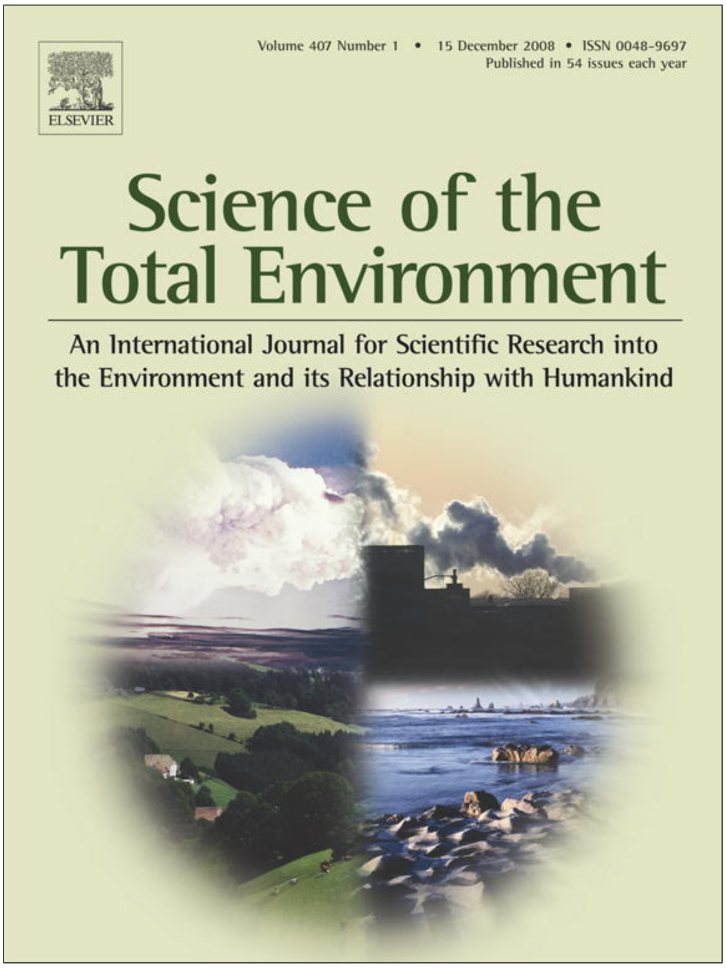
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Short Communication

Lead content in household paints in India

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ABSTRACT

Lead and its compounds are used in paints not only to impart colour but also to make it durable, corrosion resistant and to improve drying. Adverse health impacts of lead especially on children have led countries to restrict or ban its use in paints. While U.S. and other developed countries instituted measures to limit the use of lead in paints, some developing countries including India have failed to regulate their lead content. The present study was undertaken to determine the levels of lead in new latex (water-based) and enamel paints (oil-based) intended for residential use in India. A total of 69 paint samples (38 latex and 31 enamel samples) from six of the most popular brands were analysed for lead concentrations. While all latex paint samples contained low levels of lead, (i.e., well below 600 ppm as regulated by United States' Consumer Products Safety Commission) the enamel paint samples of all but one brand contained significant concentrations of lead, ranging up to 140,000 ppm. In fact 84% of the enamel paints tested exceeded 600 ppm whereas only 38 % of all samples (including latex and enamel types) exceeded this regulatory level.

1. Introduction

Lead is added to paint not only to impart colour but also to make it durable, corrosion resistant, and to improve drying. A number of lead compounds are used as pigments in paints such as lead oxide, lead carbonate (also known as white lead) and lead chromate (ILZSG, 2004). There are, however, readily available substitutes for all lead compounds in paint including titanium dioxide, barium sulfate, and silicon or aluminum oxides used to increase durability (Tanquerel des Planches and Dana, 1848; Rabin, 1989; Adebamowo et al., 2007).

