



Assessment of Lead Levels in some Children's Plastic Toys

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Abstract

The objectives of this study were to determine total lead concentrations, and assess potential health risks, in children's plastic toys. A survey study was collected by obtaining 100 children's plastic toys from the three metropolitan cities (Nakhon Si Thammarat Province, Phattalung Province, and Songkla Province). Children's plastic toys were collected to determine lead concentration by atomic absorption spectrophotometer. Of the 100 children's plastic toys samples, 13 contained > 600 parts per million (ppm) of lead, the maximum level of concern for the US CPSC. The average lead level in the samples as 287.93 ± 721.02 ppm (range 3.01-4486.11 ppm). Among seven colors, pink products had higher lead levels (average 731.63 ± 1375.16 ppm, range 3.82-4486.11 ppm) than products of other colors. Price was not significantly associated with lead level ($r=0.167$, $p=0.096$). Forty samples had hazard quotients of 1.0 (low hazard level). Therefore, lead contamination in children's plastic toys should be investigated regularly. Education of parents would help them realize the toxicity of lead, and encourage them to make more strenuous efforts to protect their children.

Keywords: Assessment lead level, Children's plastic toys

1. Introduction

Some recent, well-known incidents of accidental poisoning have occurred because of the chewing, licking, and swallowing behaviors of children, a common source of lead exposure (1). Children are at particular risk of lead poisoning. Lead exposure can be especially detrimental during pregnancy, fetal development, and early childhood. Chemical exposure to children, especially from toys, is an emerging concern. Metals in materials and paints are loosely bound to

the surface and can leach easily. Lead poisoning from toys causes learning disabilities, kidney failure, anemia and irreversible brain damage in children (WorldNet Daily, 2009) (2). The chewing, licking and swallowing behavior of children is a common source of lead and cadmium exposure (Kelly et al., 1993) (1). Children can absorb up to 50% of the lead they ingest (3). Children's high gastrointestinal uptake, and the permeable blood barrier, makes them more susceptible to neurological damage. However, the duration of the half-life of lead in children's bodies is not clear (3). Lead-contaminated toys

became one of the biggest environmental health stories of recent times. Lead was detected in 20 percent of the toys tested by HealthyToys.org (2008) (4). In many countries, an important route of entry for chemicals and metals is through consumer products. In USA, 35 percent of 1,200 children's products tested were well above the 600 parts per million (ppm) federal recall standard used for lead paint, and will exceed the U.S. legal limit, according to the new Consumer Product Safety Commission (CPSC) regulations. In China, conducted by Greenpeace East Asia and IPEN, measured toxic metals in 500 children's products purchased in five Chinese cities: Beijing, Guangzhou, Hong Kong, Shanghai, and Wuhan. Overall, the data indicated that approximately one-third of the products contained at least one toxic metal above levels of concern. The data revealed 48 products (10 percent) that contained lead at or above the regulatory limit in China. Eighty-two products (16 percent) exceeded the 90 ppm regulatory limit for lead content in paint used in the US and Canada (2011) (5). From tested products in Philippines, the study measured toxic metals in 435 children's products in Cebu, Davao and the metro Manila area in the Philippines. The data revealed 67 products (15 percent) that contained lead at or above the US regulatory limit. Fifty-seven samples (13 percent) contained more than one toxic metal (5). In Thailand, Adisak P (2009) (6) examined the lead levels of children's products and found that 28 of 31 items (90.32 percent) exceeded the 600 ppm. limit recommended by the U.S. Consumer Product Safety Commission (US CPSC, 2005b) (7). Of these 17 pre-school child care centers, there were 187 samples taken from paints, toys, food containers, drinking water and its containers, cups, spoons, dust on floor, etc. to detect for lead contamination. The study found that 11 out of 187 samples, which were collected from the total of 10 pre-school child care centers, had lead concentrations higher than the standard level (10

