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HIDDEN DANGER: LEAD IN PUGET SOUND HOMES






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EXECUTIVE SUMMARY

Lead has been known for centuries as a potent toxic chemical, but actions taken by companies in the 20th century have resulted in lasting contamination of U.S. homes and communities. Unfortunately, we can't turn back the clock on the use of lead in products like paint and gasoline that brought this toxic metal into our homes and soil and caused profound, lifelong harm to children. But we can help prevent further damage to children's developing brains and bodies by identifying current sources of lead exposure in our homes and communities. To better understand sources of children's exposure to lead in the Puget Sound area, Toxic-Free Future worked with 34 families to test lead contamination of their homes. We found that lead is present in and around many homes at levels that may threaten health. Approximately 30% of participant households had lead in house dust at potentially harmful levels, and more than a quarter had concerning contamination of soil where children play. This study underscores the need for local and state agencies to take action to protect children from ongoing lead exposure. Some relatively simple actions can go a long way toward further identifying the extent of lead exposure in homes, and then eliminating those sources to protect children's health. Recommended actions include requirements for rental inspections, screening of children, financial support for remediation, and ongoing community education.

Introduction: The Long Shadow of Yesterday's Mistakes on Today's Children

Despite advances in science about the harms of lead exposure and public health efforts to reduce it, today approximately 500,000 children in the U.S. ages 1-5 have blood lead levels above the Center for Disease Control's reference level of 5 micrograms per deciliter (µg/dL)[1].

Lead exposure poses a risk to nearly every human body system, with impacts ranging from slowing children's growth and development to behavioral and learning problems[1, 2]. Children are the most vulnerable to lead's harm, particularly its devastating effects on brain development, and no safe level of exposure has been identified[1,2].

The use of lead is nothing new, with lead mined and made into pots and pans, water pipes, and jewelry since ancient times[3,4]. But in the 20th century, when manufacturers knew of lead's harms, widespread use of lead as an additive in gasoline, in paint for homes and other buildings, and as part of solder in cans for consumer foods led to a crisis of severe lead exposure in U.S. children. By the time the U.S. government began to take action on lead in gasoline in 1973 and on lead in paint in 1978, a great deal of damage had been done and the toxic metal was in homes and soil across the country.[5,6] Industrial emissions have also been a significant source, and lead is a common contaminant at Superfund sites [8]. Children's blood lead levels in the U.S. fell dramatically following regulations to reduce these and other sources, but children from low-income families, racial minority children, those living in older, poorly maintained rental housing, and children whose parents have contact with lead in the workplace continue to face particularly high rates of exposure [9,10].

In the Puget Sound area, deteriorating lead-based paint, such as chipping and peeling paint and paint in house dust, is considered the most common source of lead exposure [11, 12]. In addition, the Asarco smelter that operated in the Tacoma area for nearly 100 years contaminated 1,000 square miles of soil in Pierce, King, and Kitsap Counties with lead and other toxics [13, 14.].

HIDDEN DANGER: UNDERSTANDING LEAD EXPOSURE IN PUGET SOUND'S HOMES

Background and Methods

In the Puget Sound area, information is limited on levels of lead in the home environment. Regional data on environmental lead levels has often been limited to specific areas of concern, such as soil in the plume footprint from the Asarco smelter in Tacoma. To help close this gap, Toxic-Free Future participated in a national program led by Healthy Babies Bright Futures to pilot its "Vida" program of lead testing in homes.

Toxic-Free Future enrolled 51 participant households in the pilot program, and 34 households completed all phases of testing for lead. Eligible households included those with a child under three years old, someone currently pregnant, or someone planning for a pregnancy. To maximize diversity in the study population, Toxic Free future partnered with community-based organizations to communicate the availability of the program to potential participants.

Households completed three phases to participate in the study. To begin the study, participants completed an online interactive questionnaire designed to identify key areas of the home for testing. Participants provided information on the age of their home, the condition of the paint, renovations, and

other items in the home such as spices and toys. In the second phase, based on the questionnaire responses, Healthy Babies Bright Futures mailed a sample kit with instructions to each participant. As such, each kit was unique to the participant, based on the profile developed through the online questionnaire. The team at Toxic-Free Future followed up with participants and assisted those who desired help with sample collection. The pilot was designed, however, to rely mainly on self-collection of samples without researcher assistance.

