Spatial and Temporal Analysis of Childhood Blood Lead Levels Across Kansas: 2006-2011

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Abstract

The negative developmental and behavioral effects of chronic low dose exposures to lead in children are being better understood as research technology advances. To monitor and prevent childhood exposures, the CDC recommends that states create their own targeted screening programs. Here we use data from STELLAR, a statewide childhood blood lead tracking program for the state of Kansas, to analyze spatial and temporal relationships in the distribution of child blood lead tests for the 6 year study period of 2006 to 2011. Nonspatial demographic data from STELLAR is also analyzed to identify potential demographic target zones such as race, ethnicity, or sex. Data from the database was analyzed in ArcGIS software by county or census tract along with the most recent available census data to understand both the spatial and nonspatial trends within the demographic data. Geographic mean blood lead levels were also calculated for Kansas counties and displayed spatially. A large quantity of missing or errant geographic (address) and demographic data within the STELLAR database, however, created a lack of confidence in observed trends and made it impossible to conclusively identify potential targeted screening regions. Higher quality data and consistent data entry at physician locations is necessary for spatial analyses such as these to provide conclusive evidence for future interventions and screening programs to prevent childhood lead poisoning and exposures.

Introduction

Toxic effects of acute and chronic lead exposure in children have been known for decades, and as both research and technology advance, even more effects are being seen in children chronically exposed to low levels of lead. “Lead is highly toxic and affects virtually every system of the body; at extremely high levels, lead can cause coma, convulsions, and death; at lower levels, studies have shown that lead can cause reductions in IQ and attention span, reading and learning disabilities, hyperactivity, and behavioral problems” (United States General Accounting Office 1999). The American Academy of Pediatrics Committee on Environmental Health estimates that a blood lead level of 20µg/dL can lead to a loss of 2-3 IQ points in children (American Academy of Pediatrics 1998). Exposures in children can come from many sources, but lead-based paint remains the leading cause of childhood lead poisoning today, even though the Consumer Product Safety Commission banned the use of lead-based paint in residential housing in 1978 (CDC 2012, Reissman 2001, U.S. Dept. of Housing and Urban Development). While the use of lead in paints was officially banned in 1978, there was a voluntary reduction of the concentration of lead used by the paint industry between 1950 and 1977, and as a result, houses built prior to 1950 pose the highest risk for exposure (Roberts 2003; Warren 2001).

The adverse effects from chronic exposure to lead at early ages – learning and behavioral disorders, hearing impairment, decreased intelligent quotient, and decreased attention span – often do not become apparent until puberty, after irreversible damage has already occurred. (Bellinger 1995, Miranda 2002, Needleman 1990, Needleman 1996, Schwartz 1991, Schwartz 1994, Thacker 1992). In response to the threat that lead poses to the health of children in the U.S., the Healthy People 2000 and Healthy People 2010 initiatives both included goals of eliminating elevated blood lead levels in children. While there has been a decrease in the number of elevated blood lead cases in children from 2000 to 2010, children in the U.S. and in Kansas are still being found every year with the blood lead levels greater than 10µg/dL. The new Healthy People 2020 initiative continues the goal of eliminating elevated blood lead levels in children, as well as increasing the number of pre 1978 homes tested for the presence of lead and decreasing the number of homes that have lead-based paint hazards (Healthy People 2020).

Deteriorating lead based paint can chip, flake, or chalk into dust both inside or on the outside of a house, making certain regions such as the soil around the house, windowsills and window blinds high accumulation areas (Jones 1999). Household lead dust from deteriorating paint may also be more dangerous than exposure to paint chips, because the smaller dust particles are more easily absorbed into a child's gastrointestinal or pulmonary tracts (Miranda 2002). Further amplifying the risks from paint dust are those associated with children at risk of nutritional deficiency due to low family income (U.S. General Accounting Office 1999, National Research Council 1993). Certain nutrient deficiencies have been proven to increase the toxicity of lead; iron, calcium, and zinc for example. Children with nutritional deficiencies are also more likely than others to develop pica, a compulsion to eat non-nutritional substances (U.S. General Accounting Office 1999, PubMed Health 2012, Erickson 2005). Nutrient deprived children are constantly mouthing objects that may be contaminated with lead dusts from deteriorating paint, significantly increasing the chances of lead exposure (Erickson 2005). Lead-based paint also tastes sweet, making children even more likely to ingest chips and dust (Miranda 2002). Consequently, since hand-to-mouth activity is normally more frequent in one- and two-year old children, health authorities consider children in that age group at greatest risk of lead exposure (U.S. General Accounting Office 1999).

Because of these exposure risks from lead-based paint found in pre 1950 homes, many descriptive studies examining childhood blood lead poisoning for local or statewide areas automatically label pre-1950 housing as "high-risk". Neighborhoods with high quantities of pre-1950 homes then become the focus of attention for interventions. These “high-risk” areas are used to identify target zones where children are at risk of blood lead poisoning, as indicated in the CDC’s 1997 lead screening guidelines (Erickson 2005, U.S. General Accounting Office 1999). These guidelines include buildings other than the current child residence, such as a grandparent’s or babysitter’s house, because the exposure does not necessarily have to come from the child’s own home. Targeted screening methods are also recommended due to their cost-effectiveness. All lead-based paint hazards are resolvable, but feasibly, due to limited finances and resources, remediation and screening needs to be done where it is posing the most risk (Reyes 2006). Screening rates nearing 100% for Medicaid eligible children is an example of a demographic target zone, because low household income has been found to be associated with blood lead poisoning (Vivier 2001, U.S. General Accounting Office 1999).

Using the CDC guidelines, the state of Kansas has implemented its own lead prevention program known as the Healthy Homes and Lead Hazard Prevention Program (HHLHPP). HHLHPP’s mission is “to establish an infrastructure of trained personnel to screen, identify, and recommend proper medical and environmental management of lead-poisoned children” (Kansas Department of Health and Environment). This mission is pursued through promotion of public awareness, certification, licensure, accreditation, enforcement of lead-based paint regulations, professional education, and training across Kansas. The training activities cover blood lead screening techniques, environmental assessment, and appropriate case management; including follow-up activities. HHLHPP uses a database known as STELLAR (Systematic Tracking of Elevated Blood-Lead Levels and Remediation) as a management tool for the program. It houses all blood lead test information submitted to the KDHE by laboratories or health care providers, as required by state law. It also keeps track of case management and environmental investigation activities. The purpose of this study is to conduct a descriptive analysis of child blood lead test results as a means to identify regions in Kansas that are at high risk for childhood blood lead poisoning.

Methods

Data Acquisition

Childhood blood lead data was acquired from the state of Kansas' STELLAR database. STELLAR (Systematic Tracking of Elevated Lead Levels and Remediation) is a case and program management tool provided by the CDC free of charge to state and local Childhood Lead Poisoning Prevention Programs. This software has been used in the state of Kansas since 1995 as a repository for blood lead test results in children 0 to 17 years old, and as a case management system for children with confirmed elevated blood lead levels and environmental testing of Kansas residences.

To extract the data for this study, the following tables were exported from STELLAR as dbf files:

- ADDR Table containing detailed address information
- CA_LINK Table linking each child with one or more addresses and times of residency
- CHILD Table containing individual child identification and demographic information
- LAB Table containing blood lead test results for each child
- SIBLINK Table linking siblings to each other

These tables were all then imported into Microsoft Access 2007 databases for all data cleaning, editing, and querying.

All laboratory tests with samples collected between January 1, 2006 and December 31, 2011 were selected from the LAB table as a basis for the study. This query produced a total of 219,090 blood lead tests. Of these 219,090 blood lead tests, 171,122 (78.1%) were linked to valid addresses. The remaining invalid addresses were examined and were either corrected for typos or inaccuracies, or were updated using additional data from the STELLAR database. For blood lead tests with no addresses, we substituted the last known address of the child, if available. The last known address was taken from either previous labs or from the address associated with the child demographic information recorded when the child is first entered into the system, located in the CHILD table. The CA_LINK table; which contains the address history of each child, was used to identify the last known address. Thousands of children resided at multiple addresses throughout the duration of the study. The last known address was used under the assumption that the child still resides in the area and that the missing address was just a clerical omission. Additionally, the SIBLINK table that links siblings together was used to substitute a missing address with that of a sibling; assuming that siblings usually live at the same address. Following address corrections and substitutions, there were 179,962 lab records with complete geocodable addresses, or 82.1% of the total number of tests conducted during the study period (219,090), that will be used for analysis. In the end, a total of 8,804 addresses were corrected or substituted. To assess the effect of this activity, the data was analyzed with (n=179,926) and without (n=171,122) the corrections and substitutions.

Geographic Information Systems (GIS)

ArcGIS 10.1 software suite was used to conduct the spatial analysis, geocoding, and mapping of the data. The following map layers were obtained from the Kansas Department of Health and Environment's Geospatial Services Program; Kansas state boundary, Kansas county boundaries, Kansas major roads, Kansas major rivers, and Kansas water bodies. Additional layers used in the map include a 2010 ESRI street map layer from ESRI, and 2010 Census Tract regions and data from the U.S. Census Bureau. The data from the U.S. Census was downloaded as a shapefile containing tract population data by race and age, household and family size, and property ownership. Additional census data included for household income and the percentage of families and individuals below the poverty level was obtained separately from the Census bureau and joined in ArcMap (the spatial mapping portion of ArcGIS 10.1) to the shapefile containing the other demographic data.

Geocoding of the addresses described above was performed in two steps. First, addresses that contained complete street addresses were geocoded to the Kansas street layer from ESRI using a Kansas streetmap locator provided by the KDHE's Geospatial Services Program. Second, all addresses that were post office boxes were then geocoded separately to KS zip codes using a postcode locator also provided by KDHE's GIS Department. A minimum match score of 60% was used for all geocoding operations.

ArcGIS was also used to create chloropleth maps to display the spatial distribution of childhood blood lead levels, demography, and statistics at the state and county levels.

Data Analysis

Data Preparation

All blood lead test records (219,090) performed in children 0-17 years old between January1, 2006 and December 31, 2011 were retrieved from the Kansas STELLAR database. There were 171,122 (78.1%) lab records linked to a complete address. An additional 8,804 records were edited manually leading to a total of 179,926 (82.1%) records with valid, geocodable addresses. To assess the effect of manually updating the addresses, the data was analyzed with (n=179,926) and without (n=171,122) the corrections and substitutions.

Case Definition

An elevated blood lead (EBL) test is any blood lead test with a result of 10 micrograms per deciliter or higher. This value is used to define confirmed elevated blood lead (CEBL) tests; any elevated blood lead test from a venous draw, or two elevated blood lead tests from a capillary draw conducted less than 90 days apart. Following the address update described above, a valid address was added to 194 EBL test records that lacked one. Any child with a CEBL is considered a case. However, a child can only be considered a case once per calendar year, so select queries were used to ensure no duplicate cases were reported for the same year.

