Childhood Lead Testing and Poisoning Report: 2017 and 2018 Pennsylvania Birth Cohort Analysis

Childhood Lead Poisoning Prevention Program
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Table of Contents

Executive Summary

This is a supplementary report to the Pennsylvania Department of Health's (Department) 2019 Childhood Lead Surveillance Annual Report,[1] covering data for children born to Pennsylvania resident mothers in 2017 and 2018 and tested for blood lead levels (BLLs) in Pennsylvania before two years of age. This report serves as an overview of the 2017 and 2018 birth cohorts' blood lead testing results during the first two years of their life in Pennsylvania. The report also provides information regarding variability in the percentages of blood lead testing and the proportions of tested children with elevated blood lead levels (EBLLs) by maternal and infant demographics and neighborhood characteristics. Birth cohorts were formed from the 2017 and 2018 birth certificate datasets and linked to blood lead test data from the Pennsylvania National Electronic Disease Surveillance System (PA-NEDSS) through deterministic and probabilistic linkage methods using personal identifiable information. This report provides more accurate estimates of the percentage of blood lead testing and the proportion of elevated blood lead levels (EBLLs) for children before two years of age using the cohort analytic design than the cross-sectional design used in our annual report. The Department can use it to identify characteristics of children with potential undertesting for BLLs and with higher percentages of EBLLs. This report can also be used to identify spatial variation in childhood lead undertesting and elevations in blood lead results across counties and municipalities. Findings from this report can be used to assist state and local health departments, federal government agencies, universities, healthcare facilities, and childhood lead prevention partners in developing evidence-based childhood lead prevention programs and future research.

Exposure to lead, even at low levels, can cause intellectual, behavioral, and academic deficits.[2,3] For this reason, in 2012, the Centers for Disease Control and Prevention (CDC) redefined an elevated blood lead level (EBLL) from "level of concern" of 10 micrograms per deciliter (µg/dL) to "blood lead reference value" of 5 µg/dL.[4] This value is also used to identify children who require case management and follow-up testing of EBLLs.

Nationally, among states with older housing stock, lead-based paint continues to be a significant source of lead exposure in young children. According to the 2018 American Community Survey estimate, Pennsylvania ranks fifth in the U.S. for the percentage of old housing units identified as having been built before 1950, when lead-based paint was most prevalent. Drinking water can also be a source of lead exposure when it flows through older lead-containing pipes, faucets, and plumbing where lead-containing solder has been used (which can occur in newer plumbing as well). Other potential sources of lead exposure include lead-containing toys, ceramics, and numerous other consumer products, including imported products.

A total of 271,976 children (136,950 from the 2017 birth cohort and 135,026 from the 2018 birth cohort) born to Pennsylvania resident mothers were included in our analysis. Of the 271,976 children, 147,431 (54.2%) children were tested for BLLs before two years of age.

Among the 147,431 tested children, 1,568 (1.06%) children had unconfirmed EBLLs, and 2,883 (1.95%) children had confirmed EBLLs.

Among these two birth cohorts, non-Hispanic white children had the lowest percentage of children tested for BLLs (49.9%), while the highest percentage was seen among non-Hispanic Black children (65.7%). Percentages of children tested for BLLs were relatively low for children whose maternal educational attainment was less than high school (47.1%) as compared to children whose maternal educational attainment was high school graduate or higher. The percentage of children tested for BLLs was the lowest for children born to mothers whose principal source of payment for delivery was "self-payment" (14.5%) when compared with those with other payment sources for delivery. The percentage of children tested for BLLs was relatively low for children born to mothers who were not enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (48.4%). Additionally, percentages of children tested for BLLs were higher for children who lived in neighborhoods with lower household income, higher proportions of poverty, and higher proportions of old housing.

Among children tested for BLLs before two years of age, non-Hispanic Black children had the highest proportion of confirmed EBLLs (3.00%) among different races. Children whose maternal educational attainment was less than high school had a higher proportion of confirmed EBLLs (3.44%) as compared to children whose maternal educational attainment was high school graduate or higher. Children born to mothers with "self-payment" as the principal source of payment for delivery had a higher proportion of confirmed EBLLs (3.86%) than those with other payment sources for delivery. The percentage of confirmed EBLLs was relatively high for children born to mothers with WIC enrollment (2.45%). In addition, increased percentages of tested children with confirmed EBLLs were found in neighborhoods with lower household income, higher proportions of poverty, and higher proportions of old housing.

There was substantial variation in the percentage of children tested for BLLs and the proportion of confirmed EBLLs across counties in Pennsylvania. Mapping demonstrated that counties with relatively low percentages of children tested for BLLs were mainly concentrated in the south-central, southeastern, and northeast regions of Pennsylvania. Some of these counties also had relatively high proportions of confirmed EBLLs. This report also provides the percentage of children tested for BLLs and the proportion of confirmed EBLLs for municipalities with a total number of births of 50 or greater during 2017 through 2018. At the sub-county level, most muncipalities with relatively low percentages of children tested for BLLs were mainly concentrated in counties with relatively low percentages of children tested for BLLs. There were a few municipalities with low blood lead testing percentages scattered in counties with relatively high blood lead testing percentages. In addition, municipalities with high proportions of confirmed EBLLs among children tested for BLLs were mainly located in counties with relatively high proportions of confirmed EBLLs, while a few municipalities with high proportions of confirmed EBLLs were sparsely located in counties with relatively low proportions of confirmed EBLLs. Finally, it is worth noting that municipalities with lower percentages of

children tested for BLLs were often associated with higher proportions of confirmed EBLLs throughout Pennsylvania.

