. This loading is below the loading of 0.19 $\mu g/cm^2$ where the predicted lead concentration is 90 ppm with a 99% certainty. The XRF instrument used thus appears capable of detecting lead at 90 ppm with 99% certainty.

The distribution of XRF loading ($\mu g/cm^2$) less than or equal to 2.0 shows that the majority of the loading values (83%) are in the lowest quartile (0–0.5), 10% are between 0.51 and 1.00, 2% from 1.01 to 1.50 and 5% from 1.51 to 2.00.

A comparison of surface lead loading ($\mu g/cm^2$) by lead concentration (ppm) range for data from paint samples from the four countries is presented in Table 19. For the 37 samples in the concentration range ≤ 45 ppm the highest lead loading value was 0.67 $\mu g/cm^2$. The single sample in the concentration range of 46–90 ppm had a loading of 1.13 $\mu g/cm^2$ and a concentration of 73 ppm. Three of the paint samples in the 91–600 ppm concentration range had lead loading values less than or equal to 2.0 $\mu g/cm^2$,

Table 14
Summary of paints in India by brand that decreased in lead concentration from >90 ppm to <90 ppm.

Brand	Table 8 data	Table 11 data	Total decreases	# Remaining >90 ppm
Asian	5	3	8	1 (140 ppm)
Berger	4	2	6	0
Nerolac	3	4	7	1 (380 ppm)
Shalimar	3	0	3	2 (9500 ppm, 30,000 ppm,)
Total	13	9	22	6

Table 13
Distribution of lead concentration (ppm) in other colors of major brands in India using results from previous analyses.

Brand	Number of # samples	Average (ppm)	% >90 ppm	% >600 ppm	% $\geq 10{,}000$ ppm	Maximum (ppm)
Asian-first samples[a]	3	64,000	100	67	33	187,000
Asian-recent samples[b,c]	3	40	0	0	0	90
Berger-first samples[a]	2	21,000	100	100	50	39,000
Berger-recent samples[b]	2	70	0	0	0	70
Nerolac-first samples[a]	4	37,000	100	75	75	90,000
Nerolac-recent samples[b,c]	4	43	0	0	0	80
Overall-first samples	9	43,000	100	78	56	187,000
Overall-second samples	9	48	0	0	0	90

[a] Clark et al. (2009). Paint manufactured or purchased from 2001 to 2006.
[b] Berne et al. (2011).
[c] Toxics Link/IPEN (2009).

Table 15
Lead concentration (ppm) results by country for new enamel decorative paints.

Country	Number of brands tested	Number of samples	Average (ppm)	> 90 ppm (%)	> 600 ppm (%)	≥ 10,000 ppm (%)	Maximum (ppm)
Armenia	8	26	25,000	77	77	38	130,000
Brazil	8	20	5600	35	30	10	59,00
India	7	26	16,600	42	35	19	134,000
Kazakhstan	8	26	15,700	81	77	38	71,000

Table 16
Comparison of paint can label information on lead content with laboratory analysis of lead content.

Country (brand #)	Information on label on can pertaining to lead content	# Of paints	Lead concentration values (ppm)
Armenia (35)	No added lead, mercury, arsenic and cadmium	2	< 9, 41
Brazil (48)	Does not contain heavy metals	2	< 9, < 9
Brazil (49)	Does not contain heavy metals	2	< 9, < 9
Brazil (51)	No lead	5	< 9, < 9, < 9, < 9, 91
Brazil (53)	No lead	3	< 9, 1470, 2000
Brazil (55)	No lead	1	1910
India (19)	No added lead	6	< 9, < 9,10.2,18.7, 41, 143
India (35)	No added lead	2	13.7, 15.2
India (20)	No added lead	4	< 9, 9.1, 10.1380
India (64)	No added lead	3	< 9, 14.4, 9500
India (67)	No added lead	2	< 9, 134,000

Table 17
Prediction of geometric mean lead concentration (AA ppm) and confidence interval from lead loading (μg/cm^2).

XRF loading (μg/cm^2)	AA-ppm [geom. mean (confidence interval)] associated with loading
0.5	16 (2, 142)
1.0	37 (4, 320)
2.0	85 (10, 740)
5.0	250 (30, 2200)
10	580 (67, 5000)
30	2100 (250, 18,400)
50	3900 (450, 34,000)
75	6400 (730, 55,999)
100	8900 (1030, 77,000)
300	33,000 (3800, 290,000)
500	61,000 (7000, 520,000)
1000	138,000 (16,000, 1,000,000)
2000	320,000 (36,000, 1,000,000)

Table 18
The lower limit for XRF loading reading where AA values are 90 ppm.

	The lower limit for XRF loading
95% Certainty	0.34
99% Certainty	0.19
Number of obs.	98

the CPSCIA limit for small areas on toys. None of the samples with concentrations higher than 600 ppm had lead loading levels less than 2.0 μg/cm^2. Of the three paints in the 91–600 ppm with a lead loading less than 2.0 μg/cm^2, one was from Brazil (1.59 μg/cm^2 and 90.7 ppm) and two were from India (0.92 μg/cm^2 and 143 ppm, and 1.97 μg/cm^2 and 382 ppm). These three samples are false negatives and represent a false negative rate of about seven percent (3 out of 41) when using the CPSIA limit for an XRF analyzer for determining compliance with the 90 ppm lead concentration limit in the samples in this study.

As can be determined from the data in Table 19, the number of samples with lead concentrations that did not exceed 90 ppm: 38 (39%) was similar to the number that did not exceed 600 ppm: 43 (44%). Of the 38 samples that did not exceed 90 ppm in lead concentration, 37 (97%) contained less than or equal to 45 ppm and 33 (82%) contained less than or equal to 15 ppm.