Although children are known to eat paint chips, more commonly lead paint in and around homes contribute to dust and soil contamination that is often the most significant source of exposure for children (Adebamowo et al., 2007). Exposures may also occur when disturbing lead paint during sanding, scrapping and remodeling. Lead in paints at even relatively low levels can become a hazard following remodeling or construction activities that cause significant amounts of paint to be disturbed. Use of lead containing paints in various products has caused worldwide concerns (Nriagu et al., 1997; Kumar and Pastore, 2007). The U.S. Centers for Disease Control and Prevention (CDC) consider blood lead levels in children greater than or equal to 10 μg/dl as the beginning level of concern (CDC, 1991). In fact a growing body of literature points out that children exposed to even lower levels have shown intellectual impairment (Koller et. al., 2004; Needleman, 1995; Needleman and Bellinger, 2001; Needleman et al., 2002).

Evidence that the lead content of residential paints is significant enough to result in lead poisoning among children

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Table 1 – Standards for lead (Pb) in new paints in select countries

USA	Australia	China	Singapore
600 ppm (0.06 %) (Legislation has passed mandating the reduction in the allowable lead paint level to 90 ppm)	1000 ppm (0.1 %)	90 ppm (0.009 %) (soluble lead)	600 ppm (0.06 %)

has been building since the 1890s when it was first linked to symptoms in children in Australia. One of the first pediatric deaths linked to lead paint in a child's crib was reported in 1913 (Rosner et al., 2005; Warren, 2000). For more than a century the hazards associated with lead paint were recognized and have led many countries to enact bans or restrictions on the use of lead for interior paint: France, Belgium, and Austria in 1909; Tunisia and Greece in 1922; Czechoslovakia in 1924; Great Britain, Sweden and Belgium in 1926, Poland in 1927; Spain and Yugoslavia in 1931; and Cuba in 1934 (Markowitz and Rosner, 2000). In 1922 the third International Labour Conference of the League of Nations recommended the banning of white lead for interior use (AJPH, 1923).

The Unites States restricted the use of paints containing more than 600 ppm of lead in 1978 (U.S. Consumer Product Safety Commission, 1977), which has since become a *de facto* reference standard for characterizing lead in paints globally. Although the U.S. standard was not set on health-based criteria, it serves as a practical way to differentiate paints that have lead intentionally added from those products which have very low levels of lead as a naturally occurring contaminant. China has an even more stringent standard for lead in paint at 90 ppm (Barboza, 2007). In fact some have suggested lowering the regulatory level in the U.S. to 40 ppm and recent action by the U.S. Congress in 2008 requires that the standard be lowered to 90 ppm in one year (Best, 2007; U.S. Consumer Product Safety Improvement Act, 2008). India has no regulatory standard on lead in paint. However, a voluntary component of the Ecomark Scheme under the Bureau of Indian Standards (BIS) cites a limit of 0.1% (1000 ppm) of lead in paint (Bureau of Indian Standards, 2004). Table 1 summarizes the select national standards for lead in new paints.

The objective of the present study is to measure the concentration of lead in commercially available decorative paints intended for residential use in India. Paints and coatings are categorized as decorative or industrial. Decorative paints are primarily used on the interior or exterior of homes and buildings and include other coatings such as emulsions, enamels, varnishes, wood finishes and distempers. Decorative paints are also classified as water-based or oil-based paints. In India, latex paints are water-based, while enamel paints are oil-based.

2. Methodology

A total of 69 paint samples were purchased from retail shops in Delhi and Mumbai in November and December 2006 and brought to the Toxics Link office in Delhi. The selected paints were from six common brands readily available in the Indian market and one sample came from a locally distributed brand. One of the brands purchased came with a label indicating, "no added lead, mercury, chromium compounds". According to shopkeepers, all selected paints were intended largely for residential uses for painting the interior and exterior surfaces of houses. Thirty-eight water-based latex paint samples were purchased in 1 L containers and 31 oil-based enamel paints were purchased in a mixture of 50/100/200 ml cans. Sample descriptions are given in Table 2.

