Report on the

Spatial and Temporal Variation in Childhood Blood Lead in New Jersey, 2000-2004

Demonstration Project on

Geographic Patterns of Childhood Blood Lead and Environmental Factors in New Jersey

Program 03074, Environmental and Health Effects Tracking
National Center for Environmental Health
Centers for Disease Control and Prevention (CDC)

Submitted to the CDC
January 31, 2007

Prepared by the

New Jersey Department of Health and Senior Services
Consumer and Environmental Health Services
Environmental Public Health Tracking Project
and
Family Health Services
Childhood Lead Poisoning Prevention Surveillance System

In cooperation with the
New Jersey Department of Environmental Protection

Table of Contents

Overview of the Demonstration Project

The New Jersey Department of Health and Senior Services (NJDHSS) was awarded funding from the Centers for Disease Control and Prevention (CDC) to conduct three demonstration projects under the program, "Environmental and Health Effects Tracking," in cooperation with the New Jersey Department of Environmental Protection (NJDEP). The purpose of these demonstration projects was to develop and evaluate methods for linking data contained in ongoing, existing health effects and human exposure surveillance systems with existing data on environmental hazards and exposures. The three projects were designed to describe spatial patterns and time trends in public health data on cancer incidence, birth defect prevalence, and childhood lead exposure, and to link these health outcomes with environmental hazard data.

This report includes a descriptive analysis of childhood blood levels in New Jersey in the period 2000 through 2004. The specific objective of this descriptive analysis is to enhance existing surveillance by examining spatial and temporal variation in measured blood lead among New Jersey children aged 6 through 29 months, using geographic information systems (GIS) and appropriate statistical analyses.

This demonstration project was conducted by the Environmental Public Health Tracking Project (EPHT) in Consumer and Environmental Health Services, NJDHSS, in partnership with the Childhood Lead Poisoning Prevention Surveillance System (CLPPSS) in NJDHSS and the New Jersey Department of Environmental Protection (NJDEP).

Study Team

New Jersey Department of Health and Senior Services

Consumer and Environmental Health Services

Jerald Fagliano, M.P.H., Ph.D., Principal Investigator
Michael Berry, M.P.H.
Perry Cohn, Ph.D., M.P.H.
Barbara Goun, M.P.H., Ph.D., Project Coordinator
Patricia Haltmeier, L.P.N.
Richard Opiekun, M.S., M.A., Ph.D.

Family Health Services

Jaydeep Nanavaty, M.S., C.M.L.T.

New Jersey Department of Environmental Protection

Steven Anderson, M.S.
Linda Bonanno, Ph.D.
Judith Klotz, M.S., Dr.P.H., consultant

Summary

The New Jersey Department of Health and Senior Services, as part of an environmental and health effects tracking project, conducted a descriptive analysis of childhood blood levels in New Jersey in the period 2000 through 2004. The specific objective of this descriptive analysis was to enhance existing surveillance by examining spatial and temporal variation in measured blood lead among New Jersey children aged 6 through 29 months. The dataset used for descriptive analyses contained 326,047 unique children (89.2% of original dataset). Cases missing sampling date, age at screening, or whose residential address could not be geocoded to a latitude and longitude were excluded from analysis.

Results from this descriptive analysis of childhood blood lead data in New Jersey have shown an increasing trend in the number of children screened during the period 2000-2004. There is a noticeable seasonable pattern, with higher numbers of screenings occurring in the summer months of each year, and the fewest in the winter months.

There is considerable geographic variation in childhood blood lead levels. Mean childhood blood lead levels, and the proportion of children with elevated blood lead levels (i.e., $\geq$ 10 µg/dL or $\geq$ 20 µg/dL), were highest in several contiguous, industrialized counties in northeast New Jersey (Essex, Passaic and Union), in central New Jersey (Mercer County), and in southern New Jersey (Cumberland County). Analysis of data for 22 select, large municipalities identified certain cities within these areas (East Orange, Irvington, and Newark in Essex County, Paterson and Passaic in Passaic County, and Trenton in Mercer County) having children with higher risk of elevated blood lead levels. Cluster analysis using SaTScan software further identified localities within these areas in which there was a higher risk of elevated blood lead among screened children.

Blood lead levels also increased with the age of the child. Mean childhood blood lead levels, and the proportion of children with blood lead levels $\geq$ 10 µg/dL or $\geq$ 20 µg/dL, were higher for children aged 21-27 months compared to children aged 9-15 months. These differences may reflect cumulative exposure to lead sources and greater mobility of the child to access lead-contaminated media such as dusts and soils.

There has been a general downward trend in blood lead levels through time, particularly for municipalities that had higher levels in the early part of the period. The decrease in blood lead concentrations may be attributed to real decreases in exposure, or alternatively, may be due to increased screening of children at lower risk of exposure. These data cannot be used to distinguish between these explanations. In New Jersey's 22 largest municipalities, almost 7% of the children tested in 2000 had a blood lead concentration exceeding 10 µg/dL, while this proportion was reduced to only 3% by 2004.

Introduction

Lead is a heavy metal that has been widely used in consumer products and industrial processes. When absorbed into the human body, lead affects the blood, kidneys and nervous system. Lead's effects on the nervous system are particularly serious and can cause learning disabilities, hyperactivity, decreased hearing, mental retardation and possibly death. Lead exposure is particularly hazardous to children less than six years of age, and may cause intellectual and behavioral deficits (ATSDR, 1999).

Lead may enter the body through ingestion or inhalation. Common sources of lead exposure are, or have been, lead-based paint, leaded gasoline, occupation or hobby, tap water, food stored in lead soldered cans or improperly glazed pottery, and traditional folk remedies and cosmetics containing lead (ATSDR, 1999). High exposures in children are typically associated with ingestion of lead paint chips or dusts in housing stock built prior to 1978. However, the highest risk for children is found in houses built before 1950, when paints contained a very high percentage of lead (Clickner et. al, 1995; MMWR, 2003). Nearly one million housing units in New Jersey (30.2% of the housing units in the state) were built before 1950. Each of New Jersey's 21 counties has more than 9,000 housing units built before 1950.

While blood lead levels in U.S. continue to decline, 2% of U.S children less than age 1 year and 4% of children 1 to 5 years are estimated to have blood lead levels ≥ 10 µg/dL (CDC, 2005). Nearly 3% of New Jersey children age 6 to 29 months are estimated to have blood lead levels ≥ 10 µg/dL (NJDHSS, 2004).