4. Discussion

The observation that there was little difference in the percentages of paints with lead concentrations exceeding 90 ppm and 600 ppm in this study has also been made elsewhere (Toxics Link/IPEN, 2009; Clark et al., 2009). A plausible explanation for this pattern may be that when lead compounds are not used in manufacturing paints, the resulting lead concentration in the paints is due to small amounts of impurities in other paint components. This possible explanation is also supported by the higher proportion of samples containing ≤ 15 ppm in the current study compared to that in former surveys (Table 1) because 79% of these samples in the current survey with very low lead concentrations are from brands of paint in Brazil and India that exhibited very steep declines in lead concentration that appear to be due to the cessation of the use of lead compounds in making the paints.

The regulatory limit on paint lead content that was established in Brazil may have had some role in the reduction of the lead concentration in paints of larger paint companies to very low lead concentrations (below detection 9 ppm); however smaller companies were shown to have produced high lead paints. Data are not available on the market share of these smaller companies. An analogous situation seemed to have occurred in India where large companies have apparently responded to pressures from NGOs and others to stop the use of lead in making paints, while other smaller companies have not done so.

Of the four paints from major brands in India for which the sample collected in the current study contained greater than 90 ppm (Asian Paint Bus Green 140 ppm, Nerolac Golden Brown 350 ppm, Shalimar Deep Orange 9500 ppm and Shalimar Bus Green 30,000 ppm), more recent samples of golden yellow paint from each of these brands now contained less than 90 ppm lead (Rajankar et al., 2013). Since the golden yellow paints generally contain the highest or close to the highest lead concentration,

Table 19
Number of XRF readings (μg/cm^2) by lead concentration (ppm) range by country (range of XRF readings indicated in parenthesis).

Concentration range (ppm)	Armenia # (μg/cm^2)	Brazil # (μg/cm^2)	India # (μg/cm^2)	Kazakhstan # (μg/cm^2)	Total # (μg/cm^2)
≤15	5 (0.14–0.50)	13 (0.03–0.55)	14 (0.03–0.67)	2 (0.09–0.4)	34 (0.03–0.67)
16–45	1 (0.39)	0	1 (0.41)	1 (0.05)	3 (0.05–0.41)
46–90	0	0	0	1 (1.13)	1 (1.13)
91–600	0	2 (1.59–11.7)	2 (0.92–1.97)	1 (10.4)	5 (0.92–11.7)
601–10,000	10 (5.3–27)	3 (21.2–28.8)	4 (12.9–73.8)	11 (29.8–341)	28 (5.3–341)
10,001–100,000	8 (59.9–402)	2 (434–1240)	4 (433–1260)	10 (315–2530)	24 (59.9–2530)
>100,000	2 (257–437)	0	1 (729)	0	3 (257–729)
Total	**26**	**20**	**26**	**26**	**98**

it is likely that a current sample of each of the four paints would contain less than 90 ppm.

The two paint samples with lead concentrations closest to 90 ppm (73 ppm and 90.7 ppm) had lead loadings (μg/cm^2) of 1.13 and 1.59, respectively, which are within the range of 0.5–2 μg/cm^2 predicted by Cobb (2009) for single coats of paints that meet the 90 ppm limit.

5. Conclusions

Total lead concentrations in new decorative enamel paints purchased in Armenia and Kazakhstan, where limited efforts have thus far been made to reduce the use of lead in paint were higher than those in Brazil and India, where such efforts have been under way for several years. Paints in Brazil that had lead concentrations above 90 ppm in earlier sampling (Toxics Link/IPEN, 2009), which were purchased before the effective date of the regulatory limit of 600 ppm, all had concentrations below the detection level of 9 ppm in the samples from the current study. Some brands from Brazil tested for the first time in the current study had high concentrations of lead. Using data from the current study, from earlier studies and a recently available study, it was documented that decreases from high concentrations of lead to less than or equal to 90 ppm have occurred for 24 out of 28 paint colors from four of the five major Indian brands. Other more recent data (Rajankar et al., 2013) that revealed low lead concentrations in yellow paint from these brands, the color that has often been found to contain the highest concentrations, indicated that these other four colors may now contain low concentrations of lead. The fifth largest paint brand in India had consistently produced paints with low levels of lead.

For paint samples from each of the four countries, there was little difference between the percentage of samples that do not exceed 90 ppm and 600 ppm. Of the samples that contained ≤90 ppm, 97% contained ≤45 ppm and 97% contained ≤15 ppm. Based on these data it appears to be technically feasible in many cased to produce paints that have lead concentrations that do not exceed 15 ppm.

The lead concentration of 77% of the paints from Armenia and Kazakhstan exceeded both 90 ppm and 600 ppm. The percentages exceeding those levels in Brazil and India were about one half as high as those in the other two countries. The average concentration of lead in the new paints sampled was the lowest in Brazil (5600), which is one of the lowest averages observed for any country.

Notations on paint can labels that provided information on whether the paint contained added lead were present on only about an average of one-third of the paint cans purchased but contained misleading information in some cases. For two regional market brands from Brazil with a “no lead” notation, concentrations were more than two to three times higher than the standard of 600 in Brazil; data are not currently available to us on the market share of these brands and whether or not they export any of their paints. Two brands with “no added lead” labels in India contained 9500 ppm and 134,000 ppm lead. The percentage of cans with labels that mentioned lead content ranged from 0% in Kazakhstan to 65% in Brazil.

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