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# Screening Toxic Metals in Toys Collected in a Charitable Program

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## Abstract

**Objective:** Toxic metals have been frequently detected in toys, raising public health concerns for children's health. Donated toys, if containing toxic metals, may pose health risks to recipient children who are often disadvantaged socioeconomically or via other environmental factors already. This study aimed to identify and measure toxic metals in donated toys using a handheld X-Ray Fluorescence (XRF) analyzer.

**Methods:** A toy drive on a university campus collected 72 toys during the 2022 holiday season. Sixty-one different toys were scanned by a handheld XRF analyzer for 30 target metals, including Arsenic (As), Cadmium (Cd), Chromium (Cr), and lead (Pb). The screening took less than one hour to complete on site.

**Results:** The test identified 16 metals, including Pb and As, in 8.2% and 6.6% of toys, respectively. The maximum concentrations of Pb and As reached 68 ppm and 22 ppm. These concentrations were close to the standard limits of 90 ppm and 25 ppm for Pb and As, respectively. Pb was most frequently detected in metal toys (33%, n=6) and plastic electronics (25%, n=4) toys, and as in metal and wood toys (16.7%, n=12).

**Conclusion:** A non-trivial percentage (10%) of toys had Pb or As on their surfaces, and the toys of major concern were metal, wood, and plastic electronic toys. This study suggests the need for a quick, low-cost screening program to test toxic metals in toys from charitable organizations and programs.

**Keywords:** Toxic metal; Toy; X-ray fluorescence; XRF; Charitable program.

## Introduction

Toxic metals in toys pose a potential but nonnegligible health risk to children [1]. Toxic metals such as Pb, As, Cd, and Hg are often incorporated into toys either as part of the manufacturing process, such as in paints, coatings, plasticizers, or metal components, or as unintended contaminants from raw materials used during production [2]. Research has shown that toys made from materials like plastics, particularly PVC, rubber, and even wooden toys with painted surfaces, are especially prone to containing these harmful substances [3]. Previous studies detected toxic metals in major categories of toys, including plastic toys, painted or coated toys, metallic toys and jewelry, and brittle or pliable toys [4-7]. Young children are more likely to engage in hand-to-mouth behaviors, increasing their exposure to hazardous substances [8]. Elevated metal concentrations, such as Pb, As, and Cd can lead to significant health risks, including developmental, behavioral, and neurological issues [5].

The US enacted the Consumer Product Safety Improvement Act (CPSIA) in 2008 to enhance consumer product safety. This pivotal law transformed a previously voluntary toy safety standard into a universally mandatory children's product safety regulation. Starting in 2018, any children's toys manufactured in the US or imported must undergo rigorous testing and certification in accordance with ASTM F963-17 Standard [9]. The reduction of lead in painted products, as well as toxic metals in products marketed for children, was also followed by mandatory testing for toys that are made for US markets under the American Society of Testing and Materials Toy Safety Standard (ASTM F963) [10]. These stringent regulations have led to the expectation that all toys currently available in the market should adhere to these standards. However, recent studies have uncovered instances where compliance falls short, e.g., high-level lead was found in toys sold in discount stores [11]. The media also frequently reports on toxic lead toys that are traded on major online retailers like Amazon [12].

This study was aimed at measuring toxic metals in toys collected in a Christmas toy drive with a portable, direct-reading analyzer. Upon establishing a protocol for rapid screening of toxic metals, this study could branch out to involve all local toy donation and collection centers as a visible public service.

## Material and methods

This study utilized a convenience sample of all the toys collected in a local toy drive organized by a university. A total of 61 toys were collected, and they could be generally categorized as plastic PVC (n=31), plastic electronics (n=4), cloth (n=10), metal (n=6), modeling compound (n=3), and wood cellulose (n=6) toys, based on their surface materials. All toys were tested using a handheld X-Ray Fluorescence (XRF) spectroscopy analyzer (Model: Niton XL3t, ThermoFisher Scientific, Billerica, MA). For any toy under test, the XRF scan port was placed directly on a thicker part of the toy and oriented such that the beam would go through as much of the toy as possible. On thinner toy structures, the XRF scan port was lined up to get the largest cross-section possible with the beam. Each scan lasted for 30 seconds. The XRF analyzer was pre-calibrated using a set of National Institute of Standards and Technology (NIST) standards (NIST 2709a and NIST 2579) and plastics with known concentrations of metals. This calibration was optimized to determine up to 30 metals. Details of the scanning protocol and instrumental calibration were described in a previous study [13].

## Results

The field screening identified and detected 16 metals in the 61 toys (Table 1). Fe and Zr were detected in almost all the toys (detection rate, DR=95%), and some metals were detected in only a single toy, e.g., Th, Ni, Co, Mn, and Bi.