In the final phase, participants mailed samples to a commercial lab (Waypoint Analytical Lab; Memphis, Tennessee) for analysis. Healthy Babies Bright Futures sent a detailed report electronically to each participant showing the result for each sample that was collected. The final report of results sent to participants also included action steps based on the results to guide participants in how to reduce lead exposure. Toxic-Free Future contacted all participants after the electronic delivery of their results to review the report, answer questions, and educate participants on actions they could take to reduce lead exposure.

Results for participants who completed all phases of testing were included for data analysis. Given that each participant collected different sample types based on the high-risk areas identified through the online questionnaire, only those sample types that were collected and tested for most participant households were included in this data analysis: water (sampled at first flush, after a 45 second flush, and after a 5 minute flush); house dust (floor dust, vacuum dust, and dust from a lead paint hot spot as identified by the online questionnaire, such as a window sill); and soil (garden soil, and child's play area soil).

While no level of lead exposure is safe, federal agencies have been criticized for failure to set protective standards for lead in water, dust, and other media. Therefore, we compared the concentrations found in Puget Sound homes with additional levels set by California or recommended by experts, as well as national regulatory limits.

Additional statistical analysis was conducted for sample types that had a high number of collected and tested samples: vacuum dust, floor dust, play area soil, and water at first flush. Due to non-normal distributions for all sample types, log transformations were completed before performing one-way ANOVA tests for vacuum dust, floor dust, first-flush water, and play-area soil to test for differences based on demographic factors – income level, race, education level, and home ownership status (significance set at $p < 0.05$). Linear regression testing was performed for the log-transformed values to measure associations among levels in different sample types. All statistical analysis was completed using Stata/IC 15.1.

Limitations

The relatively low number of participants who completed all phases of the program (34) limits the ability to interpret the data collected as representative of the broader population. Additionally, for floor dust and water samples, it is likely there was variation in sampling techniques due to participants' self-collection of samples based on written instructions without training. Several participants reported difficulty in understanding the instructions for collecting samples, or in performing sample collection. While these are among the factors that may limit generalization to understand population risk based on exposure source, the results nonetheless demonstrate that exposure to lead is persistent in the Puget Sound area and poses a health risk, most importantly to young children.

RESULTS, FINDINGS & DISCUSSION

The participant population largely had a child under three years old living in the household (82%), and the majority were home owners (79%) living in single-family homes (88%) built prior to 1978 (79%). Slightly more than one-fourth of families had less than the median income in King County; 71% were white and 29% non-white. Additional self-reported participant demographics are included in Appendix 1.

Table 1 summarizes the results of testing of water, dust, and soil.

We found the following:

Dust in homes continues to be a serious source of lead exposure, including in the Puget Sound area. Lead was detected in every vacuum dust sample. Levels ranged from 2 to 908 parts per million (ppm), with a median of 32 ppm. Floor dust lead levels had a median of 0.86 micrograms per square foot (μg/ ft^2) and ranged from 0.11 to 43 μg/ ft^2. Floor dust samples from more than one quarter (29%) of households exceeded a health-based goal of 2 μg/ ft^2, and levels in two homes exceeded the EPA hazard level of 10 μg/ft^2.[21]

Soil contamination is an ongoing source of exposure. Lead was detected in every soil sample, and soil in children's play areas from more than a quarter of households (27%) contained lead above California's screening level of 80 ppm. The median concentration was 36 ppm and levels ranged up to 424 ppm. Garden soil in 17% of households was above the California screening level, with a median lead concentration of 16 ppm and levels up to 110 ppm.

All household water samples were below the EPA limit and nearly all were below the American Academy of Pediatrics recommended level. All samples were below the EPA hazard level of 15 parts per billion (ppb). Among first flush samples (median = 0.46 ppb), only 15% were above 1 ppb, the American Academy of Pediatrics recommended level for school drinking fountains. Median levels decreased after a 45-second flush and 5-minute flush, with a higher percentage of homes below the American Academy of Pediatrics recommendation.

