Measurement of Lead in Soil in Key Census Tracts across Philadelphia

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Abstract

According to the CDC, approximately half a million children in the U.S. below the age of 6 have blood lead levels above 5 micrograms per deciliter (μg/dL), indicating Elevated Blood Lead Levels (EBLLs)[1]. Children under six are the most vulnerable age category to the adverse health impacts of lead (Pb) exposure. Lead is a neurotoxin that causes long-term health effects in children including cognitive impairment, behavioral changes, and worsened motor function[2]. The goal of this research was to investigate major sources of lead exposure for children in Philadelphia, with a focus on public parks. Using EBLL data, historical lead industry locations, and age demographic data, a GIS analysis was conducted in order to guide selection of public parks and spaces for soil testing. Of 121 soil samples from 23 parks, the average lead value was 162 ppm, with a median of 131 ppm. Of these samples, 5% exceeded the EPA safe limit of 400 ppm in children's play areas. This preliminary testing indicates the need for further investigation of soils as well as other sources of lead exposure, such as paint in public schools. In areas such as Nicetown-Tioga and Fishtown, further testing is recommended to characterize the extent of lead pollution.

Introduction

In 2017 the city of Philadelphia, 5.7% of children screened for lead reported an EBLL (> 5 μg/dL), totaling 2,206 cases of lead poisoning. However, only 28% of children born in 2015 were tested for EBLLs in compliance with Philadelphia's Department of Public Health[3]. Children in cities with older infrastructure, including Philadelphia, are at higher risk for lead poisoning. Some census tracts are disproportionately affected than others. Soil in public parks is considered a potential source of exposure due to the city's industrial past as well as current construction resurfacing legacy pollutants.

Methods and Materials

Using open-source data overlaid with current CEET lead data, untested census tracts were highlighted and public parks within them were identified. Focus was also given to parks in close proximity to former lead industrial sites.

Soil samples were taken from parks, playgrounds and public spaces, with the number of samples ranging from 1 to 10, dependent on size of park and amount of exposed dirt. Samples were approximately 375 grams each. After drying in an oven at 50°C for 24hrs minimum, samples were tested for lead concentration using a portable Olympus Innov-X Delta Portable X-Ray Fluorescence Spectrometer (XRF), set to take three measurements every 20 seconds. A subset of samples (n = 31) were sieved using a 60-size mesh (250 um) in order to determine whether sieving makes a significant difference in lead concentration detected. This methodology was based on EPA method 6200[4].

