Analysis of Blood Lead Levels in Cherryvale and other Selected Areas in Kansas

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Background

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. 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. Since 1978, federal and state governments have put in place regulations designed to reduce exposure to lead. A steep decline in blood lead levels has followed throughout the country, including in Kansas. The overall geometric mean (GM) of blood lead level 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 ages ≥60 years (2.2 µg/dL).[5]

Kansas Statutes Annotated (KSA) 65-1,200 through 65,1,214 authorize the Secretary of the Kansas Department of Health and Environment (KDHE) to investigate the extent of childhood lead poisoning in Kansas and to develop a data management system designed to collect and analyze information on childhood blood lead poisoning. The Bureau of Epidemiology and Public Health Informatics, housed within KDHE, maintains a database of blood lead test results for tests administered on children and adults living in Kansas. Kansas Administrative Regulation (KAR) 28-1-18 specifies that laboratories must report the results of all blood lead test results to KDHE. Analysis of the blood lead test results within the database helps to improve knowledge about the environmental factors contributing to lead exposure among Kansans.

Cherryvale, Kansas had a population of 2,367 people in 2010 according to the US Census Bureau.[6] This includes 641 (27.1%) children under the age of 18 and 1,726 (72.9%) adults ages 18 and older. Cherryvale is located in Montgomery County. Montgomery County had a

population of 35,471 people in 2010. This includes 8,399 (23.7%) children under the age of 18 and 27,072 (76.3%) adults ages 18 and older.[6]

The National Zinc Company (Cherryvale Zinc Division) facility site in Cherryvale, Kansas was a zinc smelting facility operating from 1898 to 1976 that generated large volumes of solid waste. The solid waste consisted of furnace cinders, broken clay cylinder retorts, building materials removed during facility repairs, and metallic slag created during the smelting process. These waste materials can be contaminated with heavy metals like lead, cadmium, arsenic, and zinc. As smelter waste material breaks down into smaller particles over time, the contaminants can become mobile. In addition, smelter waste was historically used as fill material throughout the community.

Because of specific concerns around the former National Zinc Company facility site in Cherryvale, the current analysis and report examines blood lead levels among Cherryvale residents and other selected areas in Kansas.

Methods

For the childhood blood lead data (children ages 0-17), all tests with a specimen collection date on or between January 1, 2005 and December 31, 2012 were included in the study. Each record represents a blood test, not an individual. Therefore, an individual may have multiple blood tests included in the database. Also included in the analysis are blood lead test results of 5 µg/dL and above with a specimen collection date on or between January 1, 2013 and December 31, 2013. Again, each record represents a blood test, not an individual. The analysis of blood lead test results from 2005 through 2012 is presented separately from 2013 because the denominator changed between these time periods. The denominator for the 2005-2012 analysis represents all blood lead test results for Kansas residents. The denominator for the 2013 analysis represents blood lead test results of 5 µg/dL and above.

For the adult blood lead data (adults ages 18 and older), all tests with a specimen collection date on or between January 1, 2005 and December 31, 2012 were included in the study. Again, each record represents a test, not an individual. Data for 2013 are incomplete and are not presented.

Geometric means (GM) were calculated for children and adults based on geography. Geometric means are a type of mean or average in which the central tendency of a set of numbers is a product of their values, as opposed to arithmetic means which are calculated using

the sum of the values. In calculating geometric means, negative values are considered invalid and are dropped prior to the calculation. Geometric means are a more appropriate measure of average blood lead levels because blood lead levels cannot include negative values, meaning it is impossible to have a negative amount of lead in the blood. Therefore, the number of records in the dataset may not match the number of records ultimately used in the calculation of the geometric mean. Geometric means, rather than arithmetic means, were calculated so that the methodology is consistent with the national methodology and so comparison can be made to national rates. Geometric means are presented for the city of Cherryvale (as defined by the 67335 zip code), Montgomery County, and the state of Kansas. 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 with Stata® and SAS® statistical software programs.

