SPECIAL REPORT

Reduction in the Lead Content of Candy and Purses in California Following Successful Litigation

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Abstract **Lead exposure causes an array of significant health problems in adults and especially in children. Therefore, reducing lead exposure is an important public health goal. Here, we analyzed data collected about the lead content in two product types, candy and purses. We show that following litigation, the prevalence of these products containing lead in California declined significantly. Results from products purchased online suggest that the decline was national, not just limited to California. Our results indicate that state consumer protection laws can be successful in reducing exposure to hazardous chemicals.**

Introduction

The consequences of children's exposure to lead are significant, well documented, and widely recognized. They include hyperactivity, attention deficits, reductions in IQ test scores, and reductions in academic achievement. The consequences of adult exposure to lead are less widely recognized but also significant. For women, these include hypertension, coronary heart disease, and cognitive decline. Exposure in pregnant women causes an increase in allergy and asthma in their children (U.S. Environmental Protection Agency [U.S. EPA], 2013). In addition, Hu and coauthors (2006) showed that prenatal exposure to lead results in IQ test score declines similar to those caused by early childhood exposure and Silver and coauthors (2016) showed that prenatal lead exposure resulted in delayed maturation of auditory and visual systems in newborns. Consequences of lead exposure for men include hypertension, coronary heart disease, and decreased semen quality (U.S. EPA, 2013). Common sources of lead exposure include paint in older buildings, lead-contaminated drinking water, and lead-based glazes on some ceramic dishware (Centers for Disease Control and Prevention, 2012).

In 2004, the Center for Environmental Health, a California nonprofit, tested popular chili and tamarind candies for lead. California agencies and media outlets were also conducting similar testing, so our results were not unexpected: some of these products contained significant amounts of lead. We were particularly concerned because children commonly eat these candies.

We began exploratory screening in 2007 of hundreds of popular consumer products for lead. We were surprised to discover that the use of lead-based pigments was common in purses, wallets, handbags, and similar items that were made from brightly colored polyurethane or polyvinyl chloride fabric. In this special report, we use the generic term "purses" to refer to these items. Because women handle purses and similar items frequently, we were concerned about poten-tial hand-to-mouth exposure, especially for women of childbearing age.

The Center for Environmental Health is experienced in using a California law, the Safe Drinking Water and Toxic Enforcement Act (1986), as a tool to improve product safety. In 2004, in collaboration with the California Department of Justice, we initiated litigation with dozens of candy manufacturers. This litigation was concluded in 2006 with consent judgments that set a health protective limit of 100 ppb for lead contamination of chili and tamarind candies. The limits were later added to California law (California Depart-ment of Public Health, 2018). The California Department of Public Health (CDPH) sub-sequently conducted regular monitoring of candies for compliance with the law. In 2009, we initiated legal proceedings to enforce the Safe Drinking Water and Toxic Enforce-ment Act with hundreds of fashion retailers and vendors. The legal actions were mostly completed in 2010 and 2011 and resulted in court-approved consent judgments that set strict standards for lead content (generally 300 ppm) for these products. In 2012, we began a systematic effort to monitor compli-ance with the legal agreements.