Paints were first applied on to individual clean glass surfaces (approximately 900 cm^2) with different brushes for each sample to avoid any cross contamination. The paints were left to dry for a minimum of 72 h. After drying, samples were scraped off from glass surfaces using clean razor blades that were not reused to avoid cross contamination. Samples were labeled and the information from the container labels was recorded. The dried paint samples were placed in sealed polyethylene bags and sent via courier to the Galson Laboratories (East Syracuse, New York), for analysis. Samples were analysed for total lead by Inductively Coupled Plasma Emission Spectroscopy, after digesting the

Table 2 – Sample description

Sample No.	Brand types	Nature of paints	Colours	Place of manufacturing
1, 2, 3, 4, 18, 65	A	Latex	Red, yellow, green, ink blue, white	Delhi
5, 6, 7, 8, 9,10,11, 12, 64	B	Latex	Red, Blue, Black, Orange, green, yellow, base, white	Delhi
13, 14, 15, 16, 17	G	Latex	Yellow, blue, red, green, white	Delhi
19, 20, 21, 22, 23, 24, 62	D	Latex	Red, white, blue, green, yellow, white, base	Delhi
57, 59, 60, 66, 67, 68, 69, 70	E	Latex	White, red, yellow, black, black, blue, deep orange	Delhi
58, 61, 63	F	Latex	White and base	Delhi
25, 52, 53, 54, 55, 56	A	Enamel	White, red, yellow, black, black, blue, deep orange	Delhi, Mumbai
26, 27, 28,	D	Enamel	Black, white, red	Delhi
29, 30, 47, 48, 49, 50, 51	B	Enamel	Orange, yellow, green, white, red, black, blue	Delhi
31, 32, 33, 34, 45, 46	E	Enamel	Red, white, orange, green, blue	Delhi
35, 36, 37, 38	G	Enamel	Red, yellow, green, blue	Delhi
39, 40, 41, 42, 43, 44	H	Enamel	Blue, green, black, white, red	Delhi

Table 3 – Statistical summary of lead concentration in enamel paint samples of different brand types

Brand Type	Maximum Concentration (ppm)	Minimum concentration (ppm)	Arithmetic mean (ppm)	Standard Deviation	Median (ppm)
A	140,000	25	33,254.20	54,088.90	7350
B	110,000	2600	36,300	43,871.50	17,250
D	62	31	49.7	16.44	56
E	86,000	72	33,345.30	38,955.70	17,850
G	64,000	8000	23,750	26,887.10	11,500
H	59,000	2200	16,250	21,786.90	8650
All	140,000	25	26,130.52	36,636.86	7800

samples with EPA method PB92-114172, Sept. 1991; SW846-740 (U.S. EPA, 2001).

3. Results

All water-based latex paints contained less than 25 ppm of total lead concentration. These paints therefore comply with the voluntary guidelines under the Indian Ecomark Scheme, which suggests that total lead concentration in paints should not exceed 1000 ppm (0.1 percent). Table 3 provides the mean, median and standard deviation for the levels of lead in the enamel paints tested by brand. In cases where the data are skewed (as noted for some of the paint brands), the median is a better measure of central tendency. However, for purposes of estimating cumulative lead exposure from these products, the arithmetic mean is more useful.

It is observed that most oil-based enamel paints contain high concentrations of lead (Pb), ranging up to 140,000 ppm (0.0025 to 14 percent). Only one paint brand tested (i.e. brand D) had results consistently less than 600 ppm. The average concentration of lead ranged from 49.7 ppm to 33,345.3 ppm among the brands tested. As per Fig. 1, the white enamel paints had the lowest concentration of lead among all colors tested. The average concentration for white enamel paint was 991.8 ppm while the maximum average concentration of lead was found in yellow colour enamel paints followed by orange, green, red, blue and then black.

As per the current U.S. standard, new paint containing more than 600 ppm (0.06 percent) of total lead is banned for residential use and from products intended to be used by children. Of 31 enamel samples analysed for total lead concentration, 84 percent of samples had more than 600 ppm of lead. The same percentage of samples exceeded 1,000 ppm limit set by Ecomark Scheme, while 61 percent of paint samples contained more than 5,000 ppm. In sum 38 percent of all samples, including latex, enamel and exterior types, contained lead at levels above 600 ppm.