µg/dl) or 58.8 percent of the total 17 pre-school child care centers being studied by EARTH (Ecological Alert and Recovery Thailand EARTH(2010) (8). Chemical exposure to children, especially from toys, is an emerging concern. Lead in materials and paints are loosely and can leach easily. However, our understanding of chemical safety is constantly evolving and there remain significant gaps in our knowledge regarding many chemicals and their potentially negative impacts on our health, and the environment. In addition, there is no information on the hazard quotient enough. There are clearly gaps in knowledge that complicate making evidence-based recommendations for children's products. In present, Public Health Officials and Ministry of Industry, in Thailand have recommended lead hazard control for the treatment of lead-poisoned children, there have been relatively few studies designed to evaluate the short- and long-term efficacy of these efforts. While it seems obvious that safely controlling children's products associated lead hazards should be effective in preventing childhood lead exposures. Therefore, the objectives of the current study were to determine total lead concentrations in children's plastic toys and to assess the potential health risks in a children's plastic toys.

2. Materials and Methods

2.1 Samples

One-hundred samples were collected by purposive sampling from discount stores and weekend markets in southern Thailand including Muang District, Nakhon Si Thammarat Province, Muang District, Phattalung Province, and Hat Yai District, Songkla Province as they are largest manufactures and supply centres for children's plastic toys (Figure 1). The samples were collected by simple random sampling (25 percentages of all samples) and varieties of sample

collection. The inclusion criteria for the many of the items were designed for children aged 3-6 years, colorful, and inexpensive children’s plastic toys. All were labeled

as Chinese imports. Once brought to the laboratory, all The samples were placed in plastic bags to prevent cross-contamination by highly leaded items.

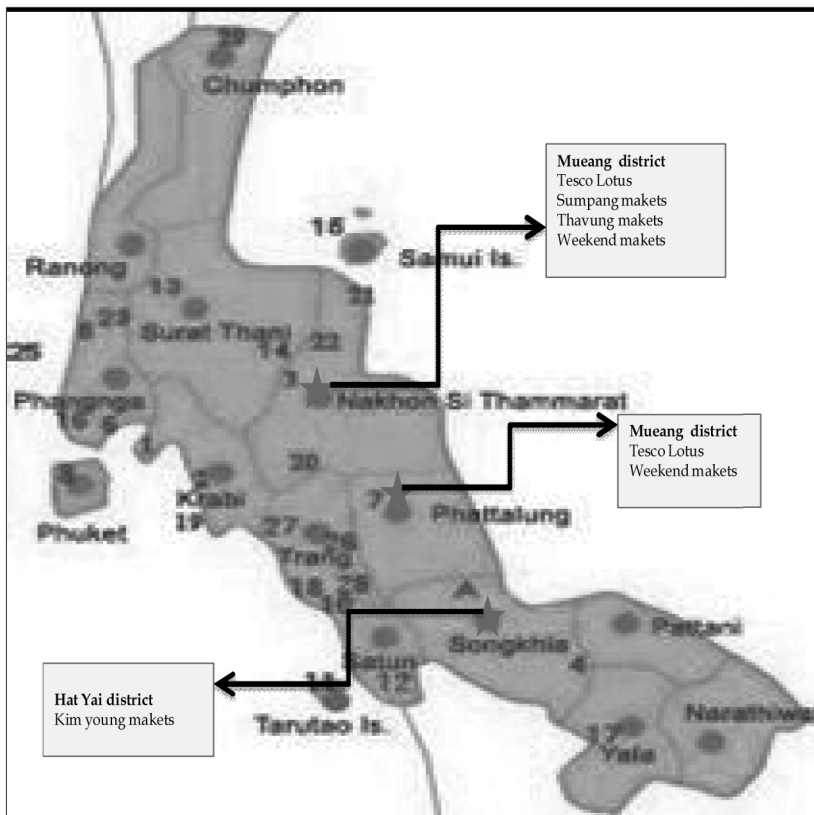


Figure. 1 Map of the province Nakhon Si Thammarat, Phattalung, and Songkla with selected area sampling