All children who reside in New Jersey, upon reaching the age of 1 and 2 years, are mandated to be screened and followed-up by their primary care providers for blood lead levels (NJAC 8:51A). Primary care providers refer the children to clinical laboratories for blood lead testing. In turn, the laboratories are required to report the results both to the child's physician and to the NJDHSS (NJAC 8:44). These results are uploaded to the CLPPSS data system as permanent records.

CDC guidelines state that a blood lead test of 10 micrograms per deciliter (µg/dL) or greater should be considered elevated. The CDC guidelines further state that a confirmed blood lead test result of 20 µg/dL or greater should trigger public health follow-up, including an environmental investigation to determine the source of the lead, and case management assistance to the family. If the test result is 20 µg/dL or greater, the NJDHSS notifies the local health department covering the community where the child resides. State law and NJDHSS regulations require the local health department to conduct an environmental investigation of each of these cases, and to provide case management for the families of these children.

The CLPPSS produces annual reports of childhood blood lead surveillance data. This EPHT report supplements data analyses included in the CLPPSS reports with more detailed analyses of spatial and temporal variation in childhood blood lead levels in New Jersey (e.g., NJDHSS, 2004).

Methods

Surveillance Population

The population of surveillance subjects consisted of all New Jersey children aged 6 months through 29 months at time of sample collection with at least one blood lead measurement reported to the NJDHSS in the five-year period 2000 through 2004. The year 2000 was the first full year of universal reporting of childhood blood lead to the CLPPSS.

Database Preparation

The CLPPSS prepared a dataset specifically for this EPHT demonstration project. This dataset was de-duplicated such that it contained only one record per individual child. De-duplication was based on the child's name and date of birth. For individuals with more than one record in the period 2000 through 2004, the record with the highest blood lead measurement for that child was included, and all others were excluded.

The CLPPSS transmitted the dataset file securely to the CEHS study team staff. The data set contained blood lead measurements in micrograms lead per deciliter of blood (µg/dL) and limited demographic information for the New Jersey resident children. Each record contained the following variables: street address; city; ZIP code; municipality code; county code; census tract code; census tract suffix code; latitude; longitude; blood lead measurement (µg/dL); date of birth; age in months; age in years; date of sample; date of analysis; sex; and race code. Latitude and longitude were coded to the ZIP+4 centroid. As a result of the de-duplication process, the child's residential address was the one at the time of the highest blood lead measurement.

Due to large numbers of cases in the dataset without data on sex and race of child, these data are not considered further in this report.

Initially, 365,524 de-duplicated records were provided by the CLPPSS to the CEHS for the 5-year period. Cases without a known sampling date, missing information on age at screening, or those with addresses that could not be geocoded to a latitude and longitude were excluded from further analysis. The final dataset used for these descriptive analyses contained 326,047 children (89.2%).

Data Analysis

At varying geographic scales, summary statistics (e.g., means, percentiles, frequency distributions, and proportion above 10 and 20 µg/dL) were examined by specific factors. These factors included: age of child at time of screening; month, season and year of sample. For descriptive purposes, blood lead levels below the laboratory method detection limit were assigned a value of one-half the detection limit. Analyses were conducted using Stata and SPSS statistical software. In addition spatial clustering was examined using SaTScan software. Mapping of data was conducted using ArcView 9 Geographical Information System software.

Time Trends in Statewide Screening Counts

Counts of screened children in New Jersey were compared by year, season and month of year.

Childhood Blood Lead Levels by County

Mean blood lead levels and proportions of children exceeding 10 and 20 µg/dL were examined by county and by age at the time of screening.

Childhood Blood Lead Levels in 22 New Jersey Municipalities

Mean blood lead levels and proportions of children exceeding 10 and 20 µg/dL were examined for 22 municipalities in New Jersey with an estimated ≥ 1,500 children less than two years of age in 2003, by municipality and by year and season.

Spatial Clustering in Childhood Blood Lead

Spatial clustering was examined using the Bernoulli model in SaTScan (Kulldorff et al., 1998; 2004). The geographic unit for this analysis was the centroid of the census tract (n=1,944 census tracts in New Jersey). Children were classified as cases if blood lead levels were ≥ 10 µg/dL or ≥ 20 µg/dL, and non-cases otherwise. The null hypothesis of complete spatial randomness was tested against the alternative hypothesis that the probability of being a case in zone z (a census tract or aggregation of census tracts) is greater than the probability of being a case outside that zone (Hjalmars et al., 1996; Kulldorff, 1997). Zones of aggregated (tracts) are constructed by allowing the radii of circles to vary continuously according to pre-determined parameters.

Protection of Human Subjects

The NJDHSS has long-standing mechanisms in place to safeguard the use of confidential health data by qualified NJDHSS scientists and researchers. All potentially identifying childhood lead information obtained from the CLPPSS is kept confidential by CEHS. Although no names were obtained by CEHS staff from the Childhood Lead Poisoning Prevention Program, address information is treated as strictly confidential. Datasets with confidential data elements were transferred between CLPPSS and CEHS by hand-carrying of password-protected compact discs. All computerized data are kept by CEHS in password-protected files on a secure local area network (LAN). Paper files at CEHS are kept in locked file cabinets which can only be accessed by authorized CEHS personnel who have a need to access the files.

Results

Time Trends in Statewide Screening Counts

Table 1 below shows the number of children screened in the State of New Jersey for blood lead by month and year from 2000 through 2004, according to the method used to construct the analytical file described above. (Since this file was de-duplicated for a period of five years, counts may not correspond to those found in previously released CLPPSS reports.) During the period 2000-2004, there was an upward trend in the annual number of children who were screened in New Jersey. The numbers screened increased from each year to the next, and, overall, there was a 45.5% increase in the number of children screened in 2004 compared to 2000.

A seasonal analysis of these data indicates that more children tended to be screened during the summer months while the fewest were screened in the winter months. The smallest number of children screened in any month was in February 2001 (3,325), while the largest was in March 2004 (7,582). The smallest number of children screened in a season was in Winter 2000 (11,263), and the largest was in Summer 2004 (22,393).

Table 1. Counts of children screened for blood lead level in New Jersey, by month and season, 2000-2004.