Pb was detected in a third of metal toys, a quarter of electronic toys, and a small portion of plastic and wood toys. Pb was not detected in toys made with cloth or modeling compounds. Arsenic was detected in plastic-PVC, metal, and wood toys, but not in other toy categories. Of the metallic toys scanned, the only two toys with magnets both had Pb, and one had as. It was speculated that the magnets contained these metals, which could be a target for further study. In summary, Pb and as had detectable levels in 8.2% and 6.6% of toys, respectively, and together, 10% of toys contained Pb or As, or both.

ASTM F963-17 Standard has limits only for Pb and as, out of the 16 detected metals. The limits are 90 ppm and 25 ppm for Pb and As in surface coatings and substrates, respectively [10]. The maximum concentrations of Pb and as were 68 ppm and 22 ppm, respectively, in the toys in this study, meaning that these two major metals of concern both met the CPSIA requirement. Except for the As concentration of 22 ppm near the limit of the allowed 25 ppm, no other toy was close to the allowable concentration, suggesting good news given that millions of toys have been recalled in recent years [13].

**Table 1:** Detection and concentrations of target metals in toys collected in a toy drive.

| Metals | DR[1] (%) | Mean (ppm) | SD[2] (ppm) | Median (ppm) | 95th[3] (ppm) | Maximum (ppm) | Limit (ppm) |
|---|---|---|---|---|---|---|---|
| Pb | 8.2 | 1.75 | 8.98 | 0.00 | 6.77 | 67.8 | 90[4] |
| As | 6.6 | 0.74 | 3.27 | 0.00 | 4.43 | 22.0 | 25[4] |
| Zr | 95.1 | 17.4 | 19.7 | 11.1 | 62.2 | 90.2 | |
| Sr | 86.9 | 16.5 | 32.4 | 4.73 | 57.3 | 224 | 4,500[5] |
| U | 32.8 | 1.46 | 2.21 | 0.00 | 5.60 | 7.04 | |
| Rb | 26.2 | 1.33 | 3.91 | 0.00 | 5.20 | 28.2 | |
| Th | 1.6 | 0.09 | 0.66 | 0.00 | 0.00 | 5.19 | |
| Zn | 63.9 | 2,988 | 16,630 | 37.2 | 4,954 | 124,067 | 3,750[5] |
| Cu | 75.4 | 70.3 | 199 | 25.2 | 168 | 1406 | 622.5[5] |
| Ni | 1.6 | 14.7 | 114 | 0.00 | 0.00 | 894 | 75[5] |
| Co | 6.6 | 86.7 | 650 | 0.00 | 34.4 | 5081 | 10.5[5] |
| Fe | 95.1 | 1,868 | 9,539 | 136 | 3,573 | 73,530 | |
| Mn | 1.6 | 0.79 | 6.19 | 0.00 | 0.00 | 48.4 | 1,200[5] |
| Nb | 80.3 | 8.40 | 5.78 | 8.87 | 17.4 | 18.8 | |
| Bi | 1.6 | 0.29 | 2.27 | 0.00 | 0.00 | 17.7 | |
| Ti | 34.4 | 4,247 | 10,738 | 0.00 | 17,004 | 62,538 | |

**Note:** 1. Detection rate (DR, in %). 2. Standard deviation (SD, in ppm). 3. 95$^{th}$ percentile (in ppm). 4. The metal concentration limits specified by the US standard. 5. The metal concentration limits specified by the European Union standard.

## Discussion

### Comparison with previous studies

In the US, new studies still find toxic metals, including lead (Pb), Arsenic (As), Cadmium (Cd), and Chromium (Cr), in a wide spectrum of toys. A screening test in a Boston daycare center found that 8.6% of plastic food toys contained >100 ppm of lead, and 7.1% had detectable levels of arsenic [13]. In seven daycare centers in Southern New England, 21% of toys contained lead levels above 100 ppm [14]. In Richmond, lead (45%) and arsenic (76%) were the most dominant toxins found in non-compliant and suspect toy samples [15]. Even toys created by new technologies are not free of toxic metals, e.g., a chamber study found that children's 3-D pens and 3-D printer toys contained 0.13-1.2 ng/g of lead [16].

### Implications for environmental public health

Toy drives are frequently used to support socioeconomically disadvantaged children and families. This may be an understudied route of exposure for children to hazardous materials. There are usually no methods for the disadvantaged population to determine if the toys being given have these toxic metals in them. Local environmental monitoring could be a good method to help the socioeconomically disadvantaged population. Public engagement with visible monitoring, such as a toy screening, can help serve the public in many ways. Support and guidance from local public health offices, research institutions, or non-profit organizations in the surrounding areas can help build a partnership to grow the screening to incorporate all the donation centers, including thrift and goodwill sites. This would be especially helpful, as vintage toys will not be susceptible to the CPSIA and have been shown to more frequently have toxic metals in them [13].