The Pennsylvania Department of Health is committed to preventing lead exposure by coordinating with other state agencies to improve the health outcomes of children throughout the commonwealth. In August 2019, Governor Wolf launched the Lead-Free PA Initiative, which seeks to increase access to blood lead testing for children, increase local response efforts, and train more certified lead abatement professionals. The Department and other state agencies participate in an interagency workgroup to achieve the goals of the Lead-Free PA Initiative. In this report, we see a significant increasing trend in the percentage of children tested for BLLs in Pennsylvania, from 48.3% in the 2015 cohort to 55.4% in the 2018 cohort. Also, there is a significant decreasing trend in the percentage of children tested with confirmed EBLLs in Pennsylvania from 2.76% in the 2015 cohort to 1.74% in the 2018 cohort. These in part could contribute to the department's effort in reducing lead poisoning in Pennsylvania. This report is intended to provide information that is succinct, comprehensible, and accessible to the public. Although lead surveillance should be considered an ongoing process, the goal of the report is to provide meaningful, useful, and easy-to-access data to the commonwealth and its residents, so that the data can be better utilized for decision-making, resources allocation, and implementing initiatives aimed at preventing exposure to lead.

Definitions

Birth cohort	A birth cohort is defined in this report as all children born to Pennsylvania resident mothers during the calendar years (2017 and 2018)
Age	This is the age of the child at the time of the first blood lead test. Children under the age of one year are 0 to <12 months, and children under the age of two years are 0 to <24 months.
Capillary blood test	Capillary blood tests draw blood via a child's finger prick to test for the blood lead level.
Venous blood test	Venous blood tests draw blood from a child's vein to test for the blood lead level.
Blood lead level (BLL)	This is the numeric result of a blood lead test, expressed in micrograms per deciliter (µg/dL).
Confirmed elevated blood lead level (EBLL)	This is defined as having one venous blood lead test ≥5 µg/dL or the first capillary blood lead test ≥5 µg/dL with another follow-up blood lead test (capillary or venous) ≥5 µg/dL done within the next 84 days.
Percentage of children tested for BLLs	This percentage is calculated by dividing the number of children under the age of one or two years who had a BLL test by the total number of children under the age of one or two years, multiplied by 100.
Percentage of confirmed or unconfirmed EBLLs	This percentage is calculated by dividing the number of children under the age of two years with a confirmed or unconfirmed elevated BLL by the total number of children under the age of two years who had a BLL test, multiplied by 100.
Race	The race of children was classified into Hispanic, non-Hispanic white, non-Hispanic Black or African American, non-Hispanic Asian, or other (all other races, unknown, or missing).
Municipality	Municipality is a political subdivision of a state where a municipal corporation is established to provide general local government for a specific population concentration in a defined area.

Introduction

Lead poisoning is a preventable environmental health hazard and, if not addressed, affects families regardless of race, ethnicity, or socioeconomic status. In recent years, there has been a national reduction in children's BLLs as sources of lead exposure for children have been reduced or eliminated. The Department continues to provide resources to families to prevent and address EBLLs through multiple strategies. Through the federally funded Childhood Lead Poisoning Prevention Program (CLPPP), the Department works collaboratively with six local jurisdictions (Allegheny County, Chester County, Montgomery County, Wilkes Barre, Allentown, and city of York) to reduce lead exposure and promote childhood lead poisoning prevention. Specifically, local partners are utilizing CLPPP funding to implement strategies and activities to 1) increase blood lead testing; 2) strengthen population-based interventions; and 3) strengthen processes to identify lead-exposed children and link them to services. Additionally, the Department maintains a toll-free lead information hotline (1-800-440-LEAD) to provide information about lead poisoning prevention, testing, follow-up, and local resources for assistance.

In 2019, lead abatement efforts continued through the federally funded Lead Hazard Control Program (LHCP), which provided local partners with funding to contract with certified lead professionals. In addition, the Department worked with partners in targeted high-risk areas across the commonwealth to identify and remove lead hazards in housing units occupied by low-income families with children aged six and under. The goal of the LHCP is to protect Pennsylvania's children from the long-term effects of lead poisoning as well as evaluate the overall living conditions within the home to obtain healthier outcomes for Pennsylvania families.

The Department's community health nurses (CHNs) continue to monitor EBLLs in children aged six and under living in Pennsylvania. The Department's CHNs cover the counties and areas of the state not covered by the 10 county and municipal health departments (CMHDs). The CMHDs include six counties (Allegheny, Bucks, Chester, Erie, Montgomery, and Philadelphia) and four municipalities (Allentown, Bethlehem, Wilkes-Barre, and York City) that have their own health departments and have their own specific case management protocols. The Department's CHNs contact families to provide education on laboratory results, potential sources of lead exposure, and actions to take to prevent or decrease the risk of exposure and help facilitate follow-up testing between clients and their pediatricians. The CHNs encourage every family of children with levels of 5 µg/dL and above to discuss the potential need for an environmental investigation with their provider; CHNs work with the pediatrician and facilitate referrals to obtain home inspections, which could identify the source of exposure as well as provide hands-on education to parents. CHNs also work to provide referrals to WIC and early intervention programs where appropriate. In 2019, the Department also continued an ongoing collaboration with the Department of Human Services on a data match project to share data between the Medicaid claims database and the lead surveillance database. The data match will

lead to lead data with improved quality and better service provision for Medicaid-enrolled children.