Month/ Season	**Year**				
	2000	**2001**	**2002**	**2003**	**2004**
January	3,369	4,374	4,901	5,641	5,126
February	4,292	3,325	4,773	4,514	6,001
March	5,206	4,744	4,960	6,195	7,582
Winter	11,263	11,452	13,978	15,125	16,096
April	4,328	4,358	6,024	5,741	6,759
May	4,653	4,736	6,074	5,733	7,147
June	5,034	5,005	5,848	5,805	7,488
Spring	14,187	13,838	17,058	17,669	21,487
July	4,690	5,214	6,246	6,725	7,381
August	5,360	5,314	6,715	5,023	7,523
September	4,970	4,795	6,112	5,869	6,717
Summer	15,084	15,533	18,809	17,553	22,393
October	4,871	5,599	6,147	6,557	6,746
November	4,426	5,074	4,902	5,430	6,318
December	3,602	3,753	4,304	4,970	4,969
Fall	14,267	15,468	17,161	17,856	19,781
Total	**54,801**	**56,291**	**67,006**	**68,203**	**79,757**

Childhood Blood Lead Levels by County

The five counties with the highest proportions of screened children with blood lead measurements at or above the action limit of 10 µg/dL were Essex, Cumberland, Passaic, Mercer and Union Counties (Table 2 and Figure 1). The same five counties had the highest proportions of children with blood lead measurements ≥ 20 µg/dL (Table 2 and Figure 2). Figures 3 and 4 map the data shown in Table 2.

Table 2. Childhood Blood Lead Levels for Screened Children Aged 6 to 29 Months, by County, 2000-2004

County	# Children Screened (2000-2004)	Mean Blood Lead (µg/dL)	% Children with Blood Lead ≥ 10 µg/dL	% Children with Blood Lead ≥ 20 µg/dL
Atlantic	8,961	3.56	1.9	0.4
Bergen	36,228	2.96	1.3	0.3
Burlington	10,652	3.23	0.9	0.2
Camden	16,884	3.69	2.3	0.3
Cape May	2,722	3.36	1.7	0.2
Cumberland	6,369	4.51	6.0	0.9
Essex	39,395	4.62	6.6	1.6
Gloucester	7,841	3.31	1.4	0.2
Hudson	22,038	3.74	2.7	0.5
Hunterdon	5,194	3.17	1.4	0.3
Mercer	13,676	3.99	4.1	0.6
Middlesex	30,497	3.08	1.5	0.3
Monmouth	20,521	3.03	1.5	0.3
Morris	19,403	2.88	0.9	0.2
Ocean	15,921	2.97	1.1	0.3
Passaic	24,322	3.93	4.3	0.9
Salem	2,034	3.82	2.7	0.4
Somerset	12,446	2.91	1.1	0.2
Sussex	4,313	2.92	0.6	0.1
Union	22,570	3.67	3.0	0.7
Warren	4,073	3.20	1.8	0.2

The mean blood lead concentration for the entire population of children screened throughout the state was 3.45 µg/dL. Among counties, mean blood lead levels ranged from 2.88 µg/dL (in Morris County) to 4.62 µg/dL (in Essex County). As would be expected, there was a close correlation among counties of mean blood lead levels and the proportions of children with blood lead levels above 10 µg/dL (Figure 5).