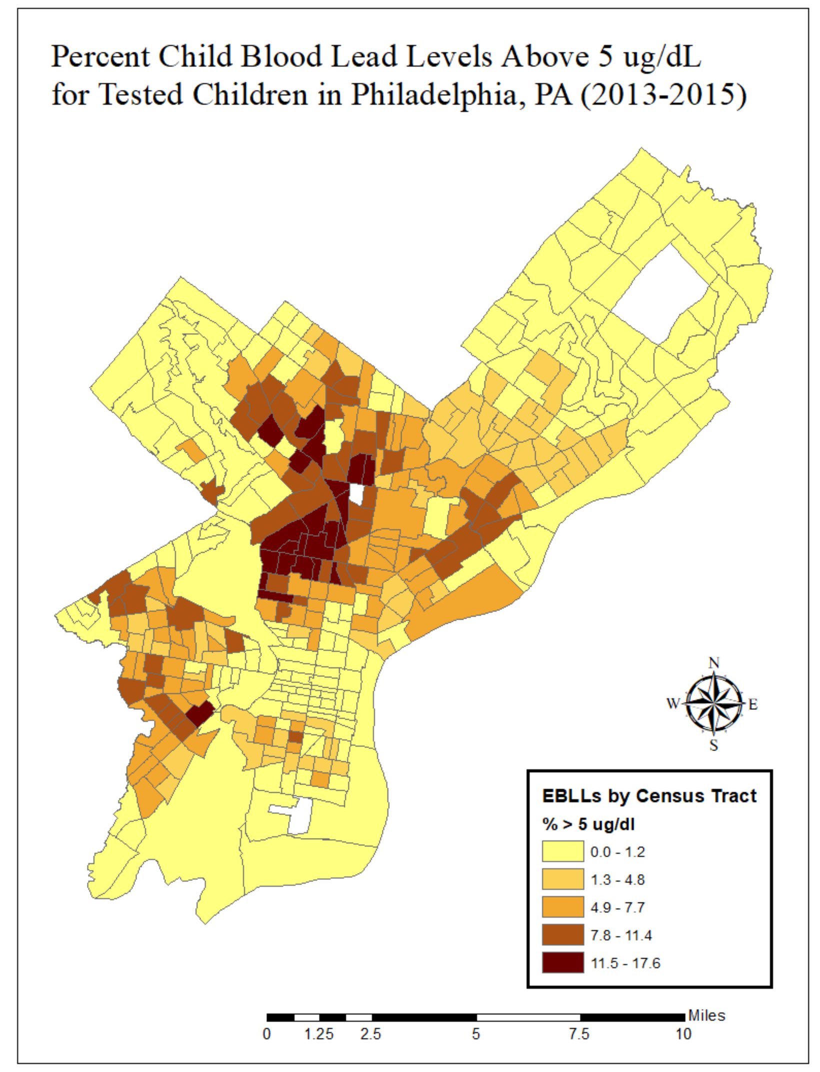

Figure 1. Blood Lead Levels by Census Tract across Philadelphia. Based on this map and public data on historical lead industrial sites, parks were selected for testing.

Figure 4. 20[th] & Tioga and James Brown parks. An elevated soil sample (1,513 ppm) was measured adjacent to the train tracks above the playground.

Figure 6. Cione Park in Fishtown. An elevated soil sample (817 ppm) was measured across the street from new construction. This park is located across from the former Anzon lead smelting factory. Elevated samples were found on this former site along the sidewalks in front and behind the Wawa shopping center.

Figure 2. Playground equipment at East Poplar playground closed due to lead-painted equipment. Samples collected nearby found elevated lead levels.

Figure 3. Eden Harris collecting soil samples adjacent to playground equipment.

Figure 5. Parks tested in West Philadelphia, including the Woodlands Cemetery, Grey's Ferry Crescent Trail, Clark Park, 48[th] & Woodlands Park, and Kingsessing Recreation center. An elevated soil sample (542 ppm) was measured at the Woodlands nearby the driveway next to the Hamilton Mansion. This elevated level may be due to formerly-used leaded gasoline leaking in the driveway.

	Park Soil Samples	Public Spaces Samples
# of sites	23	8
# of samples	121	18
Range (ppm)	10 to 1,513	34 to 3,029
Median (ppm)	131	118
# of Lead > 400 ppm	6	5

Figure 7. Comparison of samples taken from parks versus public spaces.

Results and Discussion

Of the 23 parks sampled, 6 had one sample with elevated levels of lead in soil (> 400 ppm). Of the 121 park samples, the average lead value was 162 ppm and median was 131 ppm. Samples with elevated lead levels were found in University City, West Powelton, Fishtown, Poplar, and Nicetown-Tioga neighborhoods. Elevated levels were found as high as 1,513 ppm in parks. Other public spaces, such as sidewalks, measured as high as 3,029 ppm. Of the 18 samples taken in public spaces, the average lead value was 456 ppm with a median of 118 ppm. Greater variability was found in these samples compared to park samples; this may be attributed to differences in maintenance and testing of Philadelphia Parks and Recreation spaces versus the Philadelphia Streets Department.