The Department creates an annual surveillance report to 1) help childhood lead prevention programs and partners identify populations at risk for EBLLs, 2) ensure screening services are provided to groups with a high risk of lead poisoning, 3) inform outreach activities and educational materials for parents, educators, and health professionals, and 4) ensure environmental and medical follow-up is provided to children with EBLLs. However, all previous annual surveillance reports employ cross-sectional designs that use PA-NEDSS lead testing data along with estimated population numbers for children to produce blood lead testing rates and EBLL rates in a calendar year. This method often underestimates the actual blood lead testing rate and the proportion of EBLLs. This report improves upon the previous reports using a cohort analysis design by following children born to Pennsylvania mothers for the two years of life to determine their blood lead testing rates and the proportions of EBLLs among tested children.

Methods

Birth Cohort

In this report, only children born to Pennsylvania resident mothers in 2017 and 2018 were included in the analysis. A birth cohort is defined as children born to Pennsylvania resident mothers during a specific calendar year and who were followed up to their second birthday (birth up to 24 months). In this report, children born in the years of 2017 and 2018 were included in the 2017 birth cohort and the 2018 birth cohort, respectively. Information regarding two birth cohorts' maternal and infant demographic characteristics was downloaded and extracted from the birth certificate dataset.

Reporting of Blood Lead Test Results and Case Investigations

In Pennsylvania, clinical laboratories are required to report all blood lead test results from both venous and capillary specimens for persons under 16 years of age to the Pennsylvania Department of Health (28 Pa. Code § 27.34). In addition, clinicians are required to report cases of lead poisoning (28 Pa. Code § 27.21a). Most reports are submitted electronically (either through electronic laboratory reporting or online key entry) to the Department through Pennsylvania's electronic reportable disease surveillance system, PA-NEDSS. Reports with a BLL ≥5 µg/dL were assigned to public health investigators for follow-up based on the location of the patients' residence. Investigators reviewed, verified, and corrected, when necessary, critical pieces of information such as date of birth, address, and specimen source.

PA-NEDSS is designed to handle duplicate reports from different entities. Several strategies are used as part of disease surveillance strategies in PA-NEDSS to ensure that all reports pertaining to a single patient are assigned to a single patient identifier. For this report, blood lead tests with identical specimen collection dates and identical blood lead level results from the same child were considered as a single test. All blood lead testing records for children who had at least one blood lead test from 2017 to 2020, including those collected for screening, confirmation, or follow-up purposes, were included.

Case Definition

In May 2012, the Centers for Disease Control and Prevention (CDC) accepted the recommendation from the Advisory Committee on Lead Poisoning Prevention to eliminate the term "level of concern" (associated with the level of 10 µg/dL) and to begin using a reference value of 5 µg/dL based on the 97.5 percentile of the blood lead distribution among U.S. children. A new case definition was officially implemented by CDC in 2016 and is used in this report to identify children with a confirmed EBLL. A confirmed EBLL is defined as a venous blood lead test ≥5 µg/dL, or first capillary blood lead test ≥5 µg/dL with another blood lead test (capillary or venous) ≥5 µg/dL done within the next 84 days (12 weeks). An unconfirmed

elevated BLL is defined as a capillary blood lead test ≥5 µg/dL with no other blood lead test done in the next 84 days.

To apply the CDC case definition, a number of different data elements need to be evaluated. These data elements were handled as follows in our analyses:

- If the specimen collection date was missing or illogical, either the laboratory received date or result date was used instead. If all three dates were missing, the reported date was used.
- Specimens with unknown specimen sources or characterized as simply "blood" (as opposed to venous or capillary) were treated as if they were capillary specimens.
- If an elevated capillary test was obtained on a child near the end of a year or as the child neared the limit of a particular age category, and if another elevated test result was obtained within the next 84 days, the initial elevated test was considered to be confirmed, even if the confirmatory test occurred in the following year or outside of the age category. For example, if a child had an elevated capillary test at 23 months of age in November 2018 and received a confirmatory follow-up test within 12 weeks (in 2019), this was considered an elevated BLL result in 2018 for a child aged less than two years.

Linkage Process of Childhood Blood Lead Test Data and Birth Certificate Data

First, a deterministic linkage method was used to link children's maternal and infant demographic information data obtained from the birth certificate dataset to blood lead test records related to lead surveillance (PA-NEDSS) to form the 2017 and 2018 birth cohorts used in the analyses for this report. In this step, we extracted exactly matched record pairs if their *first name*, *last name*, *date of birth*, *gender*, and *residence zip code* were identical in both data files. A simple random sampling method was used to select a subset of potential matches after this linkage step for manual review and validation.