Figure 1. Childhood Blood Lead Analysis by County for Blood Lead ≥ 10 µg/dL

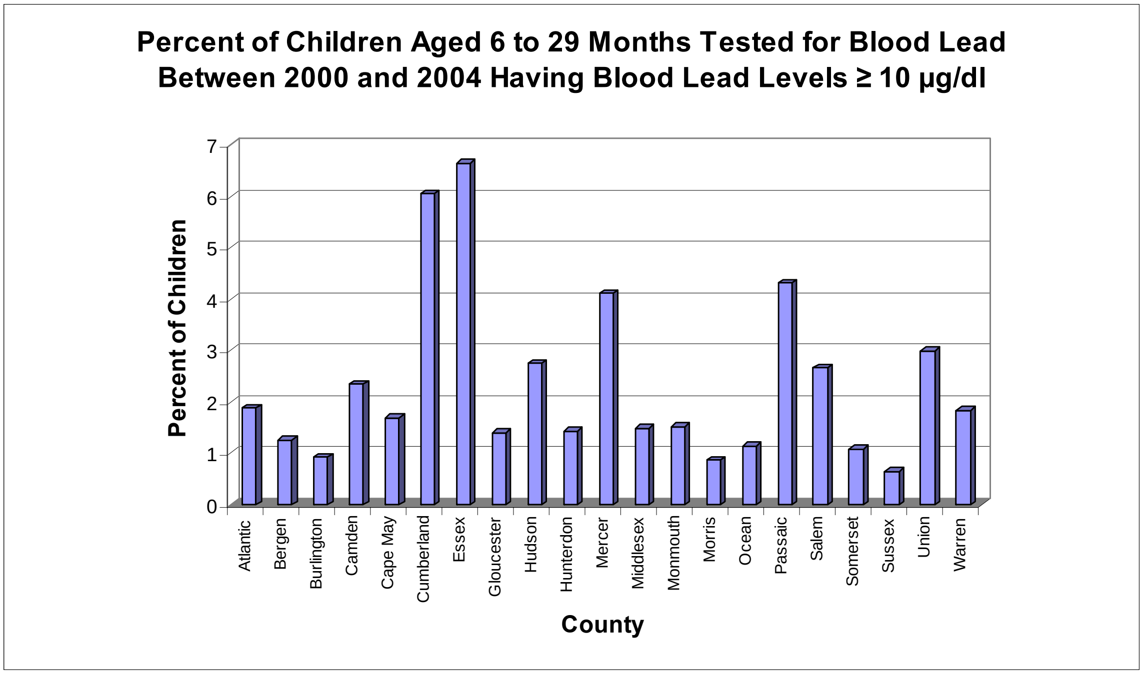


Figure 2. Childhood Blood Lead Analysis by County for Blood Lead ≥ 20 µg/dL

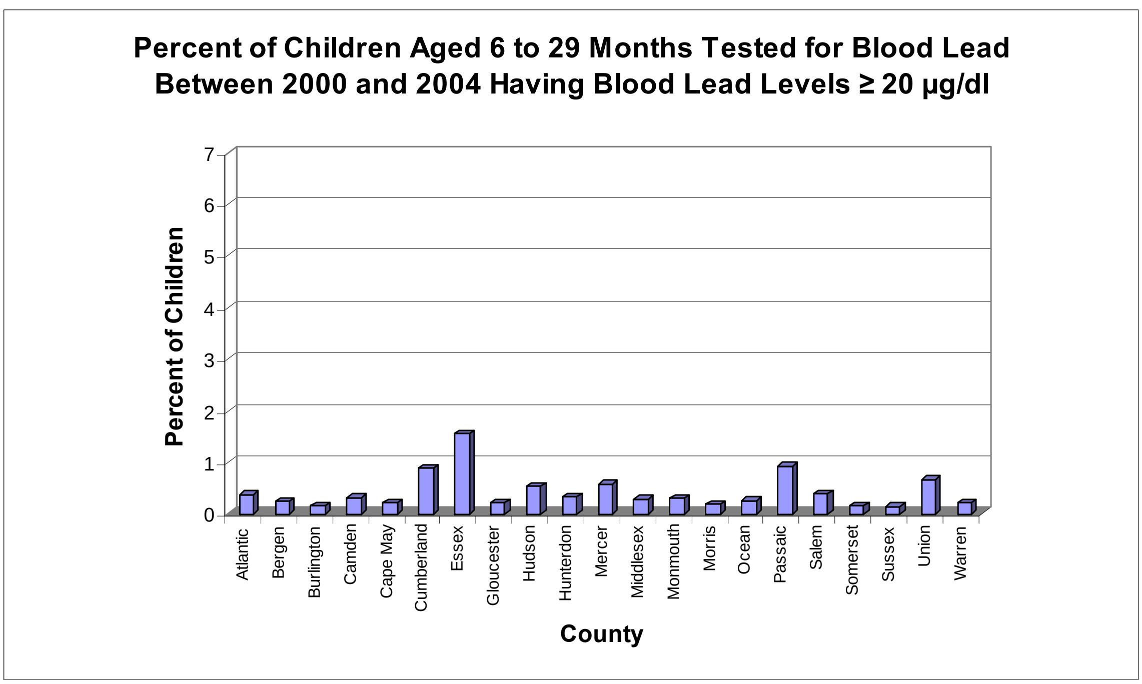


Figure 3. Percent of Tested Children with Blood Lead Levels ≥ 10 µg/dL.

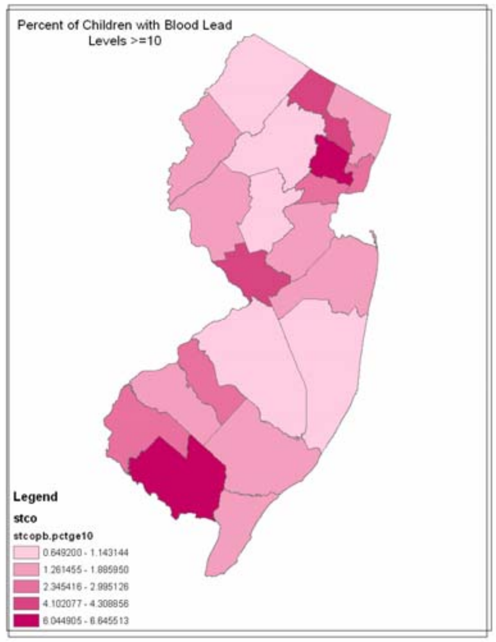


Figure 4. Percent of Tested Children with Blood Lead Levels ≥ 20 µg/dL.

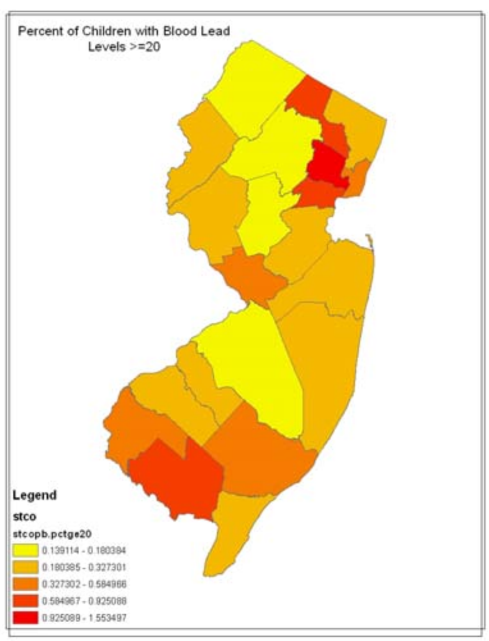
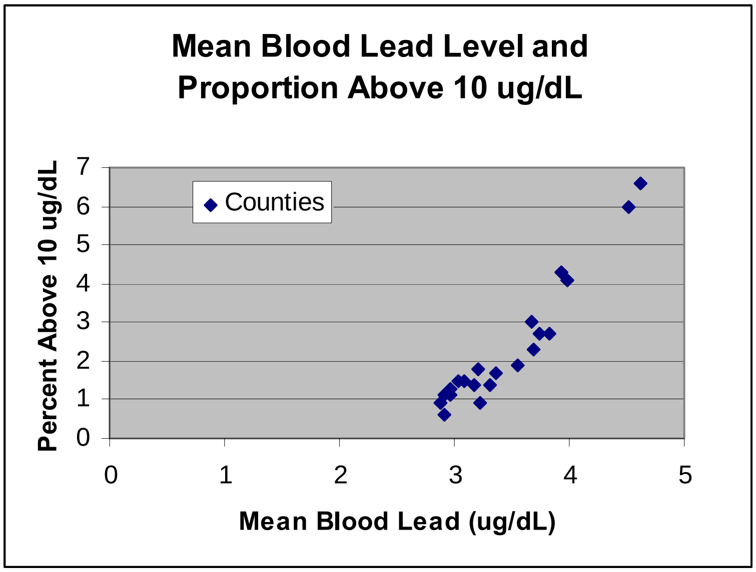


Figure 5. Mean Blood Lead Level vs. Percentage Above 10 μg/dL, by County.



In all counties, mean blood lead levels among children whose highest test was near their first birthday (9 through 15 months of age) were lower than among children whose highest test occurred near their second birthday (21 through 27 months of age) (see Table 3). Statewide, the mean blood lead concentration among children aged 9-15 months was 3.15 μg/dL, compared to 3.99 μg/dL for children aged 21-27 months from 2000-2004. This represents a 27% increase in blood lead concentration.

Similarly, proportions of children with blood lead levels ≥ 10 μg/dL and ≥ 20 μg/dL were lower among children whose highest test was near their first birthday (9 through 15 months of age) compared to those whose highest test occurred near their second birthday (21 through 27 months of age) (see Figures 6 through 9).