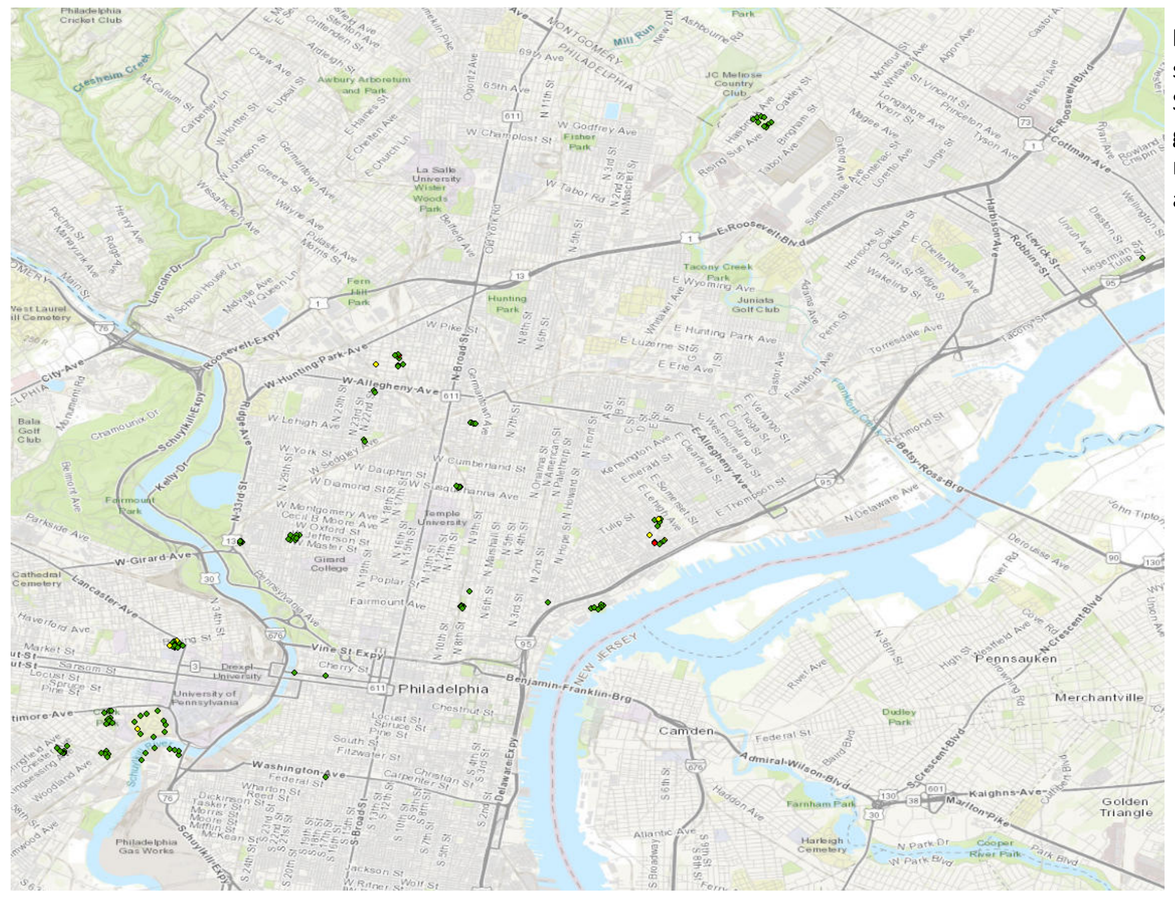

Figure 8. Map of all parks and public spaces tested in the city of Philadelphia. Samples below 400 ppm are denoted in green, between 400 and 1,200 ppm are marked as yellow, and above 1,200 ppm are labeled in red.

Conclusions and Future Directions

From these findings, public parks do not appear to be the sole contributor to EBLLs in Philadelphia; only 5% of samples exceeded the EPA limit for lead in play areas. However, other public spaces such as sidewalks may pose a risk to children under six. Still, given the limited scope of this research, further testing to characterize the extent of lead pollution in public parks is necessary to determine the need for land remediation. Future investigation of other contributors to lead poisoning in children under six is necessary to quantify their impacts on EBLLs. Other contributors to lead poisoning include dust, dirt, and brass drinking water fixtures in residential homes as well as schools; measuring these health hazards will allow for comparison with soil sample measurements. Next steps also include reporting findings to the EPA to ensure that elevated levels of lead in soil can be remediated to eliminate risk. Additionally, by correlating levels of lead with other heavy metals detected by the XRF, the source of each site's lead pollution can be determined, allowing for more effective remediation.

References

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