Geocoding

The original uncorrected lab test records included 171,122 with addresses and are divided into 1.) 167,257 records with standard physical US addresses, including street number, name and type, city, state, and zip code; and 2.) 3,865 records with Post Office Box addresses, including PO Box number, city, state, and zip code. At the first attempt, all PO Box addresses were successfully geocoded to the corresponding zip code, and most standard physical US addresses (149,445 or 89%) were successfully geocoded at the street level.

For the corrected lab test records there were 179,926 with addresses that were divided into 1.) 175,679 records with standard physical US addresses, including street number, name and type, city, state, and zip code; and 2.) 4,247 records with Post Office Box addresses, including PO Box number, city, state, and zip code. At the first attempt, all the PO Box addresses were successfully geocoded to the corresponding zip code and most standard physical US addresses (156,947 or 90%) were successfully geocoded to the street level. Interestingly enough, correcting addresses and filling in absent ones did not change the proportion of geocoded addresses in the data set.

Comparison of the geocoding results for all EBL tests and CEBL tests (Cases) was also performed between the Raw and Updated data sets using ArcGIS (Table 1). The Raw data set for EBL tests resulted in 4,153 tests and an additional 122 tests with PO box addresses being successfully geocoded from the total 4,715 attempted. The Updated data set of EBL tests resulted in 4,326 tests and 126 PO Box tests successfully geocoded out of the 4,913 tests attempted.

Cases (CEBL) continued to follow this trend with 2,170 Raw cases and 60 Raw PO boxes cases out of 2,418 being successfully geocoded, while the Updated case data set resulted in 2,264 cases and 61 PO Boxes cases out of 2,522 being successfully geocoded.

The Raw EBL and Updated EBL data sets both geocoded at a 90% overall success rate and both Case data sets geocoded at 92% overall success rate. This shows that the addition of addresses to the Updated data set is not significant enough to increase the geocoding success rates between the two datasets. Due to the negligible differences shown here, only the Updated data set was used for further analysis of spatial distributions.

Spatial Analyses and Distributions

To understand the spatial distribution of childhood tests in Kansas, the data sets were cleaned up to eliminate duplicates, and each address where there has been at least one test during the study period was geocoded and mapped. Addresses where there was one or more cases of confirmed elevated blood lead (CEBL) were also identified (Figure 1). This reduced the data set to 150,512 addresses, of which 130,961 (87%) were successfully geocoded.

Spatial trends were also examined regarding their relationship to income levels. While the samples were from multiple years spanning 2006-2011, the most recent 2010 census tract data was used for determining regions of poverty. The first method of examining these trends uses an arbitrarily chosen value of 30% to select the regions of highest poverty across the state. Regions with these high poverty levels were all isolated to urban areas, with the exception of the town of Chanute, which will be discussed later. To better examine the impact of poverty statewide, a second method used quintiles of the census poverty data spectrum to determine high levels of poverty. These values provided 384 cases found in the top quintile – regions where greater than 14.7% of individuals are living below the poverty line.

Screening rates were calculated using birth cohorts of children less than 72 months of age for each specified study year as the denominator. For example, to calculate the screening rate in 2006, the 2001 cohort was used. This cohort includes all children born between January 1, 2001 and December 31, 2006 who would all be less than 72 months old by the end of 2006. These cohort screening rates were calculated for all Kansas counties and subsequently used with county case data for incidence rate calculations. Incidence rates were calculated using the number of cases per county divided by the cohort population for the specified year. Furthermore, elevated test rates were calculated by dividing the number of children found with EBL levels numbers by the number of children tested per county for each year of the study.

To address the fact that the blood lead test results data is skewed to the right because of the large number of negative (0 µg/dL) blood lead results, the geometric mean of the blood lead levels for Kansas counties was calculated instead of using the arithmetic mean. The geometric mean blood lead level was also calculated for all tests with no valid address grouped together to serve as a comparison against tests that did have a valid address, to rule out the existence of a systematic bias. Geometric mean blood lead levels were determined statewide and for all Kansas counties for the entire study period, as seen in Table 5. While the resulting data is spatially displayed by county in Figure 8, it was not limited to the geocodable data used for the previously described spatial relationship analyses. Additional statistics were calculated for race, sex, and ethnicity demographics, but are not displayed spatially in this study.

Results

Spatial Relationships

The spatial relationships concerning childhood blood lead levels were examined to identify potential target regions for preventative screening efforts. The distribution of cases is more densely seen in regions with higher populations; the Kansas City area, Topeka, and Wichita. A noticeable exception to this trend, however, is a higher density of cases coming from Chanute and Parsons, KS, populations 9,085 and 10,454, respectively (U.S. Census Bureau, 2013).

The screening rates for Kansas counties were calculated based on cohorts for each year of the study and the total number of children tested per year (Figure 2 and Table 2). A general increase in rates was seen statewide during the study period, but 2011 was the only year in which a county, Greely, exceeded a 50% screening rate. Few counties consistently had very poor screening rates relative to the state as a whole during this time period (Butler and Hamilton counties did not exceed a 5% screening rate), but the statewide screening rates themselves were consistently low. Statewide rates for the study period based on our birth cohorts were 9.79%, 10.97%, 10.71%, 12.48%, 12.81%, and 13.38% for 2006-2011, respectively (Figure 4).

Incidence rates for Kansas counties were nearly all less than 1% for the duration of the study. These values were calculated from county case numbers and the cohort values for the appropriate years, shown in Table 3 in values per 10,000 children (Table 3). There were eight counties that had rates greater than 1% during the study: Chase County (1.01%) in 2007; Meade (2.33%) and Wallace (1.30%) counties in 2010; and Barber (1.04%), Greenwood (2.07%), Jewell (1.27%), and Rooks (1.53%) counties in 2011. The general increase in incidence rates in 2011 is reflected in the noticeable jump in statewide incidence during 2011. To further examine this phenomenon we also calculated elevated test rates for Kansas counties throughout the study period (Table 4). This data set shows a consistent statewide decline in elevated test rates from 2006 to 2010, followed by the same noticeable jump in 2011 that was seen in the Incidence Rate data (Figure 5). 2011 also had the highest screening rates seen in the study, even though it was not a significant increase like what was observed in the incidence and elevated test rates.

Figures 6 and 7 show the spatial distribution of blood lead poisoning cases throughout the state in relation to census tracts determined to be of high poverty through two different methods. Figure 6 is representative of the arbitrarily chosen cutoff of 30% poverty to define regions of high poverty. Using this method, 94 cases were identified within a small number of isolated urban regions, limiting the analysis to only the densely populated regions. The second method described using quintiles to define the poverty cutoffs uses a lower percent poverty (14.7%) to define the parameter, and provides a broader spatial distribution (Figure 7). Most cases were still in the more densely populated urban areas, but overall are much more dispersed through the state, clustering in several other regions where income may be an important risk factor for exposure. The most apparent non-urban cluster throughout the state is located within the tri-state mining district in the southeast corner of the state, providing insight about another possible reason to target the high risk District. Other small clusters can be seen in Junction City, Dodge City, Salina, and Hiawatha.

Nonspatial Results

Of the 105 counties in Kansas, only two had a geometric mean BLL of greater than 4 µg/dL; Comanche (4.11) and Greenwood (4.24) Counties; but 14 other counties ranked in the top quintile with a geometric mean BLL of greater than 3.6 µg/dL. Every county had a mean level less than the 5 µg/dL level at which the CDC recommends that public health action be taken (Centers for Disease Control, Lead, 2013).

Equally important to a targeted screening program, but not described spatially in this report, is the risk associated with different demographic groups. Table 6 shows the dispersion of tests between sexes and by child age for all 219,090 tests reported between 2006 and 2011. The distribution among males and females was very similar, with only a small percentage (1.45%) of recorded tests lacking data regarding the child sex. The distribution was clearly different in regards to child age, with one year old children (0-12 months) receiving the highest proportion tests, and a general decrease in the number of tests is seen with each additional year of age. While the STELLAR database was designed to track childhood blood lead tests, Kansas law requires physicians to report all elevated blood lead test results statewide. Because of this legal requirement for physicians, blood lead tests for anyone older than 72 months of age, likely tested due to symptoms or known exposures, will be present in the STELLAR database and is responsible for the >72 months category seen in Table 6.

The final set of data examined was race and ethnicity data. The analysis was not stratified by race or ethnicity because of the high amount of missing values in the database (Table 7). 88% of the race information and 93.5% of the ethnicity information for Kansas children from the analysis set was missing. More concerning, however, is the trending increase in the percentage of unknown demographic data over time (Figure 9).

Discussion

A comparison of geocoding results between the Raw and Updated datasets was made for the Tests, Elevated BLL, and Confirmed Elevated BLL (Cases) datasets to show that a difference in data quality can be made by proper entry of patient information by physicians, as the data is extremely important to the real-world accuracy of spatial analyses. The quantity of samples added to the Updated dataset, however, was too negligible to provide any additional spatial insight regarding the distribution of such a large number of childhood blood tests throughout Kansas. Additionally, this small improvement in geocodable addresses did not create observable or statistical differences for Elevated BLL or Confirmed Elevated BLL because of the large size of the data set. This does not disprove, however, the need for proper address recording by physicians, laboratories, and patients. 39,164 (18%) of the 219,090 BLL tests performed during the study period contained insufficient or missing address information and were, therefore, unavailable for inclusion in the geocoding analyses. While there is no reason to believe that the missing and incomplete addresses are not randomly distributed, they are still important for managing cases of childhood lead poisoning. These 39,164 missing or invalid addresses in the STELLAR lab table results in a major information gap in the program management.

Spatial analysis of blood lead poisoning cases throughout Kansas indicated a non-urban concentration of cases in the southeast corner of the state, particularly near the cities of Chanute and Parsons. These southeastern Kansas cities are not densely populated, but are home to two hospitals within Neosho and Labette Counties; Kansas counties on the border of what is known as the Tri-State Mining District. The Tri-State Mining District was once one of the largest lead mining locations in the world, and has left massive, exposed mounds of mine tailings near residential areas, with some of these tailings being used as fill in residential areas as well as for roads (Malcoe, 2002). The high risk of exposure from obvious, unavoidable lead presence alone is worthy of making this Tri State Mining District a target zone for the Childhood Lead Poisoning Prevention Program, even if the case distribution only shows a high density of cases in one of the counties encompassed by this region. Neosho, Labette, Crawford, and Cherokee counties are in or border the Tri-State Mining District, and had 23, 18, 14, and 20 cases, respectively, during the six year study period. The high potential of exposure in this region is known to physicians and residents, who, based on the dense distribution of childhood BLL Tests in Southeastern Kansas in Figure 1, appear to be taking the necessary screening precautions.