After the deterministic linkage step, a probabilistic linkage method was used to compare the remaining nonmatched blood lead test records with the nonmatched birth certificate data based on whether they agree or disagree on the selected identifiers (*first name*, *last name*, *date of birth*, *gender*, and *residence zip code*). We conducted probabilistic record linkages to assess the likelihood that record pairs are matches or nonmatches based on the calculation of linkage scores and the application of blocking and decision rules by using Match*Pro software. After probabilistic linkage, we conducted clerical review to manually assess those matched record pairs with lower linkage scores to check if they were true matches.

If blood lead test records did not successfully match any birth certificate data after two linkage processes, these records were assigned as "nonmatches". For a child whose multiple blood lead test records were linked to different records in the birth certificate dataset, we manually

reviewed these matched record pairs one by one and only retained one of them with optimal validity and reliability.

Statistical Methods

In the analyses of the percentage of children who received a blood lead test at different ages, birth cohorts were categorized into two groups: 1) age at blood lead test <1 year, and 2) age at blood lead test <2 years. A child's age when receiving a blood lead test was calculated as the time between birth date and blood lead testing date. In the analyses of the percentage of tested children who were found to have EBLLs, children who received a blood lead test by two years of age were categorized into two groups: 1) unconfirmed EBLLs, and 2) confirmed EBLLs. A child's EBLL confirmation status is defined in the Case Definition section.

In this report, descriptive analyses were conducted to explore how the percentages of children tested for BLLs by 12 or 24 months of age and the proportions of tested children with confirmed or unconfirmed EBLLs vary by maternal and infant demographics and by neighborhood characteristics among the 2017 birth cohort and the 2018 birth cohort separately. Demographic information on maternal and infant characteristics was obtained from the birth certificate dataset, supplied by the department's Bureau of Health Statistics and Registries and categorized as follows: gender (male or female), race (Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic white, or other), maternal educational attainment (< high school: less than high school graduate; high school/some college: high school graduates or had attended some college but had not received a college degree; ≥ college: college degree or higher; or other), principal source of payment for delivery (private insurance, Medicaid, self-payment, or other), maternal smoking (yes or no: mothers reported cigarette smoking or no cigarette smoking during the three months before pregnancy or during pregnancy; or unknown), WIC enrollment (yes or no: mothers participated or did not participate in WIC program; or unknown), maternal infection (yes or no: maternal infections, including gonorrhea, syphilis, herpes simplex virus, or chlamydia were or were not present or treated during pregnancy), and maternal risk factors (yes/no: mother had or did not have any risk factors, including pre-pregnancy diabetes, gestational diabetes, pre-pregnancy hypertension, gestational hypertension, previous pre-term birth, previous poor pregnancy outcomes, vaginal bleeding, pregnancy resulted from infertility treatment, or previous cesarean, during pregnancy).

Neighborhood characteristics data were extracted at the census tract level from the U.S. Census Bureau American Community Survey (ACS) 1-Year Estimates Data Profiles in 2017 and 2018. Neighborhood characteristics include median household income (household income), the percentage of families and people whose income in the past 12 months is below the poverty level (poverty), and the percentage of housing units built before 1970 (older housing). Census tracts were ranked based on the percentage of each neighborhood characteristic and assigned to a quartile for each characteristic, respectively. These neighborhood characteristic data were

linked to birth cohorts' birth certificate data based on each child's maternal residential address, geocoded using ArcGIS (ArcGIS Desktop: Release 10.4.1. Redlands, CA: Esri, 2016).

Moreover, descriptive analyses were conducted to explore how the percentage of children tested for BLLs and the proportion of confirmed EBLLs among tested children vary by county of residence in the 2017 birth cohort and the 2018 birth cohort separately. For each county, the Cochran-Armitage test was used to analyze trends in the precentage of children tested for BLLs and the proportion of confirmed EBLLs among tested children among birth cohorts born in 2015, 2016, 2017, and 2018. The precentage of children tested for BLLs and the proportion of confirmed EBLLs among tested children among birth cohorts born in 2015 and 2016 were estimated in the previous Childhood Lead Testing and Poisoning Report: Pennsylvania Birth Cohort Analysis.[5] A two-sided $p < 0.05$ was considered statistically significant. For the sub-county analyses, descriptive analyses were presented to explore how the percentage of children tested for BLLs and the proportion of confirmed EBLLs among tested children vary by the municipality of residence, where the total number of births in 2017−2018 was not less than 50. For the county and municipality analyses, geocoding information of each child's maternal residential address (longitude and latitude) reported in the birth certificate dataset was used to determine their county and municipality of residence. For some children who had missing or incomplete longitude and latitude information of maternal residential address, zip code centroid of maternal residential address was used to determine their county and municipality of residence. Finally, separate maps were used to display the geographic distribution of the percentage of children tested for BLLs and the proportion of confirmed EBLLs at the municipal level and county levels using ArcGIS.

Findings

Percentages of children tested for BLLs by maternal and infant demographics and neighborhood characteristics

Among 136,950 children born to Pennsylvania mothers in 2017, 72,628 children (53.0%) received a blood lead test before two years of age. The percentage of children tested for BLLs increased to 55.4% in the 2018 birth cohort. As shown in **Table 1** (page 19), there was an upward trend in the percentage of children tested for BLLs from the 2015 birth cohort (48.3%) to the 2018 birth cohort (55.4%).