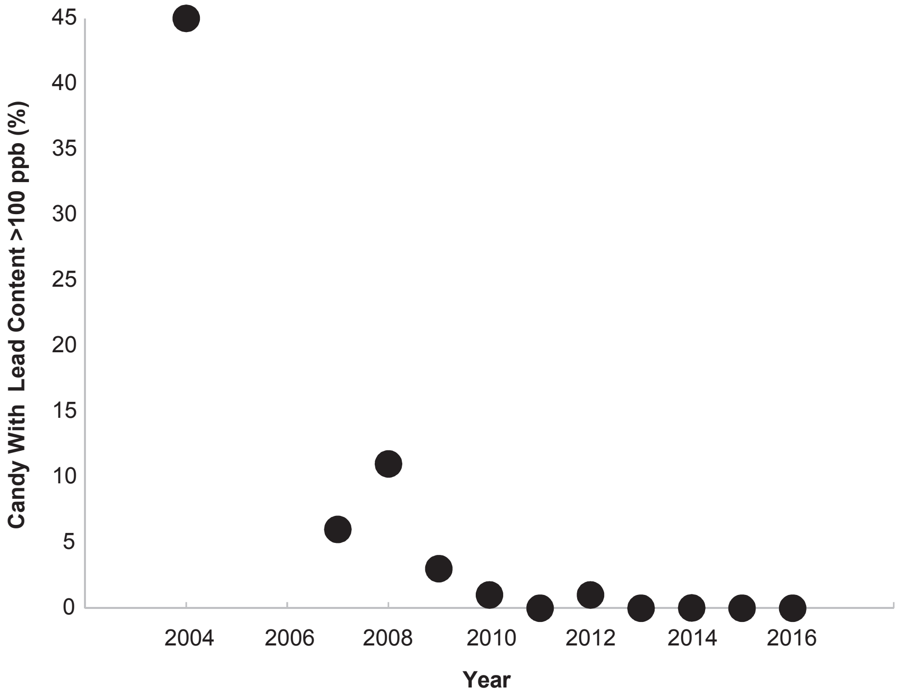
Here, we present data about the prevalence of lead-containing candy and purses in the years following our legal actions. While litigation is commonly used to address hazardous products, there has been little quantitative data to support the efficacy of this approach to increase the availability of safer products. We are aware of only one previous study, our anal-ysis of lead in jewelry (Cox & Green, 2010).

Methods

We analyzed publicly available data from CDPH regarding lead contamination in candies, limiting our analysis to the chili and tamarind candies that were the focus of our litigation. CDPH purchased a convenience

FIGURE 1

Occurrence of Lead-Contaminated Chili and Tamarind Candies in California After Litigation and Legislation in 2006



sample of candy throughout California and the department's internal laboratory tested the candy with a detection limit that varied, but typically was 50 ppb. We used data from 2004 as baseline data, and data from 2007–2016 as post-litigation compliance data. The number of chili and tamarind candies tested was 151 in 2004, 532 in 2007, 245 in 2008, 306 in 2009, 337 in 2010, 202 in 2011, 275 in 2012, 268 in 2013, 106 in 2014, 180 in 2015, and 40 in 2016. The data are available at www.cdph.ca.gov/Programs/CEH/DFDCS/Pages/FDBPrograms/FoodSafetyProgram/LeadInCandy.aspx.

In addition, this study analyzed data about purses from 15 major retailers. The Center for Environmental Health purchased purses in California and online in 2009, and then again in 2012–2016. The 2009 purchases were prior to our litigation and thus provide baseline data; the other years were after the compliance date in our legal agreements. The 15 retailers included 6 department stores, 3 specialty fashion retailers, 3 online retailers, and 6 discount retailers (numbers do not add up to 15 as stores in the online retailer category overlap with some of the other categories.) We also purchased purses at online sites for the department stores and specialty and discount retailers. We purchased 130–370 purses each year: 137 purses in 2009, 366 in 2012, 279 in 2013, 226 in 2014, 239 in 2015, and 173 in 2016.

There are an enormous number of purses available for purchase, so we did not attempt to use a random purchasing strategy. Instead, we purchased items that were 1) brightly colored and 2) made of polyurethane or polyvinyl chloride fabric. Our purchasing strategy was similar across the years of this study, so we believe this protocol is adequate to detect time trends.

We screened the fabric components of each purse using an X-ray fluorescence analyzer (Olympus Delta Classic) to identify components with lead-containing pigments. The limit of detection for this instrument was <10 ppm. Typically, the lead pigment was in a surface layer bonded to a thicker layer of uncolored material. When we identified lead-containing pigments, one of two independent commercial laboratories determined the lead concentration of the lead-containing layer. One laboratory used the National Institute for Occupational Safety and Health (NIOSH) Method 7082 with inductively coupled plasma mass spectrometry substituted for atomic absorption spectrophotometry (Ashley & O'Connor, 2016); the second laboratory used U.S. Environmental Protection Agency Methods 3050B and 6010B (U.S. EPA, 1996a, b). Both methods are similar and use an acid digestion process to extract lead from the fabric.