The Kansas Department of Health and Environment, in partnership with the City of Cherryvale and the Montgomery County Health Department, offered a free blood lead screening clinic on November 13-14, 2013. The screenings were available to all interested residents of Montgomery County. The number of children and adults with blood lead levels above the case management level are also presented. For children, the level of 10 µg/dL and above is considered the level that warrants case management by a health care professional, and for adults the level is 25 µg/dL and above.

Results

Children

There are 280,519 blood lead test results for children ages 0-17 years tested between January 1, 2005 and December 31, 2012 for the state as a whole (Table 1). Each record represents a blood test, not an individual. About 19.9% of the zip codes are missing or invalid.

There are 1,408 blood lead test results greater than or equal to 5 µg/dL for children ages 0-17 years tested between January 1, 2013 and December 31, 2013 for the state as a whole. About 7.3% of the zip codes are missing or invalid.

There are 113 valid childhood blood lead test results from the 67335 zip code in the database between 2005 and 2012 (Table 2). Again, valid test results only include non-negative test results. This represents about 0.04% of all tests on children during this time period. The

mean blood lead level among children living in Cherryvale, as defined by the 67335 zip code, was statistically significantly higher (4.54 µg/dL) than the mean for Montgomery County (3.17 µg/dL) and the mean for Kansas (2.49 µg/dL). The mean for Montgomery County (3.17 µg/dL) is also statistically significantly higher than the state mean, even after removing values for Cherryvale residents (3.11 µg/dL).

There are 10 valid childhood blood lead test results from the 67335 zip code in the database for 2013 (Table 3). Again, valid test results only include non-negative test results. This represents about 0.71% of all tests on children during this time period. The mean blood lead level among children living in Cherryvale was not statistically significantly different (12.32 µg/dL) than the mean for Montgomery County (11.29 µg/dL) or the state (9.05 µg/dL). The mean for Montgomery County, with and without Cherryvale residents included, was similar to the state.

Adults

There are 82,885 blood lead test results for adults ages 18 and older between January 1, 2005 and December 31, 2012 for the state as a whole (Table 1). Again, each record represents a blood test, not an individual. Roughly 18.3% of the zip codes are missing or invalid.

There are 16 valid adult blood lead test results from the 67335 zip code in the database between 2005 and 2012 (Table 4). Again, valid test results only include non-negative test results. This represents about 0.02% of all tests on adults during this time period. The mean blood lead level of Cherryvale adults living in the 67335 zip code was 2.32 µg/dL. This was statistically significantly lower than the state mean blood lead level (8.33 µg/dL). The mean blood lead level for Montgomery County adults (2.61 µg/dL) was also statistically significantly lower than the state mean blood lead level.

November 2013 Blood Lead Screening Clinic

Of the 132 Montgomery County residents that were screened during the November 2013 blood lead screening clinic, 47 children (35.6%) ages 0-17 years and 85 adults (64.4%) ages 18 and older were screened. The results of the screening identified 2 children and 0 adults with blood lead levels at or above the level recommended for case management by a health care professional. For children, the level of 10 µg/dL and above is considered the level that warrants case management by a health care professional, and for adults the level is 25 µg/dL and above. A total of 5 blood lead samples, 2 children and 3 adults, had an insufficient quantity of blood to run

the test. These people were asked to contact their physicians or local health department for a new blood lead test.

Discussion

The analysis of childhood blood lead test results for tests conducted between 2005 and 2012, presented in this paper, shows that the mean blood lead level among children living in Cherryvale was statistically significantly higher than the mean for Montgomery County and Kansas as whole. The mean for Montgomery County was also statistically significantly higher than the state mean, this result being independent of the results for Cherryvale children. This indicates that Montgomery County is an area of the state with historically high blood lead levels among children, and that Cherryvale is one specific area within Montgomery County which has particularly high blood lead levels.

The analysis did not show an increase in blood lead levels among adults in Cherryvale compared to the state. This result is not surprising as the majority of the test results in the database are from testing performed on adults working in occupations with exposure to lead; therefore, the state average for adult blood lead is relatively high.