Table 2 (page 20) provides the number and percentage of children who had a blood lead test in the 2017 birth cohort and 2018 birth cohort before the age of one or two years by maternal and infant demographics and neighborhood characteristics. There were no significant gender differences in the percentage of children tested for BLLs. We observed substantial racial disparities in the percentage of children tested for BLLs in each birth cohort. Non-Hispanic Black children had the highest percentage of children tested for BLLs (65.7% and 65.7% in the 2017 birth cohort and the 2018 birth cohort, respectively), while the lowest percentage was seen among non-Hispanic white children (48.3% and 51.6% in the 2017 birth cohort and the 2018 birth cohort, respectively). By maternal educational attainment, the lowest percentage of children tested for BLLs was observed among children whose maternal educational attainment was "< high school" (47.3% and 46.8% in the 2017 birth cohort and the 2018 birth cohort, respectively). In terms of the principal source of payment for delivery, the highest percentage of children tested for BLLs was observed among children whose principal source of payment for delivery was "Medicaid" (63.6% and 64.1% in the 2017 birth cohort and the 2018 birth cohort, respectively), while the lowest percentage was seen among children whose principal source of payment for delivery was "self-payment" (15.1% and 13.9% in the 2017 birth cohort and the 2018 birth cohort, respectively). The percentage of children tested for BLLs was higher for children with WIC enrollment (65.6% and 66.3% in the 2017 birth cohort and the 2018 birth cohort, respectively) than among those without WIC enrollment (46.5% and 50.2% in the 2017 birth cohort and the 2018 birth cohort, respectively). In addition, we observed higher percentages of children tested for BLLs among children whose mothers reported cigarette smoking either during the three months before pregnancy or during pregnancy and among children whose mothers had at least one infection during pregnancy.

The percentage of children tested for BLLs varied significantly with respect to their neighborhood characteristics. Children who lived in neighborhoods of lower quartiles of household income, higher quartiles of poverty, and higher quartiles of old housing had higher percentages of blood lead testing.

Percentages of EBLLs among children tested for BLLs by maternal and infant demographics and neighborhood characteristics

Among the 72,628 Pennsylvania children tested for BLLs before the age of two years in the 2017 birth cohort, 1,583 children (2.18%) had confirmed EBLLs. The percentage of confirmed EBLLs among children tested for BLLs decreased to 1.74% in the 2018 birth cohort. As shown in **Table 1** (page 19), there was a decreasing trend in the percentage of EBLLs among tested children from the 2015 birth cohort (2.76%) to the 2018 birth cohort (1.74%).

Table 3 (page 22) provides the number and percentage of unconfirmed or confirmed EBLLs among children tested for BLLs before the age of two years by maternal and infant demographics and by neighborhood characteristics for each birth cohort. Male children tested for BLLs had a higher percentage of confirmed EBLLs (2.22% and 1.78% in the 2017 birth cohort and the 2018 birth cohort, respectively) than female children (2.14% and 1.70% in the 2017 birth cohort and the 2018 birth cohort, respectively). We observed significant racial disparities in the percentage of confirmed EBLLs among children tested for BLLs in each birth cohort. Non-Hispanic Black children tested for BLLs had the highest percentage of confirmed EBLLs (3.46% and 2.52% in the 2017 birth cohort and the 2018 birth cohort, respectively), while the lowest percentage of confirmed EBLLs was seen among non-Hispanic white children (1.70% and 1.44% in the 2017 birth cohort and the 2018 birth cohort, respectively). By maternal educational attainment, the highest percentage of confirmed EBLLs among children tested for BLLs was observed among children whose maternal educational attainment was "< high school" (3.94% and 2.94% in the 2017 birth cohort and the 2018 birth cohort, respectively), while the lowest percentage of confirmed EBLLs was seen among children whose maternal educational attainment was "≥ college" (1.32% and 1.06% in the 2017 birth cohort and the 2018 birth cohort, respectively). Children born to mothers whose principal source of payment for delivery was "self-payment" had the highest percentage of confirmed EBLLs (3.41% and 4.35% in the 2017 birth cohort and the 2018 birth cohort, respectively), while the lowest percentage was observed among children born to mothers whose principal source of payment for delivery was "private insurance" (1.52% and 1.18% in the 2017 birth cohort and the 2018 birth cohort, respectively). The percentage of confirmed EBLLs among children tested for BLLs was higher among children with WIC enrollment (2.73% and 2.17% in the 2017 birth cohort and the 2018 birth cohort, respectively) than those without WIC enrollment (1.75% and 1.46% in the 2017 birth cohort and the 2018 birth cohort, respectively). Additionally, we observed relatively high percentages of confirmed EBLLs among children whose mothers reported cigarette smoking either during the three months before pregnancy or during pregnancy and among children whose mothers had at least one infection during pregnancy.

The percentage of confirmed EBLLs among children tested for BLLs varied significantly with respect to their neighborhood characteristics. Children who lived in neighborhoods of lower quartiles of household income, higher quartiles of poverty, and higher quartiles of old housing had higher percentages of having confirmed EBLLs.