Figures 6 through 9 also reveal a general decreasing trend in percentages of children with blood lead concentrations ≥ 10 μg/dL and ≥ 20 μg/dL among New Jersey's 21 counties during the period 2000 through 2004. This trend was most apparent among counties with high proportions of children with elevated blood lead levels at the start of the period.

Table 3. Mean Childhood Blood Lead Levels for Children Aged 1 and 2 Years, 2000-2004.

County	Mean Blood Lead for Children Aged 9-15 Months (µg/dL)	Mean Blood Lead for Children Aged 21-27 Months (µg/dL)
Atlantic	3.24	4.17
Bergen	2.81	3.21
Burlington	3.05	3.60
Camden	3.39	4.30
Cape May	3.04	4.05
Cumberland	3.96	5.37
Essex	3.86	5.70
Gloucester	3.11	3.80
Hudson	3.43	4.25
Hunterdon	2.95	3.62
Mercer	3.53	4.91
Middlesex	2.90	3.44
Monmouth	2.80	3.38
Morris	2.75	3.11
Ocean	2.83	3.34
Passaic	3.41	4.53
Salem	3.42	4.40
Somerset	2.78	3.12
Sussex	2.74	3.28
Union	3.26	4.31
Warren	2.93	3.87
Statewide	3.15	3.99

Figure 6. Proportion of Children with Blood Lead ≥ 10 µg/dL, Aged 9-15 Months, by Year.

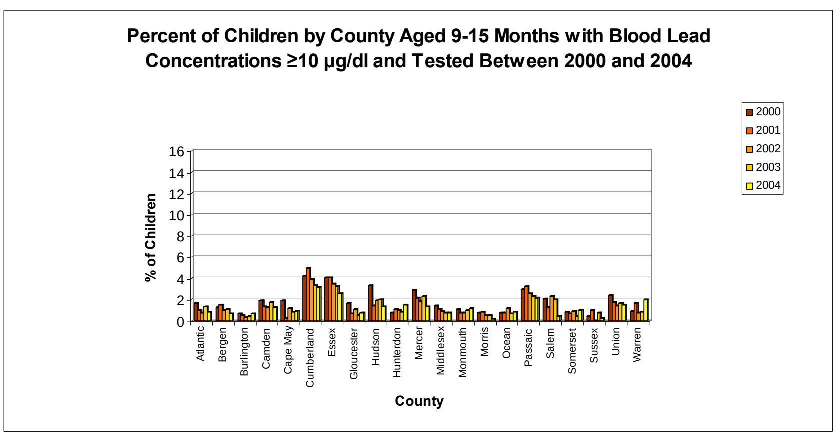


Figure 7. Proportion of Children with Blood Lead ≥ 10 µg/dL, Aged 21-27 Months, by Year.

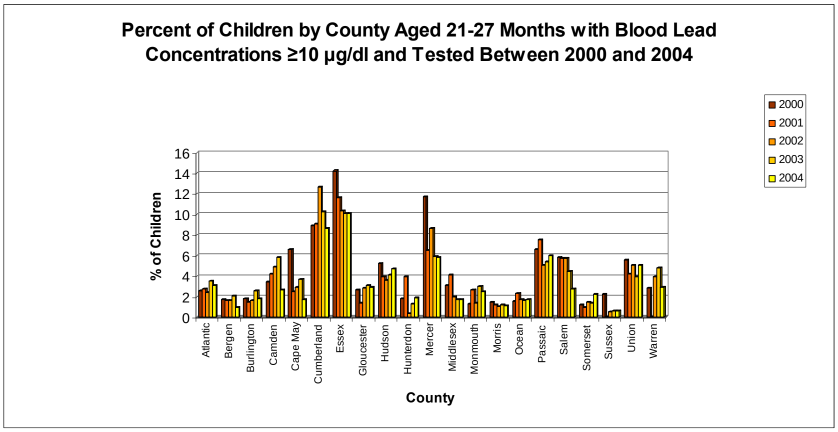


Figure 8. Proportion of Children with Blood Lead ≥ 20 µg/dL, Aged 9-15 Months, by Year.

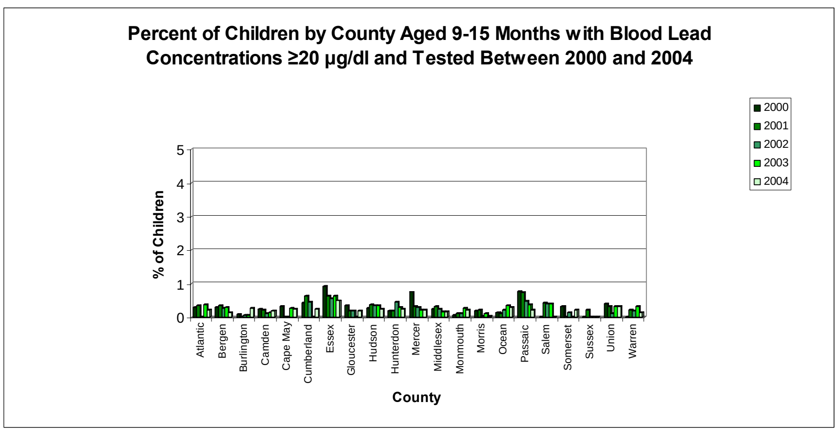
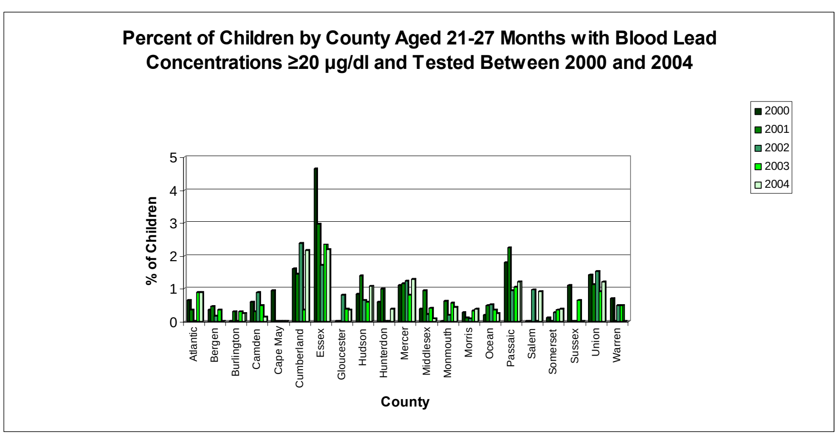


Figure 9. Proportion of Children with Blood Lead ≥ 20 µg/dL, Aged 21-27 Months, by Year.