Analysis of spatial relationships also resulted in an observable jump in elevated test rates for the state in 2011. One possible explanation for the increase from 2010 to 2011 is that the increase in screening that occurred during those years was in locations that were at higher risk of lead exposure previously neglected. A potential increase in testing in a high risk region could result in more cases being identified, therefore, increasing the incidence and elevated test rates. Examination of this phenomenon spatially, however, does not provide any observable county or region that saw a dramatic change in comparison to others that would have contributed to the sudden increase in elevated tests and incidence. Rather, there was an increase in cases throughout many Kansas counties during 2011 (Figure 3).

It may appear that there was a significant increase in Jewell County in North Central Kansas in 2011, but Jewell County is not densely populated and saw only two elevated tests during 2011, when it had zero from 2006 to 2010. Jewell County also saw an increase in screening between 2010 and 2011, which does provide some evidence that increasing screening rates will more effectively identify children at risk and target regions. This single county's data is far from conclusive, however, and there were also many other counties that saw an increase in screening rates between 2010 and 2011 that did not have elevated incidence or an increase in elevated test rates. Throughout the state, many counties with increasing elevated test rates between 2010 and 2011 provide evidence that increased screening will have a positive outcome.

Two Kansas counties had geometric mean BLL's greater than 4µg/dL, and 14 others were in the top quintile with geometric means greater than 3.6 µg/dL. It is important to recognize, however, that the higher county mean values in counties that do not have high confirmed elevated test rates (high number of cases) could be indicative of a greater quantity of children having BLL's that fall within the 5-10 µg/dL range, where it is recommended by the CDC that action be taken. This distinction is important to note because the 10 µg/dL BLL used to characterize a child as a lead poisoning case is an arbitrary value that is consistently decreasing over time with increasing research capabilities to understand the effects of chronic exposures. Therefore, it is important to acknowledge these higher geometric mean counties in conjunction with the data found in Tables 2 and 3 to provide the necessary attention to counties that may have a substantial number of children with BLL within the 5-10 µg/dL range.

Conclusions

The analyses performed here have the potential to identify target zones based on spatial and nonspatial data. With 39,164 childhood blood tests having unusable address data and 88% race and 93% ethnicity data missing from the STELLAR database it is challenging identify targeted areas using the demographic characteristics of the children tested. Quality data is necessary to represent the real-world implications of environmental lead exposure, and crucial to identifying potential target zones for prevention measures. Interventions at the physician, laboratory, and data entry level should be made to explain the importance of this data and its necessity for targeted analyses such as these. Proper data entry at physician's offices, creating more complete data sets would allow for confident and conclusive results to spatial analyses. With the STELLAR system no longer in use, creating physician awareness of the importance of accurate and complete data reporting should be considered a priority in the development or implementation of a new statewide tracking system.

Limitations

The spatial analysis may be biased due to a large number of unknown/unreported addresses. However, there is no reason to believe that the missing addresses are not randomly distributed. In addition, internal migration of families was not accounted for in this study. Birth counts were the best option to create cohorts for the age ranges of susceptible children, but do not account for the migration of those children across or out of Kansas after birth. However, the influences of internal migration are likely negligible compared to the consistently low screening rates across the state. This provides some evidence that, while this migration is inevitable, it did not likely have a major effect on the statewide data during the study period.

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Appendix I - Tables

Table 1: Geocoding Results of Elevated (EBL) and Confirmed Elevated (CEBL) Blood Tests

Successfully Geocoded Blood Lead Tests Addresses

	Raw Address Data			
	Street Addresses	PO Box Addresses	Total Analyzed	Total Success (%)
EBL	4,153	122	4,715	90.67%
CEBL (Cases)	2,170	60	2,418	92.22%
	Updated Address Data			
	Street Addresses	PO Box Addresses	Total Analyzed	Total Success (%)
EBL	4,326	126	4,913	90.62%
CEBL (Cases)	2,264	61	2,522	92.19%

Table 2: Annual blood lead screening rates for KS children less than 6 years old, per county

Screening Rate by Year (# Children Tested/ # in Cohort)						
Kansas Counties	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Allen County	0.13	0.18	0.13	0.16	0.17	0.15
Anderson County	0.16	0.17	0.21	0.13	0.23	0.22
Atchison County	0.15	0.15	0.22	0.22	0.25	0.30
Barber County	0.13	0.14	0.15	0.22	0.21	0.21
Barton County	0.07	0.06	0.17	0.24	0.14	0.14
Bourbon County	0.04	0.06	0.05	0.06	0.08	0.08
Brown County	0.14	0.13	0.16	0.15	0.21	0.21
Butler County	0.03	0.03	0.04	0.04	0.04	0.04
Chase County	0.04	0.09	0.09	0.13	0.15	0.10
Chautauqua County	0.08	0.14	0.22	0.25	0.36	0.41
Cherokee County	0.16	0.20	0.17	0.25	0.22	0.23
Cheyenne County	0.21	0.16	0.18	0.18	0.16	0.12
Clark County	0.05	0.01	0.05	0.05	0.03	0.10
Clay County	0.09	0.18	0.16	0.21	0.18	0.16
Cloud County	0.07	0.14	0.10	0.10	0.13	0.14
Coffey County	0.08	0.06	0.06	0.08	0.10	0.10
Comanche County	0.02	0.02	0.04	0.02	0.01	0.12
Cowley County	0.15	0.15	0.16	0.20	0.19	0.23
Crawford County	0.09	0.11	0.16	0.26	0.20	0.20
Decatur County	0.04	0.04	0.23	0.18	0.24	0.21
Dickinson County	0.20	0.20	0.17	0.20	0.24	0.25
Doniphan County	0.16	0.17	0.19	0.17	0.17	0.15
Douglas County	0.05	0.08	0.09	0.09	0.09	0.08
Edwards County	0.15	0.11	0.14	0.16	0.17	0.24
Elk County	0.05	0.09	0.08	0.08	0.09	0.13
Ellis County	0.15	0.18	0.18	0.19	0.21	0.20
Ellsworth County	0.31	0.32	0.44	0.44	0.44	0.45
Finney County	0.13	0.10	0.12	0.11	0.12	0.11
Ford County	0.16	0.19	0.16	0.16	0.18	0.31
Franklin County	0.08	0.10	0.13	0.12	0.13	0.13
Geary County	0.03	0.06	0.07	0.07	0.09	0.09
Gove County	0.14	0.15	0.13	0.11	0.17	0.13
Graham County	0.16	0.14	0.13	0.27	0.23	0.27
Grant County	0.08	0.10	0.09	0.10	0.09	0.11
Gray County	0.12	0.07	0.08	0.08	0.10	0.15
Greeley County	0.08	0.16	0.24	0.38	0.46	0.53
Greenwood County	0.23	0.28	0.31	0.42	0.41	0.40
Hamilton County	0.00	0.01	0.03	0.04	0.03	0.04
Harper County	0.02	0.03	0.04	0.05	0.06	0.06
Harvey County	0.07	0.07	0.09	0.14	0.15	0.16
Haskell County	0.09	0.08	0.08	0.07	0.12	0.12
Hodgeman County	0.31	0.33	0.44	0.43	0.37	0.37
Jackson County	0.17	0.19	0.19	0.20	0.20	0.21
Jefferson County	0.09	0.11	0.09	0.10	0.10	0.17
Jewell County	0.16	0.07	0.03	0.07	0.07	0.11
Johnson County	0.05	0.07	0.08	0.09	0.09	0.09
Kearny County	0.01	0.04	0.05	0.05	0.04	0.07
Kingman County	0.04	0.05	0.05	0.07	0.06	0.09
Kiowa County	0.22	0.09	0.13	0.09	0.24	0.16
Labette County	0.08	0.08	0.06	0.07	0.09	0.07
Lane County	0.02	0.05	0.03	0.09	0.09	0.04
Leavenworth County	0.09	0.11	0.09	0.11	0.11	0.18

Lincoln County	0.35	0.23	0.31	0.32	0.33	0.32
Linn County	0.03	0.06	0.08	0.09	0.11	0.13
Logan County	0.07	0.06	0.21	0.12	0.21	0.23
Lyon County	0.11	0.16	0.15	0.16	0.14	0.13
McPherson County	0.12	0.11	0.12	0.13	0.15	0.15
Marion County	0.10	0.11	0.09	0.12	0.13	0.13
Marshall County	0.22	0.28	0.38	0.32	0.36	0.28
Meade County	0.32	0.31	0.27	0.38	0.35	0.34
Miami County	0.03	0.05	0.08	0.07	0.08	0.09
Mitchell County	0.19	0.14	0.16	0.19	0.27	0.28
Montgomery County	0.08	0.08	0.08	0.10	0.10	0.11
Morris County	0.05	0.06	0.06	0.06	0.04	0.05
Morton County	0.02	0.02	0.03	0.05	0.08	0.06
Nemaha County	0.10	0.13	0.17	0.17	0.16	0.16
Neosho County	0.30	0.24	0.24	0.23	0.24	0.30
Ness County	0.11	0.07	0.10	0.13	0.10	0.14
Norton County	0.15	0.12	0.15	0.15	0.14	0.14
Osage County	0.07	0.12	0.10	0.12	0.11	0.12
Osborne County	0.05	0.04	0.03	0.04	0.04	0.07
Ottawa County	0.15	0.17	0.13	0.19	0.13	0.20
Pawnee County	0.08	0.08	0.12	0.33	0.31	0.25
Phillips County	0.07	0.06	0.13	0.12	0.10	0.08
Pottawatomie County	0.09	0.13	0.10	0.10	0.10	0.09
Pratt County	0.20	0.25	0.24	0.23	0.24	0.23
Rawlins County	0.01	0.05	0.15	0.15	0.10	0.20
Reno County	0.15	0.17	0.15	0.16	0.19	0.18
Republic County	0.08	0.12	0.10	0.13	0.15	0.14
Rice County	0.07	0.11	0.11	0.15	0.14	0.18
Riley County	0.02	0.07	0.05	0.08	0.08	0.08
Rooks County	0.16	0.16	0.17	0.19	0.22	0.27
Rush County	0.24	0.18	0.22	0.24	0.20	0.18
Russell County	0.11	0.12	0.15	0.16	0.15	0.17
Saline County	0.25	0.19	0.15	0.20	0.21	0.19
Scott County	0.08	0.06	0.17	0.26	0.33	0.25
Sedgwick County	0.07	0.08	0.07	0.09	0.10	0.11
Seward County	0.03	0.06	0.12	0.14	0.12	0.06
Shawnee County	0.18	0.17	0.10	0.12	0.11	0.11
Sheridan County	0.03	0.08	0.16	0.14	0.12	0.12
Sherman County	0.08	0.13	0.21	0.20	0.17	0.18
Smith County	0.30	0.25	0.27	0.34	0.30	0.28
Stafford County	0.08	0.09	0.14	0.13	0.12	0.13
Stanton County	0.12	0.08	0.03	0.07	0.06	0.02
Stevens County	0.10	0.12	0.09	0.11	0.10	0.12
Sumner County	0.06	0.08	0.06	0.07	0.06	0.14
Thomas County	0.02	0.05	0.14	0.15	0.16	0.18
Trego County	0.18	0.20	0.35	0.24	0.31	0.27
Wabaunsee County	0.06	0.07	0.08	0.09	0.10	0.08
Wallace County	0.04	0.11	0.22	0.15	0.47	0.24
Washington County	0.11	0.15	0.28	0.20	0.22	0.21
Wichita County	0.25	0.29	0.22	0.33	0.38	0.31
Wilson County	0.14	0.14	0.12	0.14	0.16	0.10
Woodson County	0.12	0.14	0.11	0.17	0.22	0.26
Wyandotte County	0.19	0.19	0.20	0.23	0.22	0.23
Statewide Screening Rate	**0.10**	**0.11**	**0.11**	**0.12**	**0.13**	**0.13**