2.2 Lead analysis

Preparation of samples

The lead-determination method used for the children’s plastic toys in accordance with EPA SW-846 3050 as reported by Abhay and Prashant, 2007 (9). Individual samples were broken into several pieces in a large silica crucible and charred on a hot plate until fumes ceased, followed by complete ashing in a muffle furnace at 480 °C; the samples were then placed in a desiccator to cool. Then, 2 grams of sample were placed in a separate silica crucible for acid digestion. 10 ml of nitric acid and 5 ml of hydrogen peroxide were added.

After complete digestion, the samples were transferred to 25 ml. Blank samples were prepared using the same method.

Calibration, recovery and reproducibility

Lead concentration in children’s plastic toys was analyzed by flame atomic absorption spectrophotometer (PerkinElmer Model AA analyst 700). Lead determination was calibrated by preparing a series of standard dilutions at 1, 2, 3, 4, and 5 mg/l. The correlation coefficient (*r*) between the lead concentration in the authentic lead solution and absorption intensity was 0.9997. The limit of detection (LOD) was 0.05

mg/l. The accuracy of the test results was ascertained by comparison with known samples of standard lead solution. Known samples, with lead added to the standard solution, to make up 1, 2, and 4 mg/l, were used to determine within-day accuracy, and the between-day precision of the method. The RSDs (100 x SD/mean) were calculated for 10 days for between-day precision. The accuracy of the overall method ranged from 82.9 to 90.2%, and the calculated precision was within 6% RSD.

2.3 Hazard quotient (HQ)

The HQ is the ratio of the exposure estimate to an effects concentration considered a “safe” environmental concentration. It was calculated by dividing the mean concentration of lead in the children’s plastic toys. The lead levels in the children’s plastic toys samples were < 600 ppm, which was within the exposure index limit recommended by the U.S. Consumer Product Safety Commission (CPSC).

HQ calculation used the screening ecorisk toxicology framework (US.EPA, 1992) (10):

HQ = <0.1, no hazard exists

HQ = 0.1-1.0, hazard is low

HQ = 1.1-10, hazard is moderate

HQ= > 10, hazard is high

2.4 Data Analysis

Descriptive statistics were expressed as maximum, minimum and mean ± standard deviation (SD) which used to display the lead concentrations found in the children’s plastic toys. Pearson’s test was used to test the association of the children’s plastic toys lead concentrations and price of the children’s plastic toys.

3. Results and Discussion

The results revealed the lead levels in the 100 samples of children’ plastic toys purchased from discount stores and weekend markets in southern Thailand. Overall, the average lead level in the samples was 287.93 ppm (range 3.01-4486.11 ppm). All samples were labeled as Chinese imports. Thirteen children’ product samples (13percent) had lead levels > 600 ppm (range 634.155-4486.11 ppm.)(US CPSC, 2005b)(7), the maximum level of concern for the US CPSC. A column diagram of the same data appears as Figure 2.