We used Spearman's rank correlation coefficient to evaluate the relationship between the proportion of candy or purses with lead-containing pigments and year of purchase. We used an online calculator to do the rank correlation coefficient calculations and evaluate significance levels (Lowry, 2018).

Results

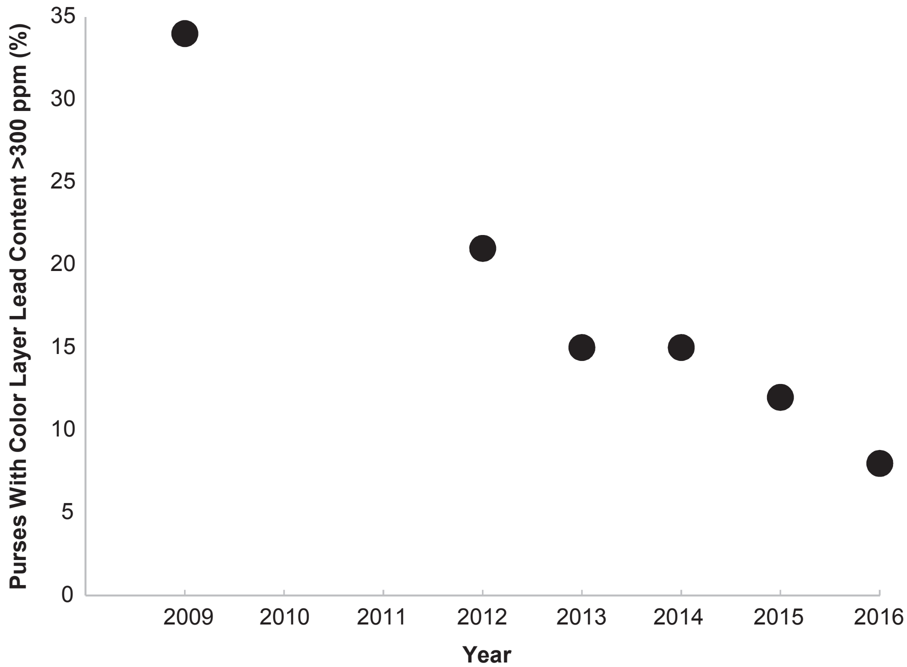
Lead content of chili and tamarind candies in the CDPH study varied from below the limit of detection to 1,100 ppb. Overall, the lead content of 5% of the candies was >100 ppb. In 2004, the baseline year, the lead content of 45% of the candies tested was above the 100 ppb standard. Then, 5 years later, the proportion of candies above the lead content standard had fallen to 3%, and in 4 of the 7 subsequent years no candy with lead content >100 ppb was found. The relationship between year and the proportion of candies above the lead content standard (Figure 1), as evaluated by Spearman's rank correlation coefficient, was negative (r = -.81) and significant (p < .01). The results suggest that litigation, followed by state-level legislation, was effective in reducing the prevalence of lead contamination in these candies.

Lead content of the pigmented surface layer of purses in this study varied from below the limit of detection to 26,100 ppm. Overall, 17% of the purses contained >300 ppm of lead in the pigmented surface layer. In 2009, the baseline year, 34% of the purses were above the 300 ppm lead content standard. In the 5 years after our litigation, the proportion of purses that were above the 300 ppm standard was approximately half (16%) of the baseline level. In 2016, the final year of the study, only 8% of the purses were above the lead standard. Two brands, each sold at one retailer, accounted for 10 of the 15 purses with high lead content found in 2016. The relationship between year and proportion of purses above the lead content standard (Figure 2), as evaluated by Spearman's rank correlation coefficient, was negative (r = -.94) and significant (p < .05). The results suggest that our litigation was an effective tool to reduce the use of lead-containing pigments in this product type.