Table 3: Annual incidence rates of blood lead poisoning among Kansas children less than 6 years old, per county

Incidence Rate by Year (# Cases/# in Cohort)*10,000						
Kansas Counties	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Allen County	9.79	29.01	9.45	9.61	9.78	~~0.00~~
Anderson County	16.45	16.00	~~0.00~~	15.65	~~0.00~~	15.43
Atchison County	15.14	30.14	22.76	7.58	38.46	15.28
Barber County	71.68	34.36	~~0.00~~	~~0.00~~	27.10	104.17
Barton County	14.10	4.53	31.35	31.42	13.25	35.16
Bourbon County	15.85	7.56	14.81	7.43	14.85	22.11
Brown County	12.18	24.07	35.50	23.28	23.45	57.14
Butler County	~~0.00~~	2.16	2.11	2.07	~~0.00~~	2.10
Chase County	~~0.00~~	100.50	~~0.00~~	~~0.00~~	61.35	~~0.00~~
Chautauqua County	44.05	~~0.00~~	~~0.00~~	41.15	~~0.00~~	~~0.00~~
Cherokee County	42.76	12.34	18.66	~~0.00~~	6.25	50.96
Cheyenne County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Clark County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Clay County	~~0.00~~	16.50	65.68	31.20	~~0.00~~	45.18
Cloud County	~~0.00~~	~~0.00~~	~~0.00~~	14.33	~~0.00~~	~~0.00~~
Coffey County	16.37	33.44	16.95	~~0.00~~	71.30	~~0.00~~
Comanche County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	83.33
Cowley County	14.38	25.69	~~0.00~~	7.20	7.04	10.49
Crawford County	6.43	3.14	~~0.00~~	15.48	9.42	9.49
Decatur County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Dickinson County	47.36	7.66	~~0.00~~	14.71	20.89	27.12
Doniphan County	20.96	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Douglas County	~~0.00~~	1.33	1.32	1.32	1.32	5.30
Edwards County	40.32	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Elk County	~~0.00~~	48.78	~~0.00~~	~~0.00~~	~~0.00~~	54.95
Ellis County	~~0.00~~	32.63	32.12	17.97	4.47	26.04
Ellsworth County	35.21	67.80	~~0.00~~	60.42	86.96	54.64
Finney County	4.25	2.16	~~0.00~~	4.30	6.50	4.40
Ford County	5.12	5.11	2.49	2.51	4.96	14.62
Franklin County	4.44	4.48	4.57	18.16	9.24	29.03
Geary County	2.91	2.76	2.60	~~0.00~~	~~0.00~~	5.91
Gove County	~~0.00~~	54.95	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Graham County	~~0.00~~	~~0.00~~	67.11	68.49	~~0.00~~	~~0.00~~
Grant County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Gray County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Greeley County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Greenwood County	21.60	21.14	63.29	87.15	22.88	207.37
Hamilton County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Harper County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	21.98
Harvey County	11.71	11.52	3.81	7.54	7.33	3.67
Haskell County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Hodgeman County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	82.64
Jackson County	28.22	~~0.00~~	9.26	~~0.00~~	9.60	9.90
Jefferson County	15.76	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Jewell County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	127.39
Johnson County	1.34	2.85	0.87	1.30	0.22	0.87
Kearny County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Kingman County	20.37	~~0.00~~	~~0.00~~	58.14	~~0.00~~	~~0.00~~
Kiowa County	45.66	49.75	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Labette County	17.87	11.60	23.13	11.27	11.17	28.69
Lane County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~

Leavenworth County	17.91	14.33	12.46	8.91	12.40	10.43
Lincoln County	47.39	~~0.00~~	47.17	~~0.00~~	~~0.00~~	43.48
Linn County	~~0.00~~	14.95	~~0.00~~	~~0.00~~	~~0.00~~	15.65
Logan County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Lyon County	15.48	9.26	15.53	9.57	6.55	13.76
McPherson County	4.74	4.83	9.48	~~0.00~~	4.84	19.20
Marion County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	14.31	28.69
Marshall County	~~0.00~~	13.95	26.88	~~0.00~~	41.55	69.54
Meade County	~~0.00~~	57.97	27.86	57.80	233.24	~~0.00~~
Miami County	8.34	~~0.00~~	8.23	~~0.00~~	~~0.00~~	17.01
Mitchell County	26.39	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	23.70
Montgomery County	17.54	17.17	13.68	13.37	10.26	20.86
Morris County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Morton County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Nemaha County	39.06	39.37	~~0.00~~	26.14	~~0.00~~	~~0.00~~
Neosho County	55.03	69.50	7.62	~~0.00~~	30.67	22.83
Ness County	~~0.00~~	~~0.00~~	~~0.00~~	60.98	~~0.00~~	56.18
Norton County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Osage County	~~0.00~~	~~0.00~~	~~0.00~~	35.21	~~0.00~~	8.90
Osborne County	~~0.00~~	45.87	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Ottawa County	49.50	24.63	25.06	50.76	~~0.00~~	~~0.00~~
Pawnee County	54.50	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	68.18
Phillips County	~~0.00~~	~~0.00~~	59.00	~~0.00~~	29.85	30.21
Pottawatomie County	~~0.00~~	16.46	10.58	5.13	~~0.00~~	~~0.00~~
Pratt County	28.74	~~0.00~~	13.81	67.48	13.48	38.17
Rawlins County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Reno County	9.92	9.96	9.94	7.90	6.01	8.10
Republic County	~~0.00~~	35.97	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Rice County	~~0.00~~	~~0.00~~	~~0.00~~	27.32	~~0.00~~	~~0.00~~
Riley County	~~0.00~~	3.49	5.13	3.32	~~0.00~~	4.62
Rooks County	28.41	27.86	~~0.00~~	27.03	52.49	153.06
Rush County	48.31	45.05	93.90	~~0.00~~	50.51	~~0.00~~
Russell County	24.63	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	19.96
Saline County	12.88	10.64	4.17	14.25	10.13	10.26
Scott County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Sedgwick County	5.22	4.49	4.00	4.15	3.92	5.14
Seward County	6.38	3.16	25.03	27.81	12.59	~~0.00~~
Shawnee County	10.68	13.85	5.92	9.20	9.85	5.93
Sheridan County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Sherman County	~~0.00~~	~~0.00~~	21.83	~~0.00~~	43.57	~~0.00~~
Smith County	52.91	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Stafford County	~~0.00~~	~~0.00~~	33.78	33.56	33.44	69.69
Stanton County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Stevens County	~~0.00~~	~~0.00~~	18.12	~~0.00~~	~~0.00~~	~~0.00~~
Sumner County	~~0.00~~	5.47	~~0.00~~	~~0.00~~	~~0.00~~	39.33
Thomas County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Trego County	~~0.00~~	~~0.00~~	52.63	52.63	~~0.00~~	113.64
Wabaunsee County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	19.69
Wallace County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	129.87	~~0.00~~
Washington County	28.41	27.47	54.95	53.62	~~0.00~~	~~0.00~~
Wichita County	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~	~~0.00~~
Wilson County	42.61	13.21	52.02	~~0.00~~	~~0.00~~	~~0.00~~
Woodson County	46.51	92.59	48.54	~~0.00~~	~~0.00~~	~~0.00~~
Wyandotte County	17.68	16.39	9.40	14.03	7.61	17.05
Total Statewide Incidence Rate	8.20	8.14	6.41	7.13	5.85	9.75

Table 4: Annual rates of blood lead poisoning cases per 10,000 children less than 6 years old tested in Kansas, per county