4. Discussion

There is considerable evidence that lead is a neurotoxin at relatively low levels and causes a range of health effects depending on the extent and duration of exposure in both children and adults (Needleman et al., 1979, 1990; Sciarillo et al., 1992; Pocock et al., 1994; Falk, 2003; AAP, 2005; ATSDR, 2005). The results clearly indicate that although water-based

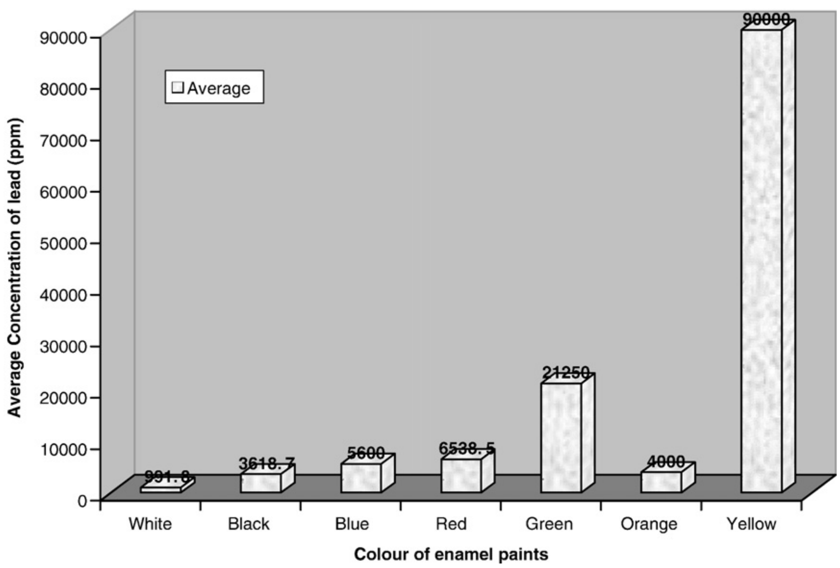

Fig. 1 – Average concentration of lead in different colours of enamel paint samples.

Table 4 – Comparison of present data with that of Clark et al. 2006

	Clark et. al., 2006	The Present Study (enamel paints)
Yellow	159,200 ppm [a]	90,000 ppm
Green	39,200 ppm	21,250 ppm
Brown	10,980 ppm	–
All Samples Median value	16,720 ppm	7800 ppm 26, 131 ppm (average)
Percentage of paint samples having lead concentration more than or equal to 600 ppm	100 (n=17)	84 (n=31)
Maximum	187,200 ppm of 2 samples (187200 and 131300 ppm)	140,000 ppm

[a] Of 2 samples (187,200 and 131,300 ppm).

latex paints have low levels of lead concentration in all brands, it is the high concentration of lead in enamel paints, which is the most worrying part of the whole issue of "lead in paints". Except for one brand, all others had multiple samples that contained high concentration of lead, exceeding the voluntary Indian guideline of 1000 ppm (0.1%) and the U.S. standard of 600 ppm. Table 4 provides a comparison of results of the present study with that of paint samples collected in India by Clark et al. (2006). Although not mentioned, the data obtained by Clark et al. (2006) relates to enamel paints (from personal communication with the corresponding author). Their study reported that 100% of new paint samples from India exceeded 600 ppm whereas the present study reports that 84% of enamel paints sampled have lead concentrations greater than 600 ppm. In general terms, the range of lead concentrations observed is consistent for enamel paints in this study. In contrast, an unpublished study of lead levels in new paints available in the U.S. in the early 1990s indicated that 90% of the 433 samples analyzed were below 0.01% by weight and the overall average was 0.004%. (U.S. Consumer Product Safety Commission, 1993) The study failed to explain the source of these very low lead levels observed.

The results from the present survey in India indicate that water-based latex paints have consistently lower levels of lead than oil-based enamel paints across all brands. The lead concentration in these latex paints suggest that lead is not intentionally added to these mixtures, but is likely contributed as a contaminant along with pigments or other components. However, the high concentration of lead observed in enamel paints suggests that most Indian manufacturers generally add lead in concentrations that exceed the U.S. standard of 600 ppm. Substitutes for lead-based pigments have been available for over one hundred years and titanium dioxide is commonly used for this purpose. At least one brand that is available within the same price range as their competitors appears to have eliminated the use of lead pigment and other lead additives. Indian paint companies can shift to lead-free alternatives and still remain competitive without affecting quality.

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