Childhood Blood Lead Levels in 22 New Jersey Municipalities

For the 22 largest municipalities in New Jersey, Table 4 and Figure 10 below show the mean blood concentrations for the entire period 2000-2004, as well as for each year. These data indicate an overall decline in mean blood lead concentrations throughout the five-year period for municipalities with the highest blood lead levels to begin with, and no trend or a slight increase for municipalities with lower levels to begin with.

The six municipalities with the highest mean childhood blood lead levels were: East Orange, Irvington, Trenton, Newark, Paterson and Passaic.

Table 4. Mean Childhood Blood Lead Measurements for 22 Municipalities, by Year, 2000-2004.

Municipality	Mean Blood Lead Conc. For 2000 (µg/dL)	Mean Blood Lead Conc. For 2001 (µg/dL)	Mean Blood Lead Conc. For 2002 (µg/dL)	Mean Blood Lead Conc. For 2003 (µg/dL)	Mean Blood Lead Conc. For 2004 (µg/dL)
Brick Township	2.74	2.42	2.78	3.00	2.84
Camden City	4.67	4.75	4.68	4.68	4.34
Cherry Hill Township	3.01	3.20	3.12	3.09	2.93
Clifton City	3.48	3.59	3.52	3.45	3.21
Dover Township	2.81	3.60	3.16	3.24	3.06
East Orange City	6.14	5.48	6.01	5.61	5.17
Edison Township	2.40	1.89	2.97	3.22	3.11
Elizabeth City	4.62	4.03	4.32	4.32	3.93
Gloucester Township	2.98	3.02	3.17	3.33	3.20
Hamilton Township	3.55	3.49	3.43	3.51	3.26
Howell Township	2.54	1.99	2.84	2.84	2.81
Irvington Township	6.26	5.38	5.29	5.48	5.22
Jersey City	4.28	3.98	4.05	4.27	4.02
Lakewood Township	3.54	3.40	3.73	3.54	2.92
Middletown Township	2.20	2.08	2.82	3.07	2.90
Newark City	6.05	5.46	5.39	5.12	4.75
Old Bridge Township	2.36	2.01	2.90	2.94	2.91
Passaic City	5.20	4.87	4.45	4.28	4.02
Paterson City	5.12	5.10	4.54	4.51	4.28
Trenton City	5.93	5.64	5.51	5.19	4.78
Union City	3.67	3.86	3.89	4.08	3.71
Woodbridge Township	2.81	2.33	3.00	3.19	3.22

Figure 10. Trend in Mean Blood Lead Levels, By Municipality, 2000-2004.

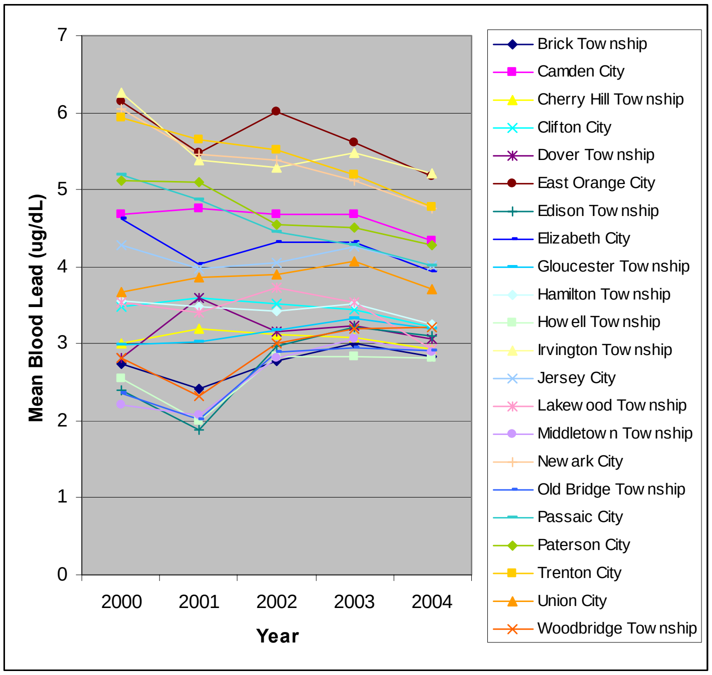


Table 5 shows seasonal blood lead means across the five-year analysis period. Overall, the mean blood lead concentrations among these municipalities ranged from 2.62 µg/dL to 5.65 µg/dL. In general, winter mean blood lead concentrations were lower than in other seasons, and summer blood lead levels tended to be highest. This trend is similar to that seen for county-level geographic scale analysis.

Table 5. Seasonal Variation in Mean Blood Lead Measurements in 22 Municipalities, 2000-2004.

Mean Blood Lead Concentration (µg/dL) by Season					
Municipality	**All Seasons**	**Winter**	**Spring**	**Summer**	**Fall**
Brick Township	2.76	2.71	2.64	2.77	2.89
Camden City	4.62	4.17	4.40	4.95	4.91
Cherry Hill Township	3.07	2.96	3.03	3.06	3.23
Clifton City	3.43	3.38	3.22	3.60	3.52
Dover Township	2.98	2.83	2.87	3.05	3.15
East Orange City	5.65	5.23	5.12	6.42	5.68
Edison Township	2.79	2.61	2.92	2.81	2.77
Elizabeth City	4.20	3.96	4.06	4.39	4.29
Gloucester Township	3.13	2.94	3.18	3.13	3.25
Hamilton Township	3.44	3.36	3.33	3.54	3.51
Howell Township	2.62	2.58	2.60	2.71	2.58
Irvington Township	5.46	5.05	4.96	6.20	5.55
Jersey City	4.11	3.97	4.01	4.22	4.20
Lakewood Township	3.33	3.19	3.38	3.49	3.23
Middletown Township	2.63	2.50	2.66	2.74	2.59
Newark City	5.29	4.70	4.76	6.08	5.51
Old Bridge Township	2.63	2.57	2.67	2.71	2.56
Passaic City	4.47	4.02	4.07	5.00	4.66
Paterson City	4.63	4.15	4.31	5.08	4.84
Trenton City	5.38	5.15	4.91	5.90	5.39
Union City	3.85	3.66	3.76	3.95	3.95
Woodbridge Township	2.94	2.86	2.86	2.95	3.08

As would be expected, the same six municipalities with the highest mean childhood blood lead levels also had the highest proportions of children with blood lead levels ≥ 10 µg/dL: East Orange, Irvington, Trenton, Newark, Passaic and Paterson (Figure 11). Irvington and Newark had the highest proportions of children with blood lead levels ≥ 20 µg/dL (Figure 12). Through the period 2000-2004, there was a tendency for the proportions of children with elevated blood lead levels to decrease, particularly in municipalities in which the 2000 proportions were high to begin with. For the 22 municipalities combined, there was a clear and steady annual decline in the percentage of children with elevated blood lead measurements (Figure 13). By 2004, approximately 3% of children tested in these municipalities had a blood lead concentration ≥ 10 µg/dL and approximately 0.5% of children had a blood lead concentration ≥ 20 µg/dL.