Elevated Test Rate by Year (# Cases/# Children Tested)*10,000						
Kansas Counties	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Allen County	76.34	161.29	70.42	60.61	56.50	0.00
Anderson County	100.00	95.24	0.00	117.65	0.00	70.42
Atchison County	98.04	198.02	105.26	34.84	156.25	50.89
Barber County	555.56	238.10	0.00	0.00	128.21	500.00
Barton County	197.37	72.99	179.49	130.60	92.02	246.91
Bourbon County	434.78	136.99	294.12	119.05	175.44	270.27
Brown County	90.09	190.48	222.22	150.38	111.73	267.38
Butler County	0.00	66.23	53.48	49.75	0.00	51.55
Chase County	0.00	1176.47	0.00	0.00	416.67	0.00
Chautauqua County	555.56	0.00	0.00	163.93	0.00	0.00
Cherokee County	263.16	60.24	112.78	0.00	27.86	217.39
Cheyenne County	0.00	0.00	0.00	0.00	0.00	0.00
Clark County	0.00	0.00	0.00	0.00	0.00	0.00
Clay County	0.00	93.46	412.37	151.52	0.00	291.26
Cloud County	0.00	0.00	0.00	147.06	0.00	0.00
Coffey County	217.39	571.43	263.16	0.00	689.66	0.00
Comanche County	0.00	0.00	0.00	0.00	0.00	714.29
Cowley County	98.28	169.90	0.00	36.76	37.38	46.15
Crawford County	73.26	29.76	0.00	60.24	46.66	47.69
Decatur County	0.00	0.00	0.00	0.00	0.00	0.00
Dickinson County	241.94	38.61	0.00	71.94	88.76	109.89
Doniphan County	129.87	0.00	0.00	0.00	0.00	0.00
Douglas County	0.00	16.03	14.53	14.62	15.48	63.90
Edwards County	270.27	0.00	0.00	0.00	0.00	0.00
Elk County	0.00	555.56	0.00	0.00	0.00	434.78
Ellis County	0.00	176.77	179.03	96.15	21.41	127.12
Ellsworth County	113.64	212.77	0.00	137.93	197.37	122.70
Finney County	33.61	20.88	0.00	40.82	56.18	38.91
Ford County	32.26	26.77	15.75	16.03	27.93	47.51
Franklin County	55.87	46.08	34.97	155.64	72.46	224.72
Geary County	99.01	45.45	39.37	0.00	0.00	66.23
Gove County	0.00	370.37	0.00	0.00	0.00	0.00
Graham County	0.00	0.00	500.00	250.00	0.00	0.00
Grant County	0.00	0.00	0.00	0.00	0.00	0.00
Gray County	0.00	0.00	0.00	0.00	0.00	0.00
Greeley County	0.00	0.00	0.00	0.00	0.00	0.00
Greenwood County	92.59	75.76	205.48	207.25	55.25	517.24
Hamilton County	0.00	0.00	0.00	0.00	0.00	0.00
Harper County	0.00	0.00	0.00	0.00	0.00	344.83
Harvey County	160.43	173.41	43.67	52.91	50.38	23.53
Haskell County	0.00	0.00	0.00	0.00	0.00	0.00
Hodgeman County	0.00	0.00	0.00	0.00	0.00	222.22
Jackson County	163.04	0.00	47.62	0.00	47.62	47.39
Jefferson County	176.99	0.00	0.00	0.00	0.00	0.00
Jewell County	0.00	0.00	0.00	0.00	0.00	1176.47
Johnson County	26.95	41.00	10.92	14.67	2.43	9.78
Kearny County	0.00	0.00	0.00	0.00	0.00	0.00
Kingman County	500.00	0.00	0.00	882.35	0.00	0.00
Kiowa County	208.33	526.32	0.00	0.00	0.00	0.00
Labette County	212.77	153.85	396.04	172.41	122.70	403.23
Lane County	0.00	0.00	0.00	0.00	0.00	0.00

Leavenworth County	206.19	129.66	138.34	83.06	108.53	58.20
Lincoln County	135.14	0.00	151.52	0.00	0.00	135.14
Linn County	0.00	232.56	0.00	0.00	0.00	123.46
Logan County	0.00	0.00	0.00	0.00	0.00	0.00
Lyon County	143.68	58.14	102.25	61.48	46.40	103.09
McPherson County	41.15	45.05	79.68	0.00	31.35	125.79
Marion County	0.00	0.00	0.00	0.00	112.36	224.72
Marshall County	0.00	49.02	70.42	0.00	115.83	250.00
Meade County	0.00	188.68	104.17	152.67	666.67	0.00
Miami County	273.97	0.00	101.52	0.00	0.00	189.57
Mitchell County	138.89	0.00	0.00	0.00	0.00	85.47
Montgomery County	230.41	220.26	181.82	134.68	101.69	185.19
Morris County	0.00	0.00	0.00	0.00	0.00	0.00
Morton County	0.00	0.00	0.00	0.00	0.00	0.00
Nemaha County	400.00	309.28	0.00	150.38	0.00	0.00
Neosho County	186.17	293.16	32.05	0.00	128.21	77.32
Ness County	0.00	0.00	0.00	476.19	0.00	400.00
Norton County	0.00	0.00	0.00	0.00	0.00	0.00
Osage County	0.00	0.00	0.00	298.51	0.00	73.53
Osborne County	0.00	1250.00	0.00	0.00	0.00	0.00
Ottawa County	327.87	147.06	192.31	273.97	0.00	0.00
Pawnee County	689.66	0.00	0.00	0.00	0.00	267.86
Phillips County	0.00	0.00	465.12	0.00	312.50	384.62
Pottawatomie County	0.00	131.58	106.95	51.28	0.00	0.00
Pratt County	144.93	0.00	58.48	294.12	55.87	166.67
Rawlins County	0.00	0.00	0.00	0.00	0.00	0.00
Reno County	66.49	58.96	65.45	48.54	31.75	44.54
Republic County	0.00	312.50	0.00	0.00	0.00	0.00
Rice County	0.00	0.00	0.00	176.99	0.00	0.00
Riley County	0.00	51.68	107.14	43.10	0.00	56.39
Rooks County	178.57	175.44	0.00	138.89	238.10	571.43
Rush County	200.00	256.41	434.78	0.00	250.00	0.00
Russell County	227.27	0.00	0.00	0.00	0.00	117.65
Saline County	51.64	54.88	28.65	70.71	48.22	53.76
Scott County	0.00	0.00	0.00	0.00	0.00	0.00
Sedgwick County	69.79	54.31	58.30	46.25	37.83	47.71
Seward County	227.27	49.02	204.60	200.89	109.29	0.00
Shawnee County	59.02	81.49	61.18	76.25	88.24	53.99
Sheridan County	0.00	0.00	0.00	0.00	0.00	0.00
Sherman County	0.00	0.00	106.38	0.00	253.16	0.00
Smith County	178.57	0.00	0.00	0.00	0.00	0.00
Stafford County	0.00	0.00	250.00	263.16	270.27	555.56
Stanton County	0.00	0.00	0.00	0.00	0.00	0.00
Stevens County	0.00	0.00	196.08	0.00	0.00	0.00
Sumner County	0.00	69.93	0.00	0.00	0.00	284.55
Thomas County	0.00	0.00	0.00	0.00	0.00	0.00
Trego County	0.00	0.00	151.52	222.22	0.00	416.67
Wabaunsee County	0.00	0.00	0.00	0.00	0.00	243.90
Wallace County	0.00	0.00	0.00	0.00	277.78	0.00
Washington County	270.27	181.82	198.02	273.97	0.00	0.00
Wichita County	0.00	0.00	0.00	0.00	0.00	0.00
Wilson County	312.50	97.09	416.67	0.00	0.00	0.00
Woodson County	400.00	645.16	434.78	0.00	0.00	0.00
Wyandotte County	94.52	84.49	47.21	61.70	34.52	75.36
Total Statewide Incidence Rate	83.77	74.20	59.86	57.19	45.65	72.91

Table 5: KS Geometric mean of blood lead levels for 0-72 month olds, by county, 2006-2011

County	Geometric Mean BLL (µg/dL)	County	Geometric Mean BLL (µg/dL)
ALLEN	3.051028	LINCOLN	3.436546
ANDERSON	3.235474	LINN	2.935242
ATCHISON	3.160623	LOGAN	2.825261
BARBER	3.849215	LYON	2.301088
BARTON	3.68566	MARION	2.561006
BOURBON	3.306365	MARSHALL	3.62813
BROWN	3.724513	MCPHERSON	2.546631
BUTLER	2.530195	MEADE	3.546189
CHASE	2.986527	MIAMI	2.666798
CHAUTAUQUA	3.54563	MITCHELL	3.349895
CHEROKEE	3.00533	MONTGOMERY	3.18984
CHEYENNE	3.307457	MORRIS	2.236369
CLARK	2.982498	MORTON	2.622136
CLAY	2.945951	NEMAHA	3.616357
CLOUD	2.642091	NEOSHO	3.446159
COFFEY	3.478262	NESS	3.043588
COMANCHE	4.109751	NORTON	3.476521
COWLEY	3.308914	OSAGE	2.299999
CRAWFORD	3.233564	OSBORNE	2.716396
DECATUR	3.090918	OTTAWA	2.820869
DICKINSON	3.014035	PAWNEE	3.310578
DONIPHAN	2.981015	PHILLIPS	2.683536
DOUGLAS	1.711717	POTTAWATOMIE	2.608937
EDWARDS	3.287181	PRATT	3.999414
ELK	3.599884	RAWLINS	3.045472
ELLIS	1.804839	RENO	2.295898
ELLSWORTH	3.337254	REPUBLIC	3.237203
FINNEY	2.372887	RICE	2.489179
FORD	2.477074	RILEY	1.798827
FRANKLIN	2.651784	ROOKS	3.547875
GEARY	1.904588	RUSH	3.06368
GOVE	2.883358	RUSSELL	2.445569
GRAHAM	3.635297	SALINE	2.426709
GRANT	2.936097	SCOTT	3.106011
GRAY	2.769306	SEDGWICK	2.213833
GREELEY	3.090079	SEWARD	2.95345
GREENWOOD	4.241054	SHAWNEE	2.561276
HAMILTON	1.819753	SHERIDAN	2.979945
HARPER	2.569421	SHERMAN	2.876075
HARVEY	2.349579	SMITH	3.4729
HASKELL	3.000218	STAFFORD	3.729337
HODGEMAN	3.349093	STANTON	3.258704
JACKSON	3.146111	STEVENS	3.365025
JEFFERSON	2.375493	SUMNER	2.686831
JEWELL	3.66636	THOMAS	2.959972
JOHNSON	2.075859	TREGO	3.740207
KEARNY	1.858374	WABAUNSEE	2.235297
KINGMAN	2.893508	WALLACE	3.473855
KIOWA	3.89496	WASHINGTON	3.650626
LABETTE	3.291795	WICHITA	3.105224
LANE	2.24289	WILSON	3.137286
LEAVENWORTH	2.1461	WOODSON	3.773183
		WYANDOTTE	2.081316

Table 6: Distribution of blood lead tests by age groups and by sex, Kansas 2006-2011

Age (months) at time of test:	# Tests	% Tests
0-12:	64368	29.38%
13-24:	51838	23.66%
25-36:	26813	12.24%
37-48:	27906	12.74%
49-60:	23779	10.85%
61-72:	12115	5.53%
>72:	12271	5.60%
Female:	104935	47.90%
Male:	110977	50.65%
Unknown:	3178	1.45%

Table 7: Distribution of blood lead tests by Race and Ethnicity, Kansas 2006-2011