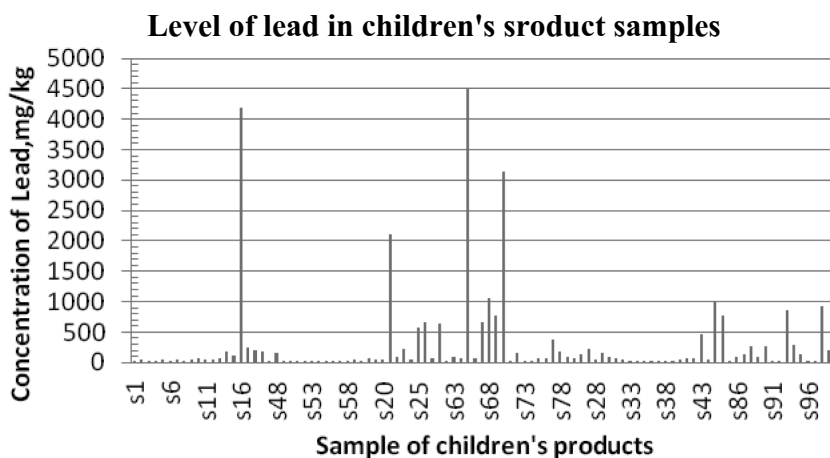


Figure 2. Lead level in children’s plastic toys

The average lead levels separated catalogue USD each, 4 percent cost >3-5 USD each, and 3% cost of samples by color. Pink children's plastic toys (10 > 5 USD each (Table 2). Pearson correlation was used samples) had higher lead levels than the other colors to determine the relationship between lead level and (range 3.82-4486.11 ppm.) (Table 1). In addition, price. The correlation coefficient for the lead levels and most of the samples cost < 5 USD. Most samples (54.0 prices of the children's plastic toys was 0.167 ($p < 0.096$). percent) cost 1-49 baht each, 39 percent cost 1.6-3.0

Table 1 Average, maximum, minimum, and standard deviation, for lead levels in children's plastic toys samples, by color (mg/kg) (n=100)

Color	Number of samples (piece)	Lead concentration (mg/kg)			
		Average (mg/kg)	Standard deviation	Minimum (mg/kg)	Maximum (mg/kg)
Pink	10	731.63	1375.16	3.82	4486.11
Yellow	23	357.41	773.94	5.60	3,132.21
Red	25	290.87	839.14	7.90	4,198.36
Black	4	269.55	337.34	37.81	765.45
Green	20	165.09	205.57	3.14	764.09
Violet	4	141.36	150.88	56.76	367.17
Blue	14	74.30	62.17	4.94	193.44
Total (Mean± SD)	100	290.03 ± 217.6476			

Table 2 Lead levels in children's plastic toys, by price (US dollars) (n=100)

Item	n (piece)	lead level in children's plastic toys (mg/kg) Average ± SD
1.6	54	133.15±236.84
>1.6- 3.0	39	381.35±863.99
>3.0 5.0	4	1534.60±2010.72
>5	3	196.24±238.24

The results of this study were similar to those been imported from China. Twenty-three samples of Jamie and Jeffrey , 2008 (11), who reported lead had lead levels of 230,000 ppm, which exceeded the contamination of inexpensive plastic jewelry in North recommended standard for lead in children' products. Central Ohio, USA. All items cost < 6 USD, and had Abhay and Prashant, 2007 (9) reported varying