Although we did not purchase products outside California, we used our online purchasing to measure the changes that occurred on a national scale after our litigation. The numbers of products purchased online were 51 in 2009, 37 in 2012, 134 in 2013, 102 in 2014, 120 in 2015, and 93 in 2016. The patterns we observed with the online products were similar to those in our complete sample, but with more variability due to the smaller sample size. Overall, 24% of the purses contained >300 ppm lead in the pigmented surface layer. In the baseline year, 2009, 33% of the purses were above the lead content standard while in the 5 years post-litigation, the proportion of noncompliant purses was 23%. In 2016, 15% of the purses were above the lead content standard and 10 of these items were from two brands, each sold at one retailer. The relationship between year of purchase and proportion of purses above the lead content standard (Figure 3) was negative (r = -.89) and significant (p < .05). The results suggest that litigation based on a state law was an effective tool to reduce the use of lead-containing pigments on a national scale.

FIGURE **2**

Proportion of Purses With Lead-Containing Pigments Sold by 15 Major Retailers in California



Note: Legal limits on lead content were set in 2010 and 2011.

Discussion

State consumer protection laws related to hazardous chemicals in products, including California's Safe Drinking Water and Toxic Enforcement Act, are controversial. For example, Fischer (2016) suggested, because of the perception that the law is costly for business and not effective, that

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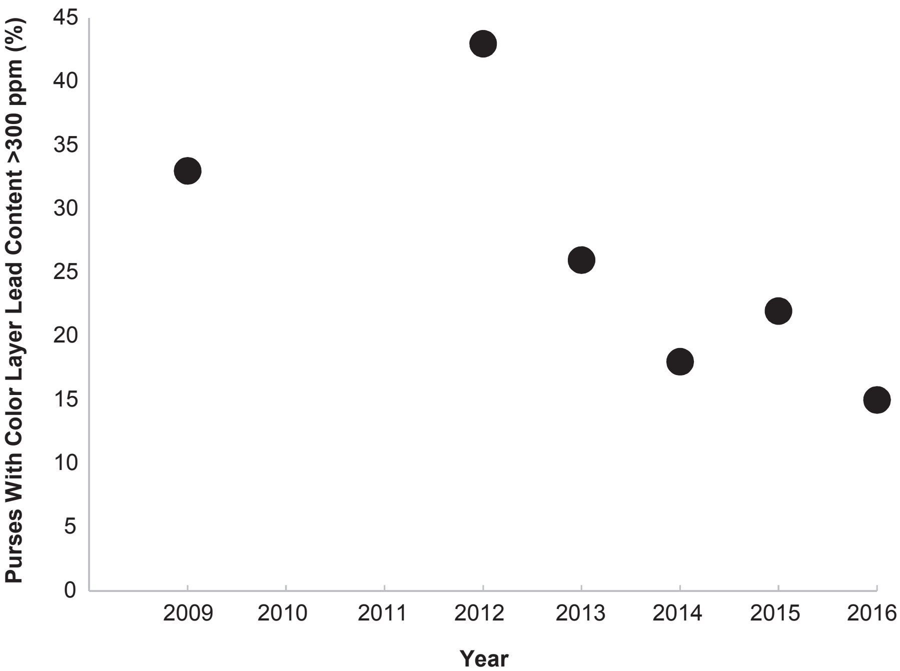
FIGURE 3

Proportion of Purses With Lead-Containing Pigments Purchased From Online Retailers



Note: Legal limits on lead content were set in 2010 and 2011.

the law "should be sunset to give way to a different approach." Suggested alternatives from this author include ecolabels and voluntary ingredient disclosure. From an opposite perspective, Burchfield (2013) suggested that the California statute does not go far enough. This author suggested that the law should provide special protections for children because of their increased susceptibility to some hazardous chemical exposures. Quantitative demonstrations of the efficacy of the law in reducing hazardous exposures, like this study, are necessary to resolve this controversy.

Conclusion

We have previously looked at the prevalence of lead-containing jewelry and concluded "litigation and legislation have been effective tools for reducing the prevalence of jewelry with high lead content in California" (Cox & Green, 2010). The two studies presented here, the CDPH data about lead contamination of candy and our study of lead pigments in purses, show similar results. Thus, they provide an important addition to the literature supporting the efficacy of California's Safe Drinking Water and Toxic Enforcement Act, and by extension, other state-level consumer protection laws.

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