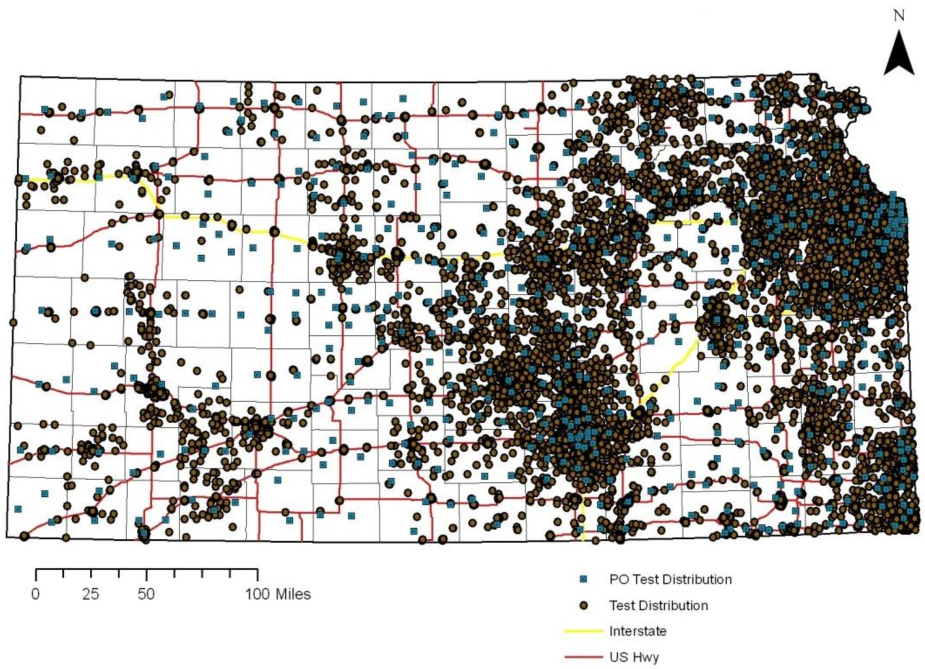
All Tests	2006	2007	2008	2009	2010	2011	Total
White	7,835	6,950	2,967	1,570	1,125	845	21,292
Black	1,591	1,447	693	400	239	178	4,548
Asian/Pacific Islander	59	85	27	20	16	10	217
Native American	48	37	10	6	3	0	104
Multiracial	4	3	0	0	1	0	8
Unknown	22,429	26,043	32,898	36,529	37,099	37,923	192,921
Hispanic	1,556	1,681	853	399	375	253	5,117
Non-Hispanic	2,734	3,210	1,417	705	421	256	8,743
Other	2	0	1	0	0	0	3
Unknown	27,674	29,374	34,324	37,421	37,687	38,447	204,927
State Total	31,966	34,565	36,595	38,525	38,483	38,956	219,090

Tests with Complete Address							
White	7,089	6,538	2,711	1,474	992	836	19,640
Black	1,467	1,357	608	364	199	177	4,172
Asian/Pacific Islander	54	82	25	20	15	10	206
Native American	44	36	10	6	3	0	99
Multiracial	3	3	0	0	1	0	7
Unknown	15,930	19,892	23,817	30,615	31,628	33,920	155,802
Hispanic	1,406	1,612	802	378	349	249	4,796
Non-Hispanic	2,552	3,043	1,311	689	411	252	8,258
Other	1	0	1	0	0	0	2
Unknown	20,628	23,253	25,057	31,412	32,078	34,442	166,870
State Total	24,587	27,908	27,171	32,479	32,838	34,943	179,926

Test demographics for All Tests recorded in STELLAR, and for all tests with Complete Addresses used for geocoding and spatial analysis. The majority of demographic data was not entered into STELLAR when blood lead test results were reported, accounting for the significant quantity of Unknown demographic data. This large proportion of missing demographic data makes targeting at-risk demographic children challenging.

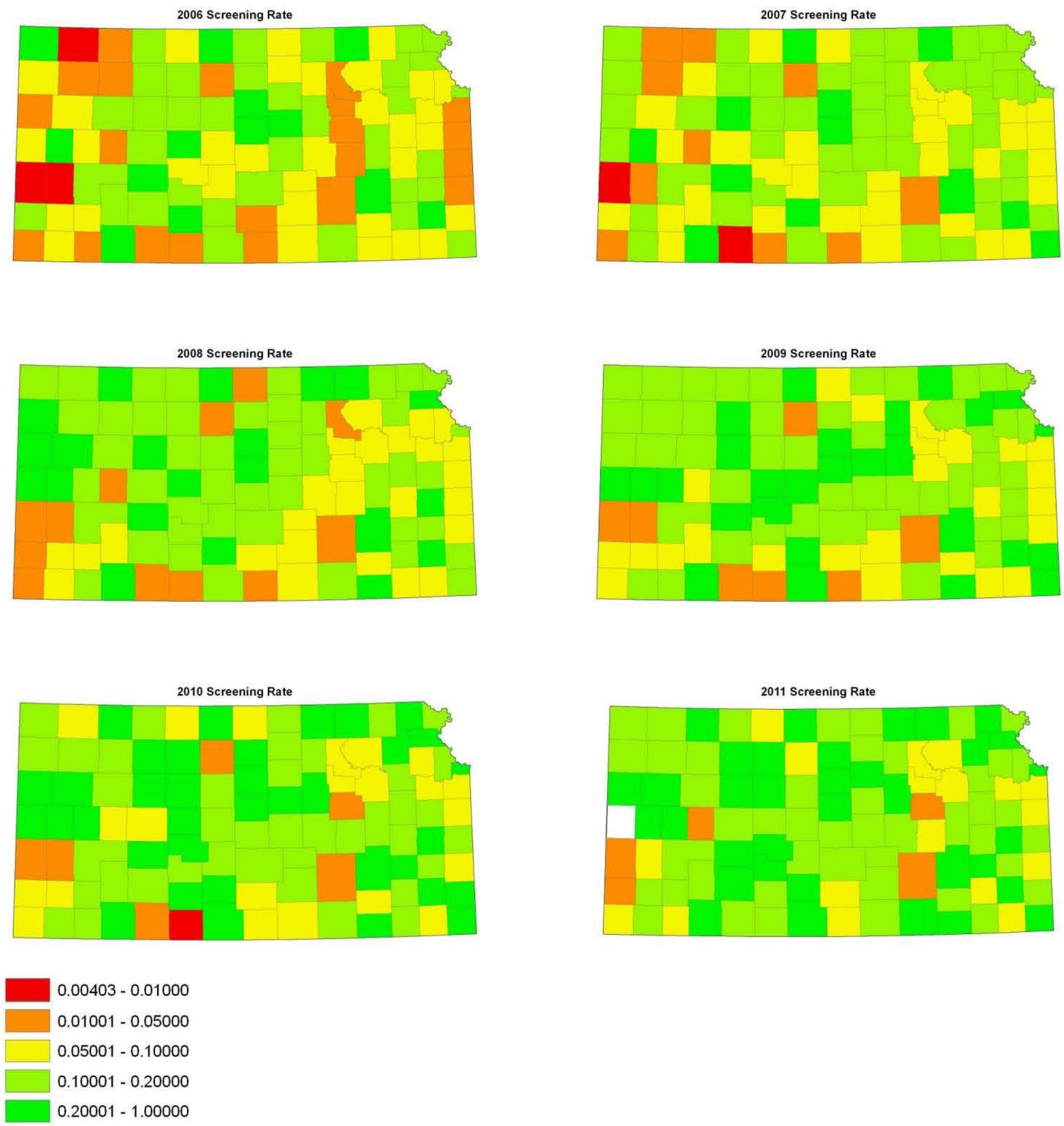
Appendix II – Figures/Maps

Figure 1: Distribution of Kansas blood lead tests among children 0-72 months old: 2006-2011



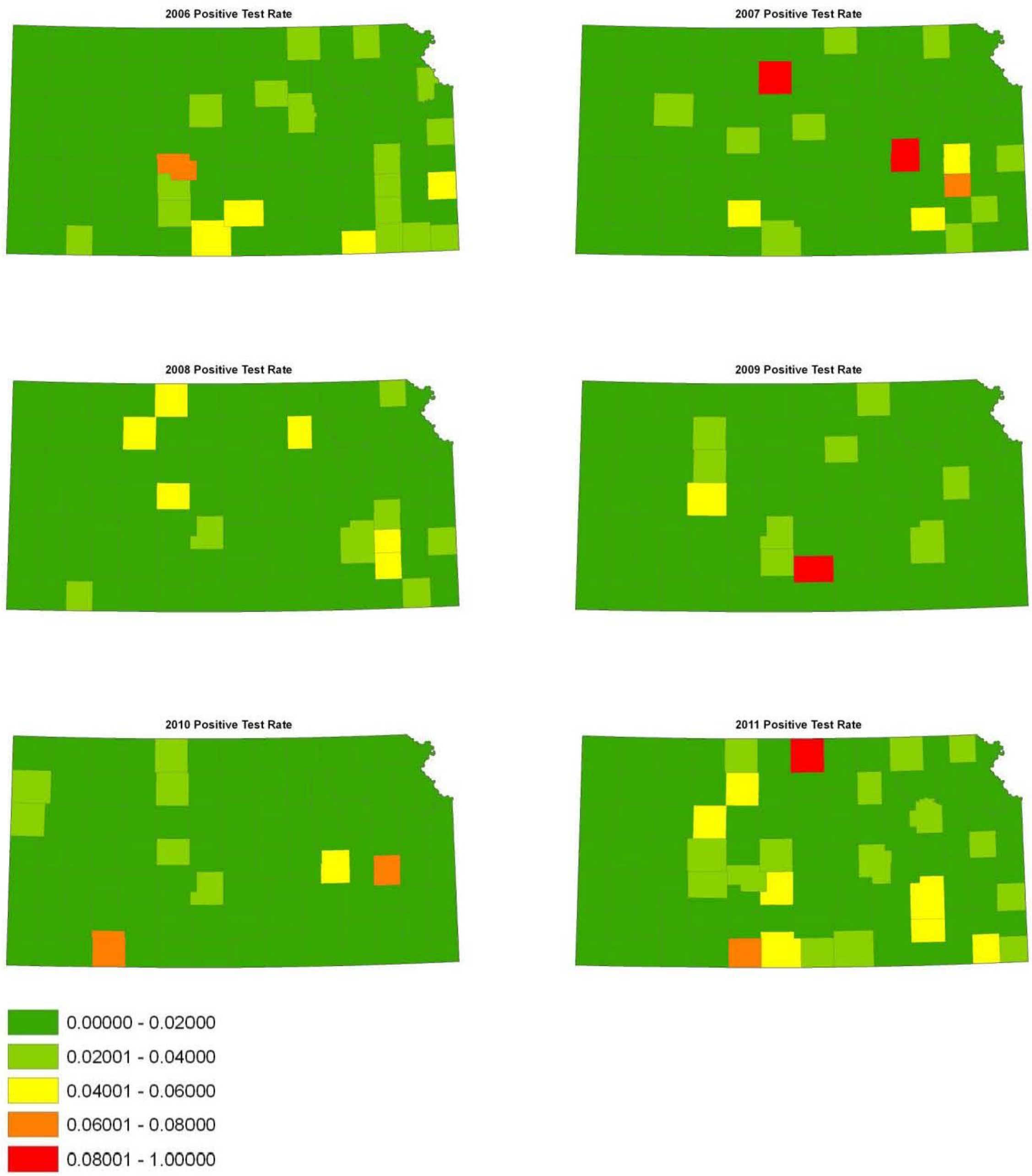
Location of addresses where at least one childhood blood lead test was performed between January 1, 2006 and December 31, 2011.