Figure 11. Municipal Blood Lead Analysis for Blood Lead ≥ 10 µg/dL.

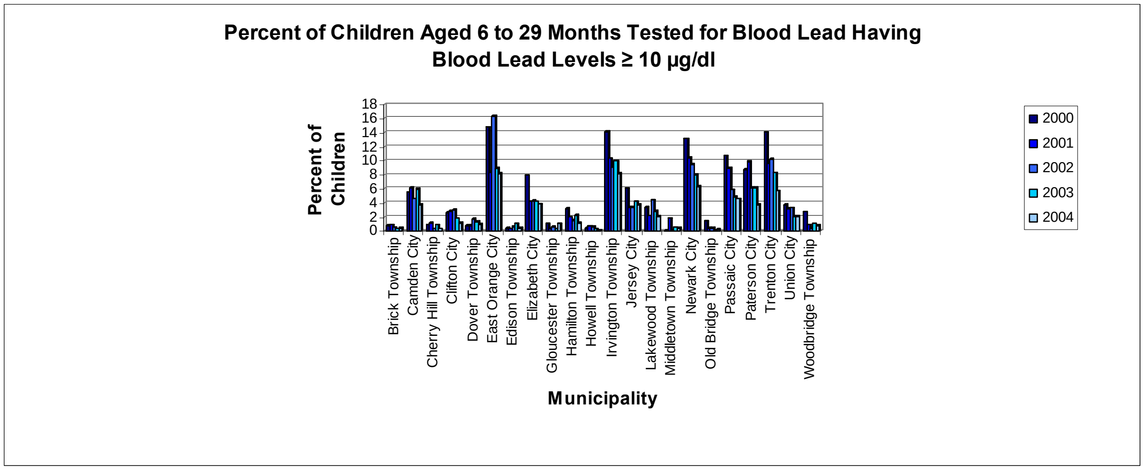


Figure 12. Municipal Blood Lead Analysis for Blood Lead ≥ 20 µg/dL

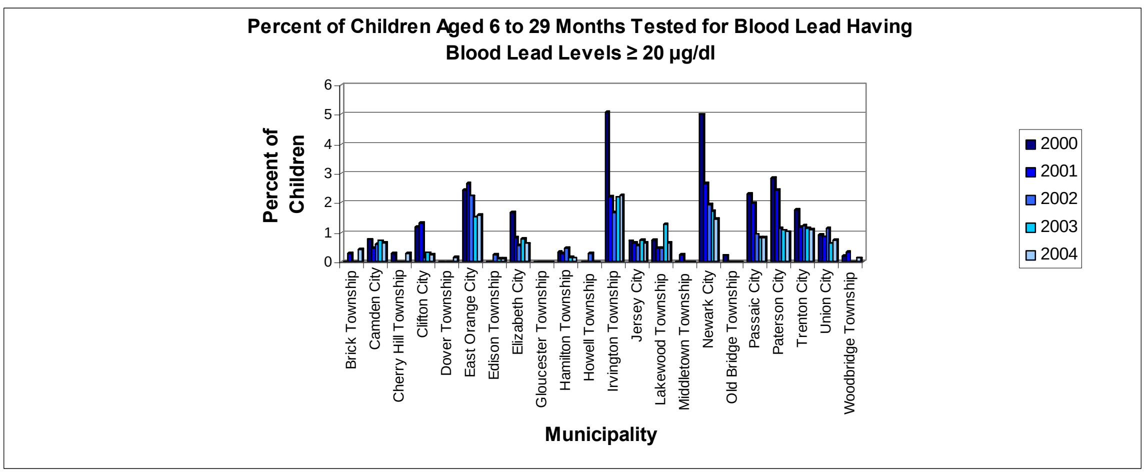
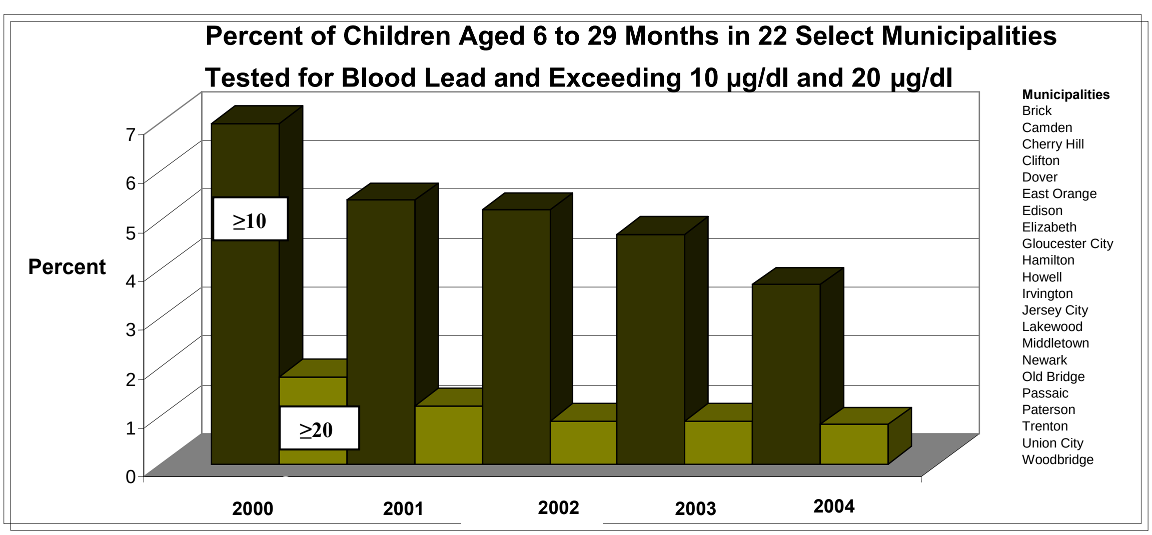


Figure 13. Municipal Comparisons Across A 5-Year Analytical Period



Analysis of Spatial Clustering of Childhood Blood Lead Results

Three statistically significant clusters of children with blood lead levels ≥ 20 μg/dL (p-value ≤ 0.001) were detected (see Figure 13). The largest cluster was found in northeast New Jersey (several census tracts in Essex County, with 524 cases) with a relative risk (RR) of 6.1. Clusters were also found in central New Jersey (census tracts in Mercer County, with 33 cases, RR=4.0) and in southern New Jersey (part of Cumberland County, with 33 cases, RR=5.1).

