Preliminary Analysis of Blood Lead Levels in Treece, Kansas

Background

Treece is located in a geographic portion of Kansas where lead and zinc ore mining was once widespread. The mining activity in the area ceased in the 1970s. The remains of the mining activity are still present in the region and were the root of environmental concerns for the residents residing in the town. Lead, cadmium, and zinc are the primary contaminants driving the cleanup efforts in Treece.

Lead is found throughout our environment. It is a naturally occurring bluish-gray metal found in small amounts in the Earth's crust. A good amount of lead in our environment comes from human activities including burning fossil fuels, mining, and manufacturing. Lead is used in the production of batteries, ammunition, and metal products.

In the United States, the most common source of exposure for lead-poisoned children is lead-based paint while the majority of adult cases are workplace-related. The health effects of lead exposure include intellectual and behavioral deficit in children and hypertension and kidney disease in adults.[1] According to the Centers for Disease Control and Prevention (CDC), approximately 250,000 US children ages 1-5 years have blood lead levels (BLL) greater than 10 micrograms of lead per deciliter (µg/dL) of blood.[2] The CDC has recommended that public health actions take place when a child is diagnosed with a blood lead level greater than or equal to 10 µg/dL or a blood lead level of 25 µg/dL or greater is found in an adult. However, several studies have shown that there is no safe level for blood lead poisoning.[3-4]

Lead poisoning is a preventable public health problem, especially in children. In the United States, the addition of lead to paint was banned in 1978 and the use of lead as an additive to gasoline was banned in 1996. A steep decline in blood lead levels has followed throughout the country, including in Kansas. The overall geometric mean (GM) of blood lead levels in the US population has declined from 2.3 µg/dL in 1991-1994 to 1.6 µg/dL in 1999-2002. The highest levels from 1999-2002 were among children ages 1-5 years (1.9 µg/dL) and adults aged $\geq$60 years (2.2 µg/dL).[5]

Cadmium is also a natural element found in the Earth's crust. All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics.

The general population is exposed to cadmium by breathing contaminated workplace air, smoking cigarettes or breathing cigarette smoke, and eating foods containing cadmium. Breathing high levels of cadmium can severely damage lungs. Eating foods or drinking water with very high levels can irritate the stomach and lead to vomiting and diarrhea. Long-term exposure could lead to a buildup of cadmium in the kidneys, lungs and bones.

Finally, zinc is also a common element in the Earth's crust. Pure zinc is a bluish-white shiny metal and has many commercial uses such as coatings to prevent rust, in dry cell batteries, and it is mixed with other metals to make alloys.

A common exposure to zinc occurs by ingesting the small amounts that are present in most food and water. Exposure may also occur in a number of different occupations including construction, painting, mining, smelting, and welding. Zinc is an essential element in our diets. However, large doses of zinc taken by mouth can cause stomach cramps, nausea, and vomiting. Large doses taken over an extended period of time can cause anemia.

Blood lead levels in Treece, Kansas

Treece, Kansas is located in Cherokee County in southeastern Kansas near the Kansas-Oklahoma state line. The 2010 population estimate for Treece was 138 individuals.[6] This included 29 (21.0%) children under the age of 18 and 109 (79.0%) adults ages 18 and older. Recent media reports estimate a population of two.

The Kansas Department of Health and Environment maintains a copy of laboratory results for all blood lead tests performed within the state. The childhood blood lead data (children ages 0-16) with a specimen date on or between December 1, 1997 and August 31, 2012 were included in this analysis. Each record represents a blood test, not an individual. Therefore, an individual may have multiple blood tests included in the database. Adult blood lead data with a specimen date on or between January 1, 2000 and December 31, 2009 were included in this analysis; however, the majority of the data is from a special effort that had been made by KDHE and the Agency for Toxic Substances and Disease Registry (ATSDR) in September of 2009 to conduct blood lead testing in adult Treece residents. Again, each record represents a test, not an individual.

Geometric means are presented for the city of Treece (as defined by the 66778 zip code). The mean values for all tests missing a valid Kansas address are also provided as they may constitute a source of bias for the study results. All statistical analyses were conducted using the Stata® 11.2 and SAS® 9.2 statistical software packages.