This study demonstrated charitable programs as an accessible venue for environmental public health research. In practice, it is logistically difficult to obtain a large number of toys for toxic metal screening by nonregulatory organizations or individuals. For any research program, access to toys in stores is almost impossible. Limited funds do not allow the purchase of large toy samples. Thus, previous programs often utilized childcare centers for toy samples [13,14]. Charitable toy programs represent a great opportunity for collecting metal contamination information for a wide variety of toys at a low cost.

### Study limitations

This pilot study collected a small toy sample at only one site. The sample had many toys made from plastic PVC for this study but had fewer toys in other categories. The detection limits of the XRF analyzer were sacrificed when the sensor could not be placed flush upon the surface, as the packing was not allowed to be opened.

## Conclusion

This screening of 61 toys collected from a toy drive showed that 10% of toys contained detectable lead and arsenic on their surfaces, but their concentrations met the standards. This study demonstrates a convenient venue for screening toxic metals in consumer items through charitable programs. The mechanisms for adding toxic metal scans to donation programs can be a feasible public health service for socioeconomically disadvantaged populations.

## Declarations

**Author contributions:** Conceptualization, Jia C; Methodology, Jia C, Specht AJ; Formal Analysis, Nored A, Fu X; Investigation, Nored A, Batbaatar N, Fu X; Resources, Jia C, Specht AJ; Data Curation, Nored A; Writing-Original Draft Preparation, Nored A; Writing-Review & Editing, Jia C, Batbaatar N, Bartelli D; Supervision, Jia C; Project Administration, Jia C; Funding Acquisition, Jia C. All authors have read and agreed to the published version of the manuscript.

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## References

1. Fenner J, et al., Hidden risks in toys: A systematic review of pediatric toy contact dermatitis. Contact Dermatitis. 2020; 82(5): 265-271.

2. Guney M, et al. Potentially toxic elements in toys and children's jewelry: A critical review of recent advances in legislation and in scientific research. Environmental Pollution. 2020; 264: 114627.

3. Shahzad L, H Zubair, M Ali. Toxic Toys Threaten the Health of the Children: An Appraisal of Potential Literature. Pakistan Journal of Medical & Health Sciences. 2022; 16(02): 13-13.

4. Guney M, GJ Zagury. Heavy metals in toys and low-cost jewelry: Critical review of U.S. and Canadian Legislations and recommendations for testing. Environmental Science & Technology. 2012; 46(8): 4265-4274.

5. Cui XY, et al. Toxic metals in children's toys and jewelry: coupling bioaccessibility with risk assessment. Environmental Pollution. 2015; 200: 77-84.

6. Szczepańska N, J Namieśnik, B Kudłak. Assessment of toxic and endocrine potential of substances migrating from selected toys and baby products. Environmental Science and Pollution Research. 2016; 23(24): 24890-24900.

7. Turner A. Concentrations and migratabilities of hazardous elements in second-hand children's plastic toys. Environmental science & technology. 2018; 52(5): 3110-3116.

8. Oyeyiola AO, et al. Statistical analyses and risk assessment of Potentially Toxic Metals (PTMS) in children's toys. Journal of Taibah University for Science. 2017; 11(6): 842-849.

9. US CPSC. Toy Safety Business Guidance & Small Entity Compliance Guide. 2023. https://www.cpsc.gov/Regulations-Laws--Standards/Statutes/The-Consumer-Product-Safety-Improvement-Act.

10. ASTM, ASTM F963-17. Standard Consumer Safety Specification for Toy Safety. ASTM International: West Conshohocken, PA. 2017.

11. Campaign for Healthier Solutions, Toxic Chemicals in Dollar Store Products: Report. Environmental Justice Health Alliance for Chemical Policy Reform: Brattleboro, VT. 2022.

12. Limmer D. Why Is It Easy To Sell & Buy Toxic Lead Toys on Amazon?, in RetailWire. 2023.

13. Ahmid K, et al. Lead and other toxic metals in plastic play foods: Results from testing citizen science, lead detection tools in childcare settings. Journal of Environmental Management. 2022; 321: 115904.

14. Sanders M, J Stolz, A Chacon-Baker. Testing for lead in toys at day care centers. Work. 2013; 44: 29-38.

15. Hillyer MM, et al. Multi-technique quantitative analysis and socioeconomic considerations of lead, cadmium, and arsenic in children's toys and toy jewelry. Chemosphere. 2014; 108: 205-213.

16. Yi J, et al. Particle and organic vapor emissions from children's 3-D pen and 3-D printer toys. Inhalation Toxicology. 2019; 31(13-14): 432-445.