concentrations of lead and cadmium in 111 toy samples purchased randomly in three Indian cities (Delhi, Mumbai, and Chennai). The average lead level was 112.51 ppm (range 0.65-2104.00 ppm). Five samples showed high lead concentrations, exceeding the US CPSC limit of 600 ppm in painted toys. Studies have found that lead contamination in inexpensive products, much of it imported from China, is widespread. Thus, the safety behaviors of children should be improved. In this study, pink children's products (10 samples) had higher lead levels than the other colors (range 3.82-4486.11 ppm.) that may be occurred from mixing colour in material process. The present study differs from EARTH (Ecological Alert and Recovery Thailand EARTH, 2010) (8) studies, the result shown the highest concentration of lead was found in a yellow colour sample 51 percent. Lead is a known neurotoxin. In this study, reported the concentration of lead in children's plastic toys low hazard level. Although considerable epidemiological research has been conducted on the health impacts of lead among children in Thailand, little has been done to ascertain its source in the children's environment (6). Children's plastic toys are an integral part of a child's developmental process. Children play with toys and learn about the world. The chewing, licking, and swallowing behaviors of children are a common source of lead exposure (Kelley et al., 1993) (1). Thus, children's exposure to chemicals is an merging concern. Friberg et al., 1986 (12) reported that exposing children to > 40 µg/dl lead could result in encephalopathy, with delirium and seizures; the disease is also related to papilledema. In addition, there is a risk of psychological-developmental impairment and neurological sequelae with persistent or chronic exposure. This study agrees with Lanphear et al., 2000 (13), who reported the association between intellectual impairment in children and blood lead level < 10 µg/dl. Thus, children chronically exposed to lead contamination in children's products are at increased risk of developing neurological symptoms and lead to DNA damage (Thuppil 2007) (14). However, lead poisoning is widespread and most poisoned children have no symptoms (CDC 1991) (15). Assessment of risk using the Hazard Quotients (HQ) in samples of children's products found that in most samples (87%), the level of lead was not a hazard (HQ of < 1.0), while 13% had HQ of 1.0 (Table 3). Given the known potential toxicity, the serious health effect and the ability of heavy metals to leach out of children's toys through contact, the continued use of lead and other heavy metals in children's products raises serious concern (CDC 2004)(16). Therefore, the crucial element of a primary prevention strategy is identification and restriction or elimination of nonessential uses of lead, particularly in both imported and domestically manufactured toys, eating and drinking utensils and prohibits their sale before children are exposed. Ultimately, all nonessential uses of lead should be eliminated (17). A limitation of the present study is the use of a survey study design. The data collection was confined to only three relatively large cities of Southern in Thailand since constraints were faced during data collection. The replication of the study at different regions of Thailand would enable better generalizability of the findings of the study. At the same time data collection could have elicited better responses improving findings. The sample for the present study comprised of 100 samples of children's products. This sample is only a very small proportion of the entire population of retail samples in the country. Therefore, research studies with much larger sample size would be required to ensure appropriate generalization of the findings of the study.

Table 3 Hazard quotients (HQ) of children’s plastic toys samples (n=100)

HQ level	n	Average lead level (mg/kg)	Range	Hazard level
<0.1	47	28.66±19.36	3.01-78.67	No hazard exist
0.1-1.0	40	154.11±117.22	9.05-570.63	Low
1.1-10	13	1637.09±1395.69	634.11-4486.11	moderate

While HQ = <0.1, no hazard exists HQ = 0.1-1.0, hazard is low HQ = 1.1-10, hazard is moderate HQ= > 10, hazard is high

4. Conclusion

The conclusion in this study, the most of children’s plastic toys had hazard quotients of 1.0 (low hazard level). The average lead levels in pink children’s plastic toys had higher lead levels than products of other colors. Children’s plastic toys imported into Thailand irrespective of the country of manufacture especially children’s plastic toys from china contain toxic heavy metals such as lead in varying concentrations and some even showing high lead concentration that may pose hazards to children’s health and create a major environmental health hazard in its use and disposal. Lead contamination in children’s plastic toys should be investigated regularly. In addition, Education of parents would help them realize the toxicity of lead, and encourage them to make more strenuous efforts to protect their children. Therefore, parents and child care providers are responsible for maintaining a safe environment free of unnecessary hazards. Children’s plastic toys are one of the most common causes of accidental injury and death, so it is important to think about toy safety during this season of giving. Toys should be age appropriate; avoid choking hazards with infants, toddlers and other risk groups (and be in compliance with Thai Industrial Standard for Toys TIS 685-2540. Exposure to lead can have a wide range of effects on a child’s development and behavior. Even when exposed to small amounts of lead levels, children may appear inattentive, hyperactive and irritable. Children with greater lead levels may

also have problems with learning and reading, delayed growth and hearing loss. At high levels, lead can cause permanent brain damage and even death. However, the approach needed is clear-identify and address existing lead hazards before children are exposed, otherwise hundreds of thousands of children will be placed at risk needlessly. The overall reduction of lead in the environment will benefit all children.

5. Acknowledgement

This research was supported by the Committee for Research and Development, Faculty of Health and Sport Science, Thaksin University. Sincere appreciation is also extended to all laboratory staff at the Faculty of Science, Thaksin University.

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