Percentages of children tested for BLLs and percentages of EBLLs among children tested for BLLs by county/municipality

Table 4 (page 24) provides the number and percentage of children tested for BLLs in the 2017 birth cohort and 2018 birth cohort before the age of one or two years by county of residence. We observed that percentages of children tested for BLLs varied significantly across different counties in Pennsylvania: ranging from 26.5% in Cumberland County to 83.3% in Cameron County in the 2017 birth cohort and from 29.0% in Susquehanna County to 84.9% in Armstrong County in the 2018 birth cohort. **Table 5** (page 26) shows that there was substantial variation in percentages of confirmed EBLLs among children tested for BLLs across different counties, ranging from 0% in Tioga County to 11.43% in Cameron County in the 2017 birth cohort and from 0% in Tioga, Fayette, Centre, Beaver, and Monroe counties to 5.43% in Cameron County in the 2018 birth cohort.

Table 6 (page 28) summarizes temporal trends in the percentage of children tested for BLLs before two years of age across 2015−2018 birth cohorts in each county. Among 67 counties, there were 52 counties that had increasing trends in the percentage of children tested for BLLs across 2015−2018 birth cohorts, and 40 counties had statististically significant upward trends. Meanwhile, Mifflin county had a statististically significant decreasing trend in the percentage of children tested for BLLs across 2015−2018 birth cohorts. **Table 7** (page 30) summarizes temporal trends in the percentage of confirmed EBLLs among children tested for BLLs across 2015−2018 birth cohorts in each county. Among 67 counties, there were 44 counties that had declining trends in the percentage of confirmed EBLLs among tested children across 2015−2018 birth cohorts, and 15 counties had statististically significant decreasing trends.

Consistently lower percentages of children tested for BLLs were observed in some counties such as Cumberland, Susquehanna, Snyder, Monroe, Lancaster, Union, Wyoming, and Columbia counties in each birth cohort as compared to the rest of Pennsylvania [**Figure 1.1** (page 32) and **Figure 1.2** (page 33)]. Meanwhile, consistently higher percentages of confirmed EBLLs among children tested for BLLs were observed in some counties such as Berks, Clarion, Venango, Northumberland, and Lancaster counties in each birth cohort as compared to the rest of Pennsylvania [**Figure 2.1** (page 34) and **Figure 2.2** (page 35)]. A few counties not only had relatively low percentages of children tested for BLLs, but also had higher percentages of confirmed EBLLs as follows: for the 2017 birth cohort, Lancaster, Lebanon, Juniata, and Venango counties; for the 2018 birth cohort, Union, Lancaster, Wyoming, and Columbia counties.

Figure 3 (page 36) showed the percentage of children tested for BLLs in municipalities with a total number of births of 50 or greater during 2017 through 2018. We observed that certain municipalities which had disproportionately low percentages of children tested for BLLs, shaded in the lighter green color on the map on page 36, were mainly concentrated in counties also with relatively low percentages of children tested for BLLs such as Lancaster, Cumberland, and Monroe counties. However, a few of these municipalities with low testing rates were scattered across counties with relatively high percentages of children tested for BLLs such as Somerset, Indiana, and Huntingdon counties. As seen in **Figure 4** (page 37), municipalities with relatively high proportions of confirmed EBLLs among children tested for BLLs were not evenly distributed

throughout Pennsylvania. The majority of municipalities with relatively high proportions of confirmed EBLLs, shaded in the darker red color on the map on page 37, were mostly concentrated in counties with relatively high proportions of confirmed EBLLs such as Lancaster and Berks counties. However, a few of these municipalities with high proportions of confirmed EBLLs were found in some counties with relatively low proportions of confirmed EBLLs such as Centre, Bedford, and Erie counties.

Discussion

This cohort analysis includes children born in 2017 and 2018 and followed up to their second birthday, using birth certificate data linked to blood lead test data and neighborhood characteristics data. This method enables the department to more accurately estimate the rate of childhood lead testing and the proportion of tested children with EBLLs by maternal and infant demographics and neighborhood characteristics. As compared to the percentage of children tested for BLLs (approximately 33.2%) under two years of age estimated in the previous annual report using the cross-sectional study design that reported on a calendar year,[1] the percentage of children under two years of age tested for BLLs is approximately 53.0% in the 2017 birth cohort and 55.4% in the 2018 birth cohort, calculated using the cohort study design in this report. In addition, an increasing trend in the percentage of children tested for BLLs and a declining trend in the percentage of confirmed EBLLs among tested children are observed across 2015−2018 Pennsylvania birth cohorts. In the previous 2015 and 2016 birth cohorts blood lead analysis report,[5] deterministic linkage method was only used to link birth certificate data to blood lead test data, while both deterministic and probabilistic linkage methods were used to improve the match process in this report.

High percentages of confirmed EBLLs among children in a population group with specific characteristics or in one geographic area may reflect a true increased risk of lead exposure in that specific group of children and in that area, or it may reflect more robust and targeted testing in that specific group of children and in that area. The burden of childhood EBLLs is best understood through a series of metrics: the percentage of children tested for BLLs, the percentage of children who appropriately receive follow-up testing within the recommended time period among those with an elevated capilllary test, and the percentage of confirmed EBLLs among children tested for BLLs. This cohort analysis details numbers and percentages of children tested for BLLs before the age of one or two year(s) and confirmed EBLLs among tested children by maternal and infant demographics and by neighborhood characteristics, as well as by county/municipality of residence.