Outdoor lead is linked to indoor lead. Lead in household dust (vacuum-collected) was significantly associated with lead in play-area soil ($p < 0.024$), suggesting track-in from outdoors as a potential source. In addition, houses built before 1955 had higher lead levels in play-area soil compared to houses built more recently ($p < 0.003$), suggesting either higher lead levels in older neighborhoods or a contribution of lead-based paint to soil lead levels.

Table 1: Lead in Water, Dust, and Soil

	Median (Interquartile Range)	Min	Max
Water First Flush (ppb) (n=33)	0.46 (0.18, 0.68)	ND	10
Water 45 sec. Flush (ppb) (n=32)	0.15 (0, 0.15)	ND	1.8
Water 5 min. Flush (ppb) (n=33)	0 (0, 0.18)	ND	1.1
Vacuum Dust (ppm) (n=33)	32 (22, 120)	2.2	910
Dust from Lead Paint Hot Spot* (µg/ft²) (n=26)	5.8 (2.2, 60)	ND	1100
Dust from Floor (µg/ft²) (n=34)**	0.86 (.24, 2.4)	0.11	43
Garden Soil (ppm) (n=18)	16 (7.7, 45)	1.8	110
Play Area Soil (ppm) (n=33)	36 (12, 81)	5.7	42

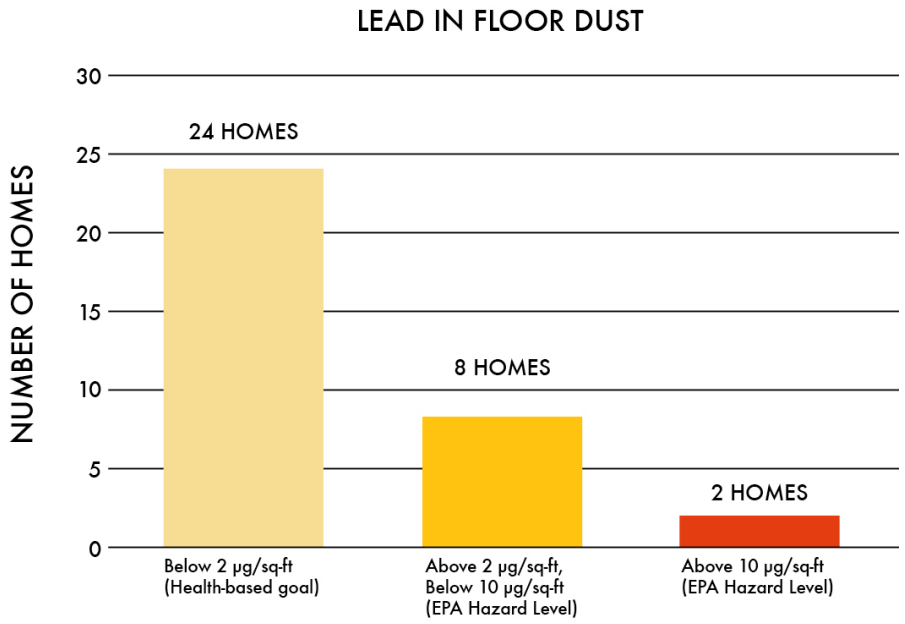
*** Lead paint hot spots dust sampling was identified through the online risk questionnaire**

