

# Lead content of retail jewelry: an analysis of products sold in California and the performance of state and federal lead regulations

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Lead (Pb) is used extensively to make consumer goods. If ingested or inhaled, this soft, malleable metal can cause serious, irreversible health effects. These health outcomes are most detrimental to children, resulting in learning disabilities and behavioral problems. With the rising popularity of electric vehicles, leaded batteries are now the most common use for lead. Once spent, dead batteries are often disassembled and their lead reclaimed overseas. This reclaimed electronic lead waste (e-waste) is being used by manufacturers in China, whose products are then sold in the United States. E-waste recycling operations are often informal and result in occupational health hazards and environmental degradation. While average childhood blood lead levels (BLLs) are dropping in the U.S., they are still too high, and it has been posited that consumer goods may be a contributing factor.

In this study, researchers, in partnership with the Center for Environmental Health (CEH) set out to study the lead content of one consumer good: jewelry sold in California. While leaded jewelry products are regulated at both the state and federal level in the U.S., the laws are written in a way that is not preventative. Watchdog groups like CEH purchase goods, test them for lead, and then legal action is taken if the item is found to be non-compliant with standards. California's large import economy has an opportunity to reduce the amount of leaded goods entering the U.S., influence the e-waste trade, and improve global health.

The purpose of this study is to: **(1)** to establish if there has been a statistical decrease in the percentage of lead-containing jewelry items sold in California, after new, stricter regulations, were enacted, **(2)** to establish if there has been a statistical decrease in the quantity of lead within lead-contaminated jewelry items sold in California, **(3)** to determine if this sample can be expanded to a population level, **(4)** to compare two lead quantification methods, **(5)** to determine any significant relationship between lead content and an item's price or retailer, and **(6)** to use the information found to recommend policy reforms.

It was found that over the course of the study the amount of lead in items purchased decreased, although not significantly [ $F(1,18) = 2.613$ ;  $p = 0.123$ ;  $\alpha = 0.05$ ], the probability of finding an item with only one leaded component was 49%, and price and lead content were not correlated [ $F(1,2172) = 0.5065$ ;  $p = 0.477$ ;  $\alpha = 0.05$ ], nor were store rank and lead content [ $F(1,2172) =$

0.5065;  $p = 0.477$ ;  $\alpha = 0.05$ ]. XRF screening and acid digest techniques both were highly variable ( $Avg. \%SD_{XRF} = 52.46$ ;  $range = 4.23 - 200.50\%$  and  $Avg. \%SD_{acid\ digest} = 25.20$ ;  $range = 2.61 - 139.67\%$ ) and their test results not equivalent ( $R^2 = 0.5048$ ;  $df = 93$ ,  $p < 0.0001$ ,  $t = -6.512$ ). However, the percentage of items in “violation” of regulations did decrease significantly over the course of the study ( $F(1,18) = 5.206$ ;  $p = 0.0349$ ;  $\alpha = 0.05$ ).

Most notably, this study shows that there was no significant correlation between price and lead content or retailer ranking and lead content. Therefore, watchdog groups and researchers cannot pigeonhole items when selecting them for testing and consumers cannot “shop their way out” of leaded jewelry. Further funding should therefore be set-aside for increased third-party testing and an electronic database of distributors’ and importers’ lead testing results established for public access, further empowering consumers and researchers.