An important implication of the report is that selected maternal and infant demographics, as well as in neighborhood characteristics, are associated with disparities in undertesting of childhood BLLs and with relatively high percentages of EBLLs. Results from the percentage of children tested for BLLs should be evaluated along with the proportion of tested children with EBLLs to guide targeted primary prevention efforts. Maternal and infant demographics combined with neighborhood characteristics provide even more specific information for targeted efforts. In addition, looking more closely at geographic variability in the percentage of children tested for BLLs and the proportion of tested children with confirmed EBLLs simultaneously, particularly at a fine spatial scale such as municipal level, provides the state and local health departments with the opportunity to efficiently evaluate health care provider practices in specific geographic areas. These more granular data can guide provider decisions on priorities regarding which children should receive a follow-up test within the recommended time period and treatment if necessary.

An emerging issue is the increasing use of point-of-care testing devices for blood lead screening. A growing number of clinical practices are able to do capillary screening tests for children on-site. These providers are often unaccustomed to reporting results to the Department and may be unaware of reporting requirements. This could adversely affect the number of screening test results counted and skew the proportion of children screened downwards. The Department is working with many clinics using point-of-care testing devices to ensure that blood test results are reported correctly. Furthermore, some point-of-care analyzers have been found to give falsely low BLL results when used to analyze venous blood. These devices should be used only on capillary specimens, but the Department generally does not know the type of equipment used to perform blood lead tests and cannot control for this source of uncertainty. The impact of this issue cannot be assessed, as the type of testing device used is not captured in the PA-NEDSS surveillance datasets. In addition, earlier this year, the CDC released a Morbidity and Mortality Weekly Report showing that many children have missed blood lead testing during the COVID-19 pandemic during the first 5 months of 2020.[6] In this report, some children born in 2018 may have missed lead testing due in their second year (2020) as a result of the pandemic and issues such as provider and laboratory office closings and parents' reluctance to risk exposure to COVID-19. Given these potential COVID-related postponements and gaps in lead testing in 2020, the rate of blood lead testing for the 2018 birth cohort may have been underestimated. Nevertheless, the overall blood lead testing rate still increased among the 2018 birth cohort.

In addition, this report has several limitations. First, blood lead test data that were not successfully linked to birth certificate data due to inaccurate and incomplete information on identifiers would underestimate the blood lead screening rate. Also, some children born to Pennsylvania resident mothers and who moved out of state before receiving blood lead testing were not included in this analysis. The inherent limitation of accuracy errors in deterministic and probabilistic linkage methods would also introduce bias into analyses, even though the manual review has been employed to check the matched record pairs to minimize these errors. Finally, because Pennsylvania does not currently have a statewide universal lead testing mandate for young children, it is important to note that the results presented in this report should be interpreted with knowledge of local lead testing related policies.

Table 1. Percentage of Children Tested for BLLs Before Two Years of Age and Percentage of Confirmed EBLLs among Tested Children by Birth Cohort, 2015–2018

	Birth Cohort			
	2015	2016	2017	2018
Percentage of children tested for BLLs (%)	48.3	49.0	53.0	55.4
Percentage of confirmed EBLLs among tested children (%)	2.76	2.52	2.18	1.74

Abbreviation: BLLs, blood lead levels. EBLLs, elevated blood lead levels.

Note: The percentage of children tested for BLLs and the percentage of confirmed EBLLs among tested children for the 2015 and 2016 birth cohorts were calculated in the previous Childhood Lead Testing and Poisoning Report: Pennsylvania Birth Cohort Analysis.[5]