Because of changes to protocols for entering blood lead test data into the database in 2013, the denominator changed to test results of 5 µg/dL and greater, rather than all test results as was the case between 2005 and 2012. Because of this change, at this time, the 2013 results cannot be compared to 2005-2012. Also, because the 2013 dataset only includes test values of 5 µg/dL and greater, the average that is calculated from this dataset is not generalizable to all Kansas residents screened for blood lead, because the full dataset should include non-elevated blood lead test results as well. Therefore, the geometric mean that was calculated from the 2005-2012 dataset, which includes both non-elevated and elevated blood lead test results, is the most reliable estimate of blood lead levels in Cherryvale today. This estimate is also a reliable reflection of the current situation because lead is stored in the blood, soft tissues and in bone and takes years to clear the body through urine and feces. Therefore, even after the source of lead exposure is removed, it will take several years for blood lead levels to decrease among children and adults.

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. Children receiving federal and state assistance were disproportionately represented among the study population. Therefore the results cannot be generalized to the rest of the population in the state. Finally, the statistically significant differences between mean blood lead levels in Cherryvale and Montgomery County compared to the rest of the state may in fact be due to increased screening and awareness in these areas. It is possible that, if data for underrepresented portions of the state were available, the differences between these areas and the state may not be apparent.

Recommendations

In conclusion, as this analysis does not address sources of exposure, further analyses may be warranted to address potential causes for the increased mean blood lead levels noted in Cherryvale and Montgomery County. This could include follow-up with families of children in Cherryvale and Montgomery County who have had a blood lead test performed to identify whether a large proportion of children are living in pre1978 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.

For questions about this report, please contact Dr. Farah Ahmed at fahmed@kdheks.gov. If you have concerns about lead exposure in yourself or your family, please contact your local health department or the Kansas Department of Health and Environment, Bureau of Epidemiology and Public Health Informatics at (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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Table 1
Number of blood lead test results by year, Kansas 2005-2012

	Number of tests on children (ages 0-17 years)	Number of tests on adults (ages 18+)	Total number of tests
2005	33,331	10,990	44,321
2006	31,944	10,432	42,376
2007	34,559	11,159	45,718
2008	36,590	9,631	46,221
2009	38,522	10,161	48,683
2010	38,481	9,660	48,141
2011	38,949	9,143	48,092
2012	28,143	11,709	39,852
2005-2012	280,519	82,885	363,404

Table 2
Mean (GM) blood lead levels (µg/dL) among
children 0 to 17 years old by zip code of residence, 2005-2012

	Number of observations	Geometric Mean	95% Confidence Interval
Cherryvale (67335)	113	4.54	3.92-5.27
Montgomery County	2,188	3.17	3.09-3.26
Montgomery County (without 67335)	2,079	3.11	3.03-3.20
Kansas	224,154	2.49	2.48-2.50
Missing zip codes	55,762	2.16	2.15-2.17

Table 3
Mean (GM) blood lead levels (µg/dL) among
children 0 to 17 years old with blood lead test results ≥ 5 µg/dL
by zip code of residence, 2013

	Number of observations	Geometric Mean	95% Confidence Interval
Cherryvale (67335)	10	12.32	8.15-18.61
Montgomery County	34	11.29	9.17-13.89
Montgomery County (without 67335)	24	10.89	8.41-14.09
Kansas	1,295	9.05	8.81-9.30
Missing zip codes	1,953	1.82	1.75-1.89

Table 4
Mean (GM) blood lead levels (µg/dL) among
Adults 18 years and older by zip code of residence, 2005-2012

	Number of observations	Geometric Mean	95% Confidence Interval
Cherryvale (67335)	16	2.32	1.68-3.20
Montgomery County	164	2.61	2.34-2.92
Montgomery County (without 67335)	149	2.64	2.35-2.97
Kansas	68,526	8.33	8.26-8.40
Missing zip codes	69,061	2.27	2.26-2.28