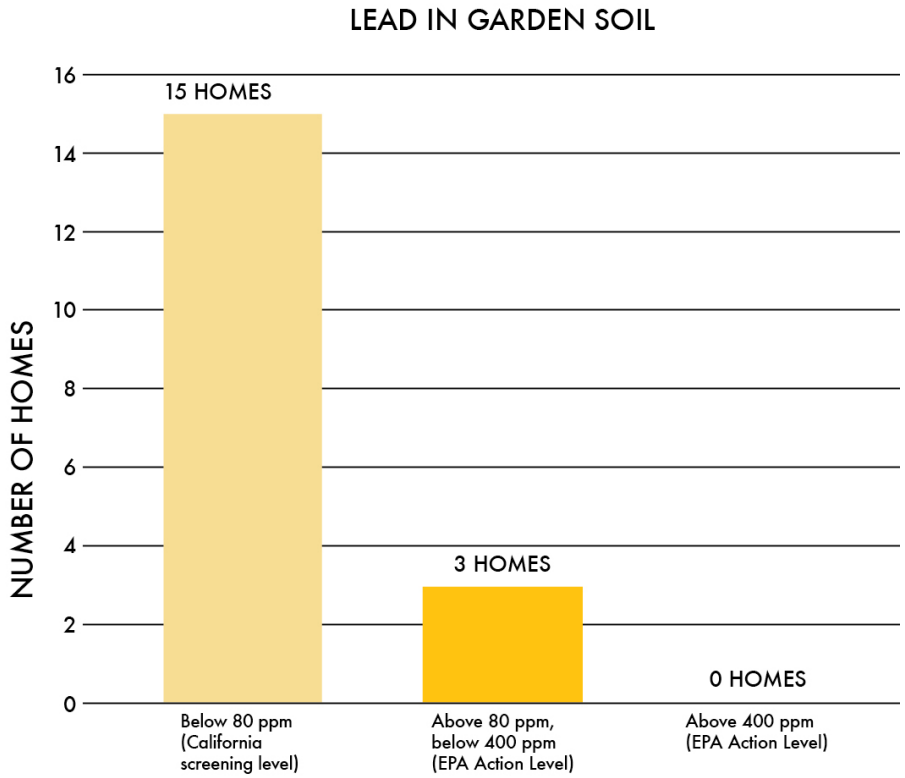
**** Floor dust sampling was identified through the online risk questionnaire**

Table 2: Regulatory and Screening Levels for Lead

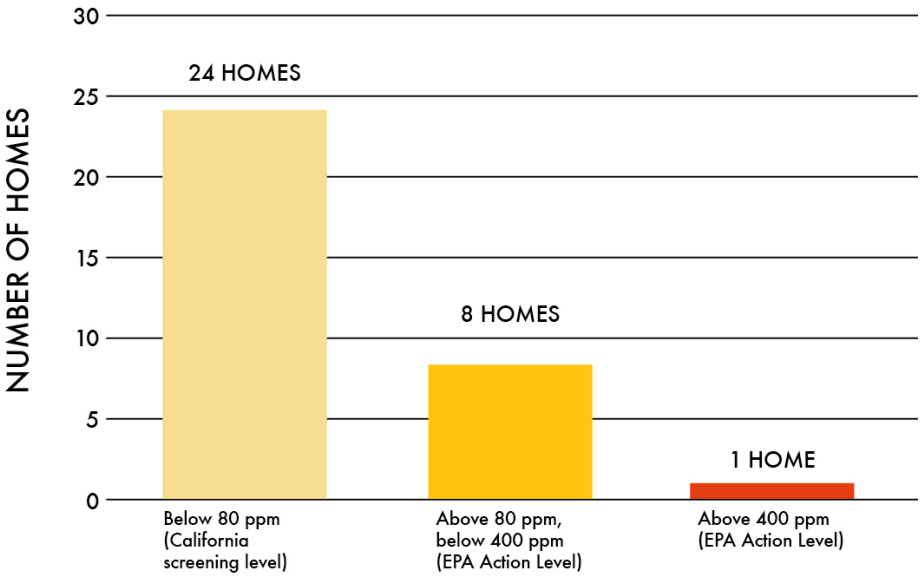
	California or Health-Based Goal	Federal Limit
Water	1 ppb [17]	15 ppb [18, 19]
Residential Bare Soil	80 ppm [20]	400 ppm [19]
Floor Dust	2 µg/ft² [21]	10 µg/ft² [19]