Five statistically significant clusters of children with blood lead levels ≥ 10 μg/dL (p-value ≤ 0.001) were detected (see Figure 14). Again, the largest cluster was found in northeast New Jersey (part of Essex County, with 2,191 cases, RR=4.8). Clusters were also found in central New Jersey (part of Mercer County, with 471 cases, RR=3.5) and three in southern New Jersey (Camden County, with 209 cases, RR=2.2; Cumberland County, with 231 cases, RR=6.3; and Atlantic County, with 49 cases, RR=2.1).

Figure 13

Figure 14

Discussion

Interpretation of Findings

Results from this descriptive analysis of childhood blood lead data in New Jersey have shown an increasing trend in the number of children screened during the period 2000-2004. There is a noticeable seasonable pattern, with higher numbers of screenings occurring in the summer months of each year, and the fewest in the winter months.

There is considerable geographic variation in childhood blood lead levels. Mean childhood blood lead levels, and the proportion of children with elevated blood lead levels (i.e., ≥ 10 μg/dL or ≥ 20 μg/dL), were highest in several contiguous, industrialized counties in northeast New Jersey (Essex, Passaic and Union), in central New Jersey (Mercer County), and in southern New Jersey (Cumberland County). Analysis of data for 22 select, large municipalities identified certain cities within these areas (East Orange, Irvington, and Newark in Essex County, Paterson and Passaic in Passaic County, and Trenton in Mercer County) having children with higher risk of elevated blood lead levels. Cluster analysis using SaTScan software further identified localities within these areas in which there was a higher risk of elevated blood lead among screened children. Cluster analysis should be considered to be exploratory only, as results are dependent on the software parameters used, data completeness, and geocoding success rates.

Blood lead levels also increased with the age of the child. Mean childhood blood lead levels, and the proportion of children with blood lead levels ≥ 10 μg/dL or ≥ 20 μg/dL, were higher for children aged 21-27 months compared to children aged 9-15 months. These differences may reflect cumulative exposure to lead sources and greater mobility of the child to access lead-contaminated media such as dusts and soils.

There has been a general downward trend in blood lead levels through time, particularly for municipalities that had higher levels in the early part of the period. The decrease in blood lead concentrations may be attributed to real decreases in exposure, or alternatively, may be due to increased screening of children at lower risk of exposure. These data cannot be used to distinguish between these explanations. In New Jersey's 22 largest municipalities, almost 7% of the children tested in 2000 had a blood lead concentration exceeding 10 μg/dL, while this proportion was reduced to only 3% by 2004.

It should be noted that the children screened throughout the period studied may not be representative of all children across the entire state. Screening rates are variable across the state. In 2004, approximately 42% of eligible children aged 6-29 months were screened for blood lead, but this proportion ranged from 11% to 80% among municipalities with > 35,000 persons, according to the CLPPSS (NJDHSS, 2005).

Lessons Learned from Demonstration Project Activities

This demonstration project resulted in a successful collaboration among staff of the EPHT project in CEHS, the CLPPSS, and NJDEP. Through the development of a protocol for data analyses, the various agency representatives had input into the kinds of questions asked of the data, and the methods of analysis.

The demonstration project examined childhood blood lead data in ways that go beyond the descriptive analyses routinely conducted and presented by CLPPSS. A new analytical tool (SaTScan) was applied to examine spatial clustering in childhood blood lead data for the first time. The method was generally consistent with other levels of analysis (such as municipal), but allowed for refinement in the areas of concern and the potential targeting of screening activities.

This examination of blood lead data was limited for certain potentially important demographic characteristics, namely sex and race/ethnicity of the child, since information on these factors is missing from reports for a high proportion of screenings. Steps to improve completeness of the reporting of these variables may be important for lead poisoning surveillance and EPHT in the future.

Similarly, there are issues with the quality of geographic information reported to the CLPPSS. It is unknown how the loss of data from this analysis due to missing geographic or other information may have affected these descriptive results.

References

ATSDR, 1999. Toxicological Profile for Lead. Agency for Toxic Substances and Disease Registry.

CDC, 2005. Blood lead levels --- United States, 1999 – 2002. MMWR 2005; 54(20); 513-516.

Clickner RP, Albright VA, Weitz S. The prevalence of lead-based paint in housing: findings from the national survey [Chapter 1]. In: Breen JJ, Stroup CR, eds. Lead poisoning: exposure, abatement, regulation. Boca Raton, FL: CRC Press, 1995:3-12.

Hjalmars U, Kulldorff M, Gustafsson G, Nagarwalla N. Childhood leukemia in Sweden: using GIS and a spatial scan statistic for cluster detection. Statistics in Medicine 15:707-715. 1996.

Kulldorff M and Information Management Services Inc. SaTScan™ v5.1 Software for the Spatial and Space-time Scan Statistics. http://www.SaTScan.org, 2004.

Kulldorff M, Rand K, Ghermanm G, Williams G, DeFrancesco D. SaTScan, version 5.1. NIH, National Cancer Institute. Bethesda, MD, 1998.

Kulldorff M. A spatial scan statistic. Communications in Statistics: Theory and Methods 26 1781-1496. 1997.

MMWR (2003). Surveillance for Elevated Blood Lead Levels Among Children --- United States, 1997-2001. September 12, 2003 / 52(SS10);1-21.

NJDHSS, 2004. Childhood Lead Poisoning in New Jersey, Annual Report, Fiscal Year 2003, July 1, 2002 – June 30, 2003. New Jersey Department of Health and Senior Services.

NJDHSS, 2005. Childhood Lead Poisoning in New Jersey, Annual Report, Fiscal Year 2004, July 1, 2003 – June 30, 2004. New Jersey Department of Health and Senior Services.