Results

Children

There are 388,036 blood lead test records for children ages 0-16 years tested between December 1, 1997 and August 31, 2012 for the state as a whole. Each record represents a blood test, not an individual. About 21.3% of the addresses are missing.

There are 62 childhood blood lead test results from Treece in the database between 1997 and 2012. This represents about 0.02% of all records. The mean blood lead level among children living in Treece, as defined by the 66778 zip code, was statistically significantly higher (4.39 µg/dL) compared to children living in all other zip codes in Kansas combined (2.58 µg/dL) (Table 1).

Table 1
Mean (GM) Blood Lead Levels (µg/dL) Among
Children 0 to 16 Years Old by Zip Code of Residence, 1997-2012

	Number of observations	Geometric Mean	95% CI
66778	62	4.39	3.95-4.82
All other zip codes in Kansas	305,147	2.58	2.57-2.60
Missing address	82,827	2.33	2.31-2.34

Adults

There are 79,916 records between January 1, 2000 and December 31, 2009 for the state as a whole. Roughly 18% of the records lack a valid address.

The mean blood lead level of Treece adults living in the 66778 zip code was 4.18 µg/dL. This was statistically significantly lower than adults living in all other zip codes in Kansas (9.94 µg/dL) (Table 2).

Table 2
Mean Blood Lead Levels(µg/dL)
Among Adults by Zip Code of Residence, 2000-2009

	Number of observations	Geometric Mean	95% CI
66778	109	4.18	3.91-4.48
All other zip codes in Kansas	65,246	9.94	9.85-10.02
Missing address	14,290	2.84	2.80-2.88

Discussion

Based on this analysis, children living in Treece, Kansas had mean blood lead levels significantly greater than those of the rest of the state. Adults living in Treece had significantly lower levels compared to adults in the rest of the state. However, the vast majority of the data in the adult blood lead database is from occupational exposure to lead. Therefore, it is reasonable that the adult Treece population would not have blood lead levels similar to adults working in lead smelters and lead battery manufacturing.

It is important to note that this analysis is based on values using various test methods with different levels of accuracy. This may bias the results if one geographic area was using more of a particular test than the others to screen the children. However, at the time of this analysis, there is no indication that this was the case for the period analyzed. It is also important to note that a number of addresses were missing or invalid. This may constitute another source of bias if those missing addresses were not evenly distributed throughout the state. Finally, the statistically significant differences between mean blood lead levels in Treece compared to the rest of the state may in fact be due to increased screening and awareness in the city. It is possible that, if data for underrepresented portions of the state were available, the differences between Treece and the state may not be apparent.

This analysis does not address sources of exposure such as living in pre-1950 housing with lead-based paint, whether parents of lead exposed children work in occupations where there is a potential to bring home lead on clothing, shoes and equipment, or whether there are common environmental sources of the exposures.

If you have any questions regarding this report, please contact Farah Ahmed at the Kansas Department of Health and Environment, Bureau of Epidemiology and Public Health Informatics (785) 296-6426.

References

[1] Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for lead. Atlanta, GA: US Department Health and Human Services, Agency for Toxic Substances and Disease Registry; 1999.

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[3]Lanphear BP, Dietrich K, Auinger P, Cox C. Cognitive deficits associated with blood lead concentrations <10 µg/dL in US children and adolescents. *Public Health Rep*. 2000;115:521-529.

[4] Canfield RL, Henderson CR Jr, Cory-Slechta DA, Cox C, Jusko TA, Lanphear BP. Intellectual impairment in children with blood lead concentrations below 10 microgram per deciliter. *N Engl J Med*. 2003;348:1517-1526.

[5]Centers for Disease Control and Prevention (CDC). Blood Lead Levels — United States, 1999–2002. MMWR Morb Mortal Wkly Rep. 2005 May 27;54(20):513-6.

[6] Population estimates according to the 2010 Census Summary File available at http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_P12&prodType=table accessed on June 27, 2013.