Figure 1: Comparison of Lead Levels to Government Limits and Screening Levels

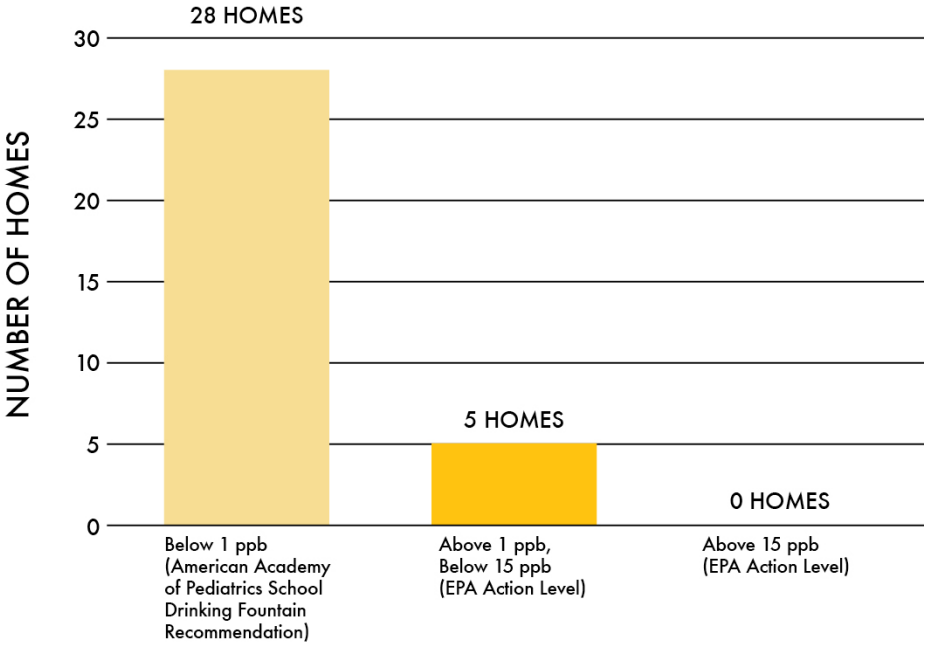




LEAD IN SOIL IN CHILDREN'S PLAY AREAS



LEAD LEVELS IN TAP WATER, FIRST FLUSH



POLICY ACTION AND COMMUNITY EDUCATION NEEDED TO PROTECT CHILDREN FROM LEAD

These results suggest, consistent with an extensive body of research, that children are exposed to lead from multiple sources in their home environments. Although children's blood lead levels have declined nationally as a result of policies banning lead in gasoline, paint and other products, more action is needed to prevent harmful effects to children's development through continued lead exposure. Washington State has prioritized action on lead, with a Chemical Action Plan published in 2009 and Governor Inslee issuing a directive (16-06) to state agencies in 2016. Additional efforts to prevent human exposure to lead in Washington State include bans on lead in children's products and in wheel weights. But more needs to be done to protect children from the lead that persists in homes and soils from older sources.

We recommend the following:

1. **All children should have blood lead screening.** This screening will guide families and local health departments to reduce exposures and prevent further harm. Local government and state government should take action to mandate universal screening.
2. **State and local jurisdictions should institute rental inspection requirements to protect renters from unnecessary exposure to lead in the home.** At least four Washington cities already have rental inspection programs. The Washington State Department of Health estimates that nearly 150,000 rental units currently contain lead hazards, and has recommended a state-level program requiring lead assessment and any needed remediation of all rental units built before 1960.
3. **State and local jurisdictions should provide funding assistance for renovations** to reduce lead exposure, using a fee on paint or litigation against responsible paint companies as funding sources. In response to Governor Inslee's directive, the Washington State Department of Health recommended creation of a remediation fund for landlords providing low-income housing.
4. **Ongoing community education to support individual actions to reduce children's lead exposure,** including limiting access to chipping or peeling paint, regular hand-washing, soil testing, and safe renovation practices.

The lack of protective policies in the past has resulted in widespread contamination of our indoor and outdoor environment with this poison. While we can't undo this mistake, policies can prevent more children from suffering new exposures that will harm their ability to learn and thrive.

Appendix 1: Participant Demographics

	Total	
	N (34)	**%**
Pregnancy or child-in-house status		
Pregnant	6	18%
Child under 3 in the household	23	67%
Child under 3 in the household, and currently pregnant	3	9%
Child under 3 in the household, and planning for a pregnancy	2	6%
Home owner or renter		
Home owner; or live with family	27	79%
Renter	7	21%
Single family home or multi-unit building		
Single-family home	30	88%
Multi-unit building	4	12%
Year of home construction		
<1950	17	50%
1950 – 1977	10	29%
>1977	7	21%
Race		
Non-White	10	29%
White	24	71%
Education level		
Some college; Associate degree; or technical or vocational program	6	18%
Bachelor's degree	11	32%
Master's degree or doctorate	17	50%
Household Income		
Under $49,999 per year	5	15%
$50,000-$74,999 per year	4	12%
$75,000-$99,999 per year	8	23%
More than $100,00 per year	15	44%
Not reported	2	6%

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