Figure 2: Blood lead screening rates among children 0-72 months old in Kansas, by county and year



The screening rates per county were determined by test data from STELLAR and birth rate cohorts. A general increase in rates was seen statewide during the study period, with few counties consistently having very poor screening rates (Butler and Hamilton counties did not exceed a 5% screening rate during the study period). Greely county was the only county during the study period that had a screening rate greater than 50% (53.26%; shown in white on 2011 Screening Rate map).

Figure 3: Rates of confirmed elevated blood lead tests among children 0-72 months old in Kansas, by county and by year



Confirmed elevated blood lead test rates (labeled as "Positive" rates in the figure) for Kansas counties from 2006-2011. Many counties had zero confirmed elevated tests but were included in the <2% category. Specific counties with no confirmed elevated tests and exact county rates can be found in Table 3. A decrease in confirmed elevated test rate was observed from 2006-2010, followed by a jump in rates, possibly explained by the increase in screening rates also seen in 2011. None of the KS counties were persistently high regarding confirmed elevated test rates; the locations of elevated test rates fluctuated annually.

Figure 4: Kansas statewide childhood blood lead screening rates; 2006-2011

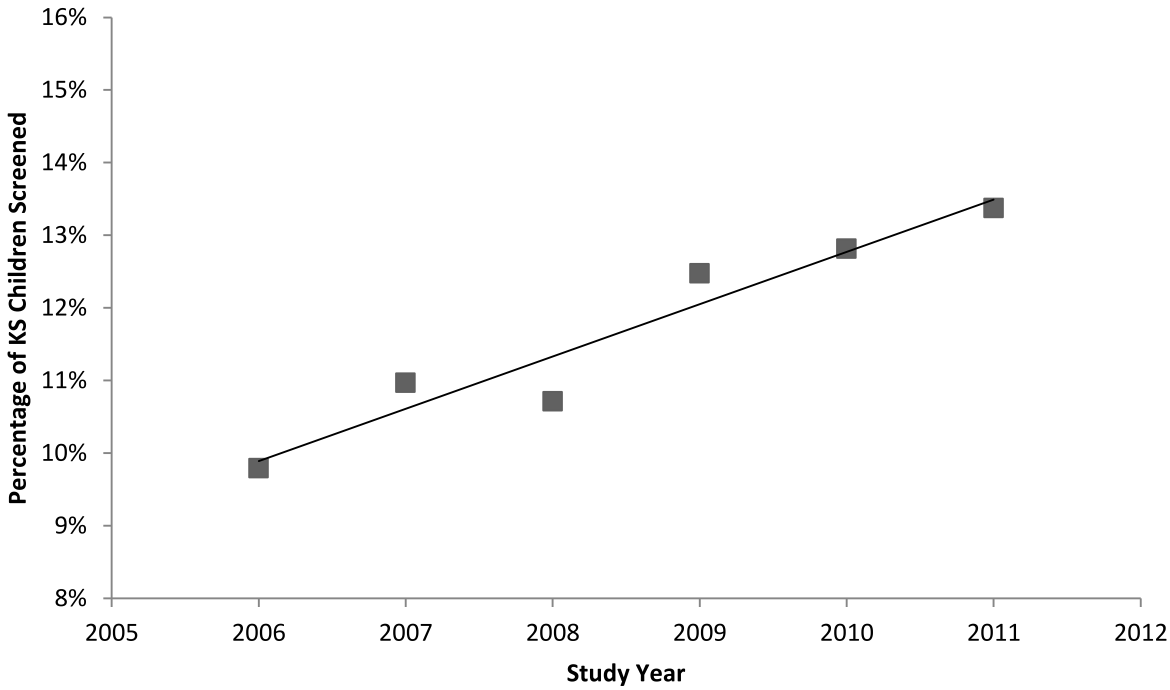


Figure 5: Rate of Elevated Blood Lead Tests in Kansas

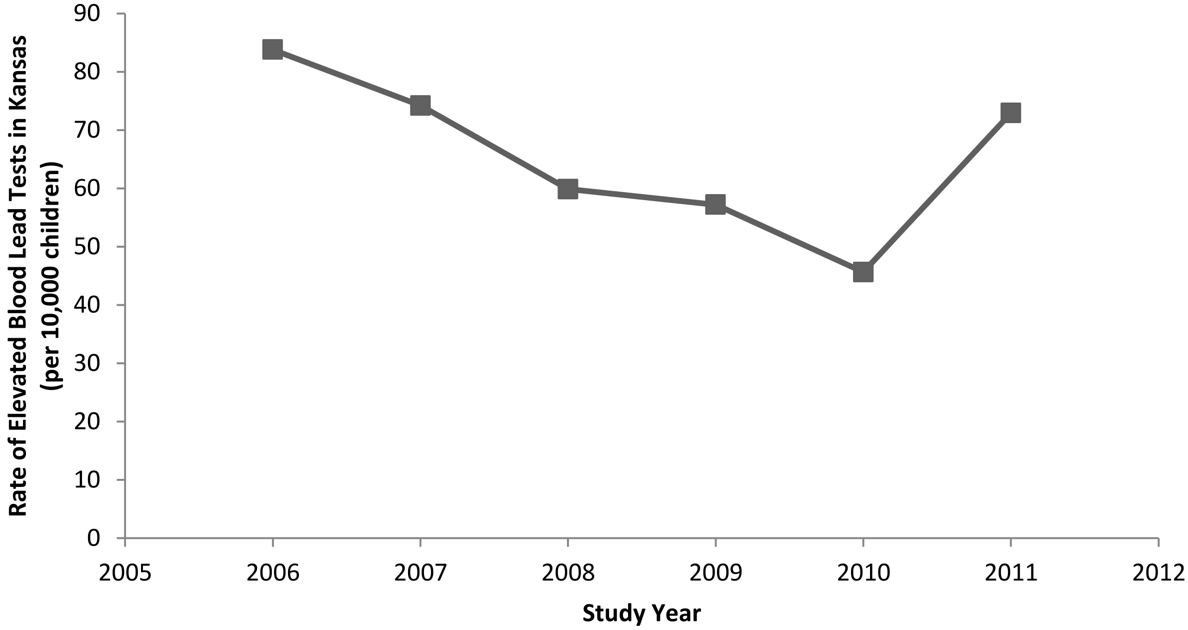
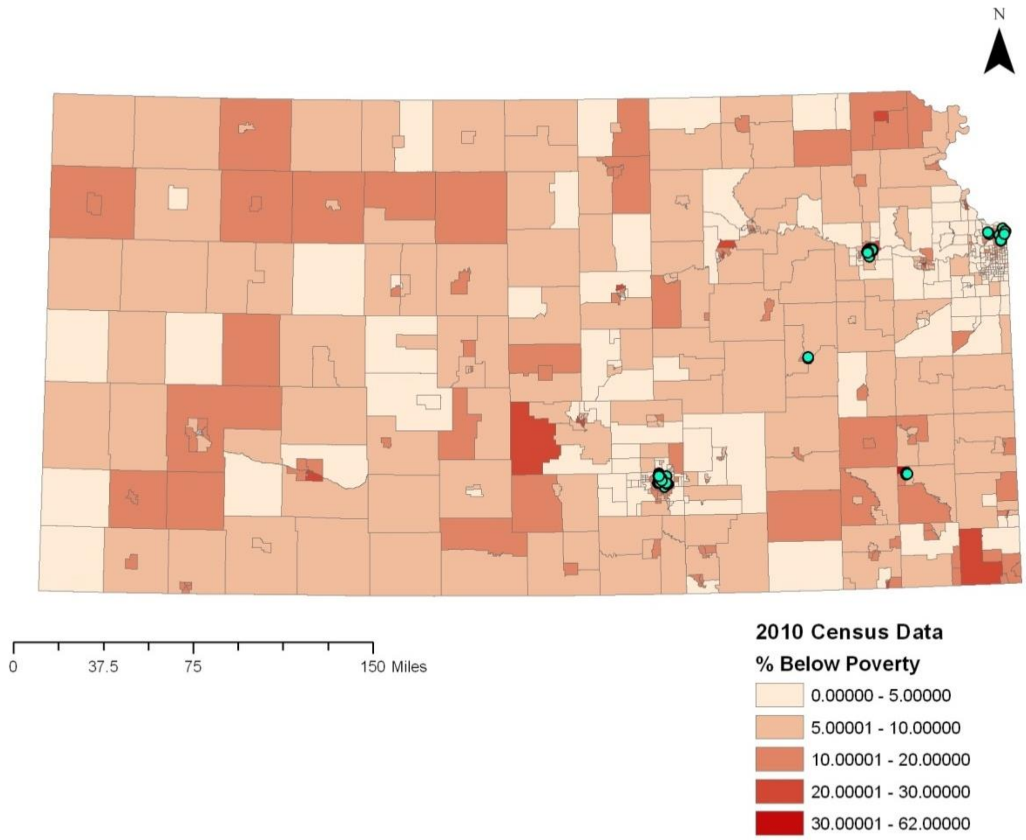
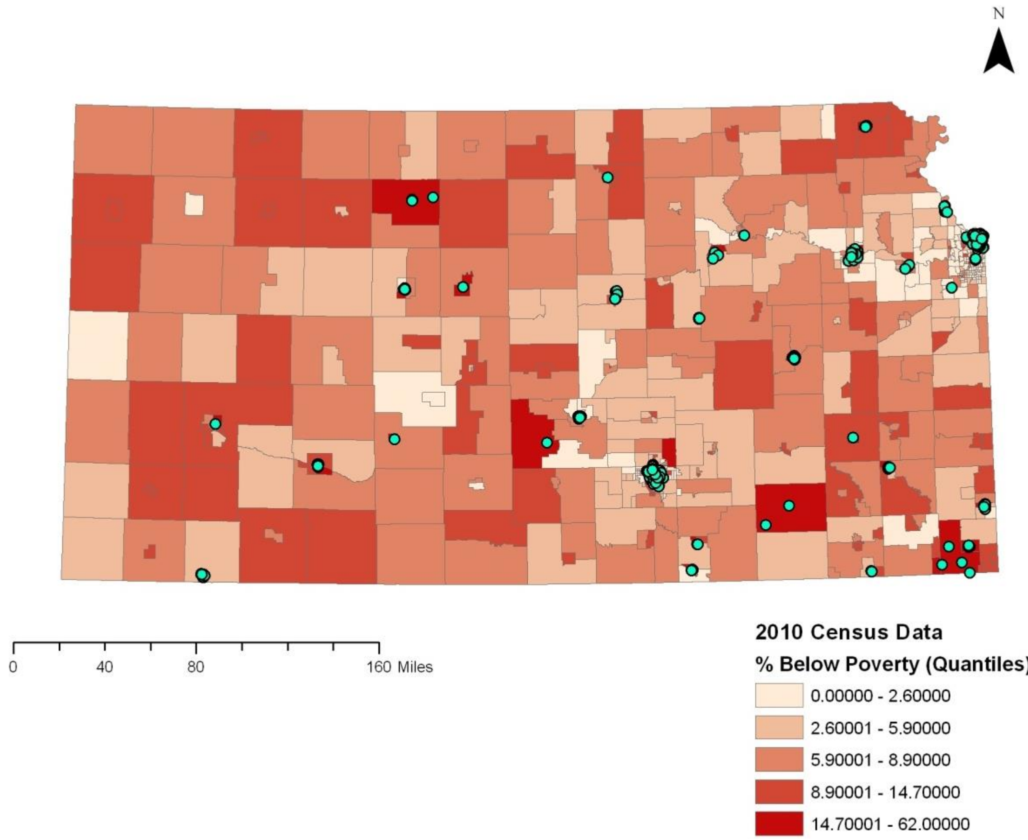


Figure 6: Spatial distribution of confirmed elevated blood lead cases within census tracts where the percentage of individuals in poverty is greater than 30



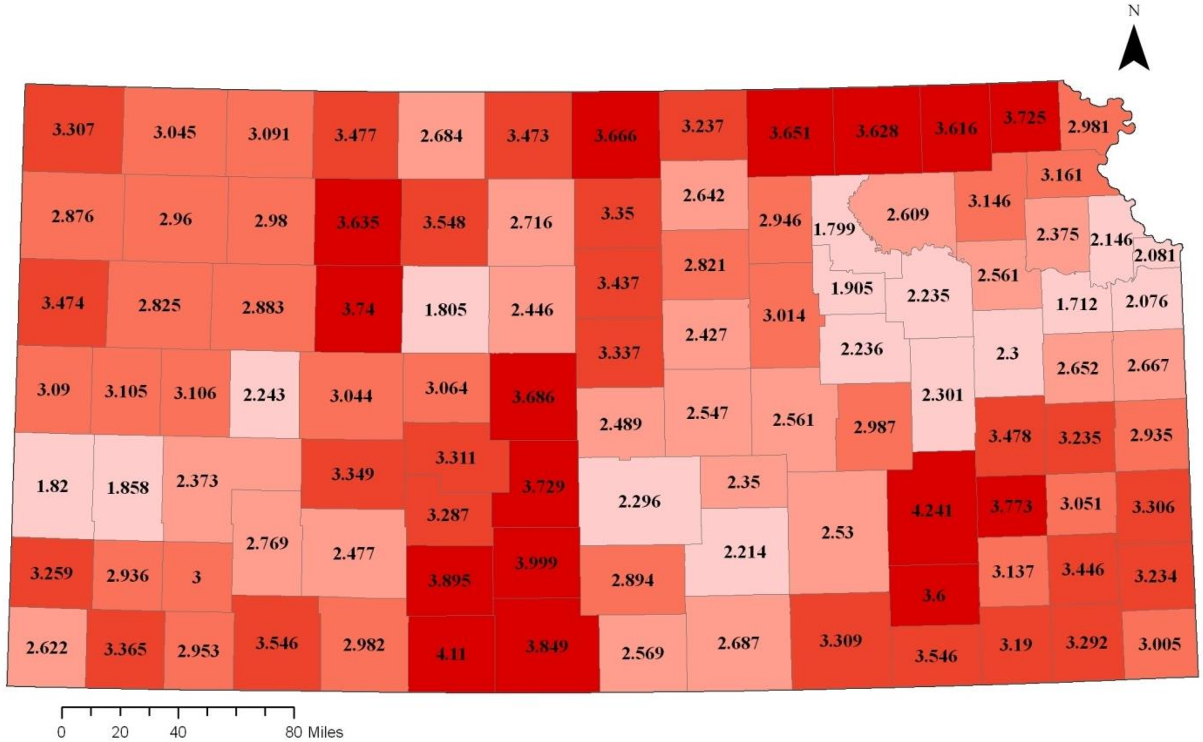
94 cases from 2006-2011 were identified in isolated urban clusters

Figure 7: Spatial distribution of confirmed elevated blood lead cases within census tracts where the percentage of household poverty is greater than 14.7 (determined by quintiles)



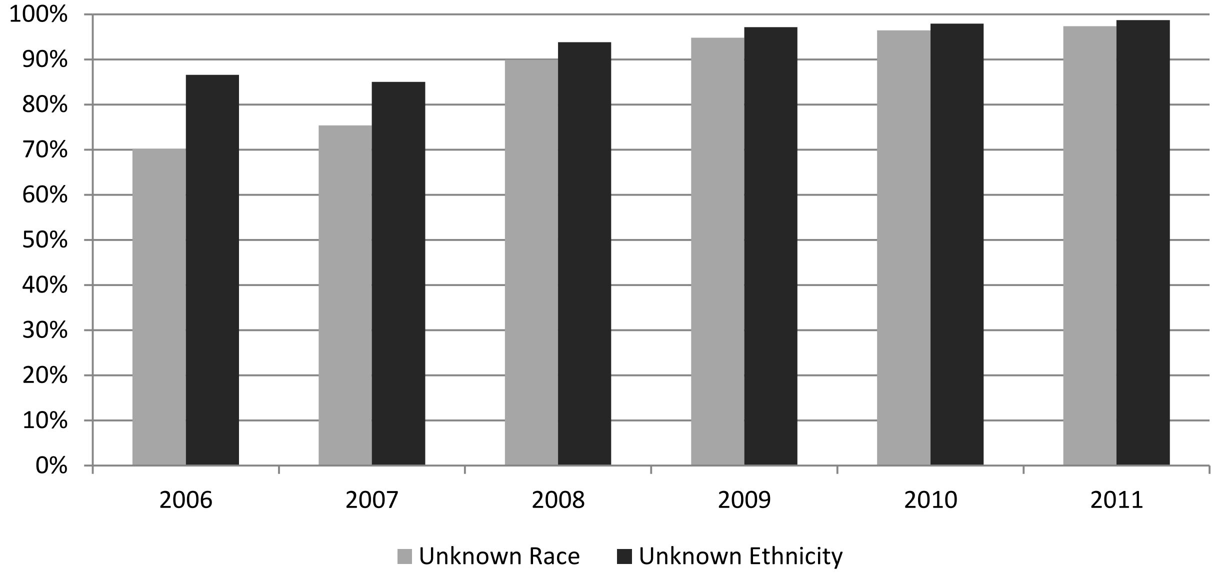
384 cases are located within high poverty census tracts determined by quintiles of the data set, and are distributed throughout the state in both urban and rural areas

Figure 8: County geometric mean blood lead levels; Kansas 2006-2011



Geometric mean blood lead levels (µg/dL) divided into quintiles with the dark red counties representing the highest quintile (>3.548 µg/dL)

Figure 9: Percentage of Unknown Demographic Data in Kansas STELLAR Database; 2006-2011



Appendix III – ArcMAP Manipulations

- Geocoding of zip codes resulted in 5 Child_ID's with unmatched zip codes. These zip codes were examined and found to be erroneous; they were given correct zip codes based on the cities used in their addresses:
    - ID 183824 = 66762 (Pittsburg)
    - ID 197954 = 66762 (Pittsburg)
    - ID 197954 (different address than above) = 66762 (Pittsburg)
    - ID 222330 = 66541 (Summerfield)
    - ID 216357 = 67880 (Ulysses)
- Microsoft Access queries used for Test Distribution maps (as well as county screening, incidence, and positive test rates) contained duplicate tests that were not filtered using SQL due to duplicate entries into the STELLAR database. The following data entry errors (repeat entries or multiple address entries per CHILD_ID) were manually removed from the ArcMap geocoding results and county statistical analysis datasets:
    - 2006 Tests:

CHILD_ID	Repeat Address Removed (County)
83254	Jackson
96770	Leavenworth
103081	Montgomery
111327	Sedgwick
117950	Sedgwick
120486	Ford
134167	Johnson
67858	Sedgwick

72573	Labette
103681	Grant

- 2007 Tests:

CHILD_ID	Repeat Address Removed (County)
19911	Leavenworth
94816	Leavenworth
101695	Wyandotte
126521	Leavenworth
151396	Leavenworth
154820	Wyandotte

- 2008 Tests:

CHILD_ID	Repeat Address Removed (County)
1313	Shawnee
11327	Sedgwick
127485	Leavenworth
162202	Seward
163701	Cowley
165514	Johnson
172632	Wyandotte
172890	Wyandotte
177360	Seward
177361	Stevens
177636	Seward

177365	Seward
177367	Seward
177368	Seward
180733	Jackson
184939	Johnson
120103	Wyandotte

- 2009 Tests: due to a large amount of repeat errors for 2009 in particular, CHILD_ID numbers are not recorded here, but rather the County and # of repeats removed is shown *

Repeat Address (County)	# of Duplicates Removed
Crawford	100
Cherokee	2
Leavenworth	2
Seward	8

- 2010 Tests:

CHILD_ID	Repeat Address Removed (County)
189700	Leavenworth
215629	Seward
232253	Leavenworth
232254	Leavenworth

* *The large number of erroneous entries during 2009 in Crawford County all had the same provider ID # from the STELLAR database, and came from multiple CHILD_ID numbers from that provider. Based on the consistency of duplicate entries it is likely that more than one person at the provider was unknowingly taking responsibility for data entry into STELLAR, or that the individual responsible at this particular provider was improperly trained in the data entry procedures.

233307	Leavenworth
233560	Seward

- 2011 Tests:

CHILD_ID	Repeat Address Removed (County)
244573	Leavenworth
257174	Leavenworth
201362	Lyon

- Microsoft Access results when querying for the Case-Distribution by Year dataset were unable to remove a small number of repeat cases from the dataset due to data entry errors when input in the STELLAR database. They were manually removed in ArcMap for each year using the "Review/Rematch Addresses" function so that no duplicate addresses were used in the case-distribution maps. The following repeat addresses (ADDR_ID) were removed for their respective years:

    - 2006 Cases: 111,327
    - 2007 Cases: 151,792
    - 2008 Cases: 162,679, 167,105
    - 2009 Cases: 191,273
    - 2010 Cases: 189,700, 232,253, 233,307
    - 2011 Cases: 242,741, 257,174