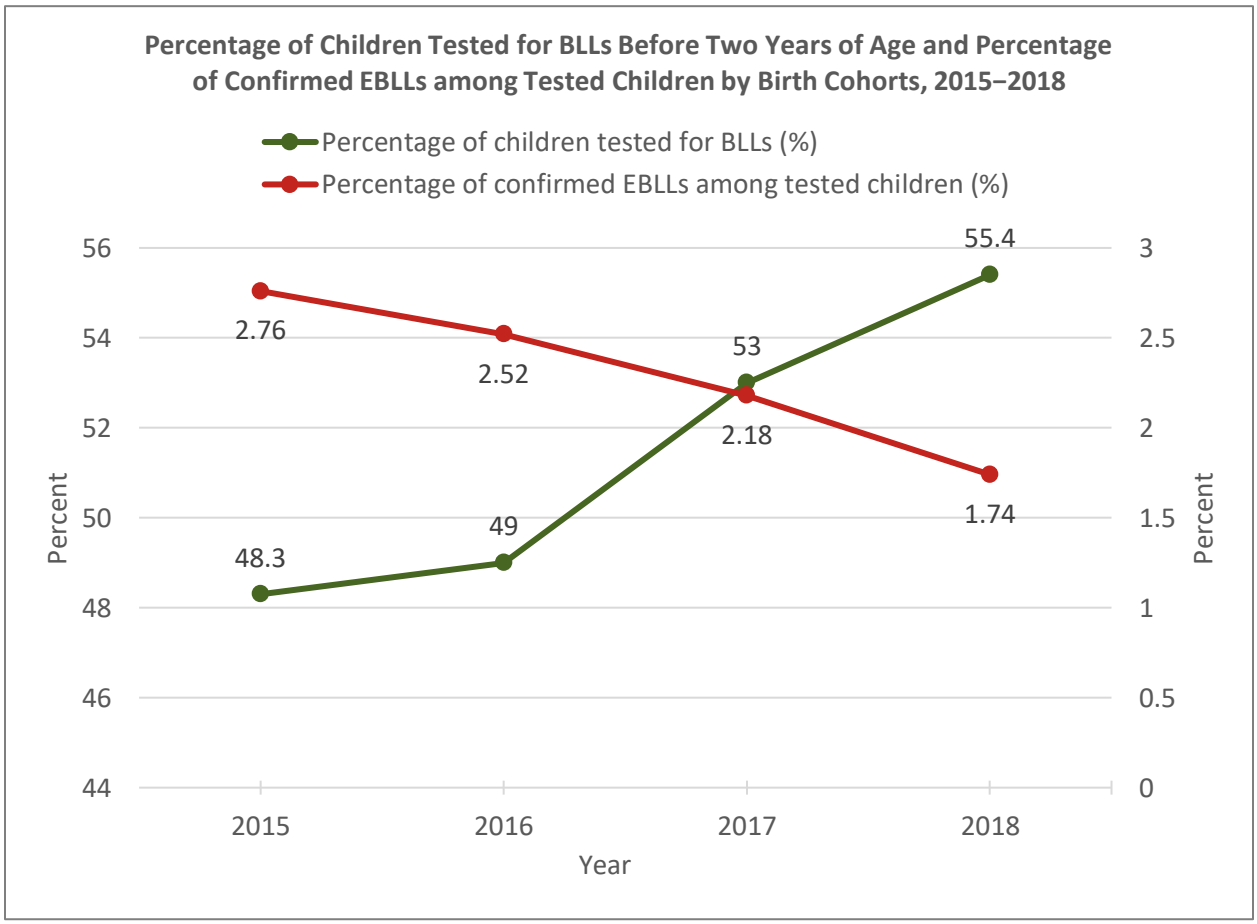


Table 2. Number and Percentage of Children Tested for BLLs Before Two Years of Age by Maternal and Infant Demographics and Neighborhood Characteristics, 2017 and 2018 Birth Cohorts

	2017 Birth Cohort					2018 Birth Cohort				
	Total	BLL Test <1 yr		BLL Test <2 yrs		Total	BLL Test <1 yr		BLL Test <2 yrs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Sex										
Female	66700	20856	31.3	35181	52.7	65617	21857	33.3	36336	55.4
Male	70249	22164	31.6	37447	53.3	69408	23080	33.3	38467	55.4
Race										
Hispanic	15839	5054	31.9	9954	62.8	15839	5185	32.7	10013	63.2
Non-Hispanic Asian	5262	1667	31.7	2929	55.7	5075	1629	32.1	2837	55.9
Non-Hispanic Black	18049	6256	34.7	11862	65.7	17439	6371	36.5	11449	65.7
Non-Hispanic white	90248	27509	30.5	43595	48.3	88967	29059	32.7	45915	51.6
Other[c]	7552	2534	33.6	4288	56.8	7706	2693	34.9	4589	59.6
Maternal educational attainment										
<High school	16422	4180	25.5	7774	47.3	16001	4158	26.0	7495	46.8
High school/some college	58524	19584	33.5	33672	57.5	56791	19922	35.1	33638	59.2
≥College	61033	18981	31.1	30696	50.3	60990	20492	33.6	33005	54.1
Other[d]	971	275	28.3	486	50.1	1244	365	29.3	665	53.5
Payment source for delivery										
Private insurance	77466	23602	30.5	38674	49.9	75541	25142	33.3	40693	53.9
Medicaid	45730	16498	36.1	29088	63.6	45675	16955	37.1	29259	64.1
Self-payment	6205	510	8.2	939	15.1	6104	453	7.4	850	13.9
Other[e]	7549	2410	31.9	3927	52.0	7706	2387	31.0	4001	51.9
WIC enrollment										
Yes	46020	17413	37.8	30175	65.6	43238	16920	39.1	28648	66.3
No	87709	24686	28.1	40822	46.5	88300	26986	30.6	44340	50.2
Unknown	3221	921	28.6	1631	50.6	3488	1031	29.6	1815	52.0
Maternal smoking										
Yes	20798	6997	33.6	11748	56.5	18858	6624	35.1	10959	58.1
No	114203	35349	31.0	59726	52.3	114291	37679	33.0	62745	54.9
Unknown	1894	654	34.5	1117	59.0	1869	629	33.7	1093	58.5
Maternal infection										
Yes	8474	2893	34.1	5060	59.7	9118	3317	36.4	5699	62.5
No	128476	40127	31.2	67568	52.6	125908	41620	33.1	69104	54.9
Maternal risk factor										
Yes	51811	15857	30.6	27316	52.7	53824	17578	32.7	29855	55.5
No	85139	27163	31.9	45312	53.2	81202	27359	33.7	44948	55.4

	2017 Birth Cohort					2018 Birth Cohort				
	Total	BLL Test <1 yr		BLL Test <2 yrs		Total	BLL Test <1 yr		BLL Test <2 yrs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Neighborhood characteristics										
Household income quartile	35820	12999	36.3	23598	65.9	34300	12909	37.6	22636	66.0
1st	31424	10852	34.5	17405	55.4	31643	11638	36.8	18342	58.0
2nd	33927	9594	28.3	15944	47.0	33250	10020	30.1	16885	50.8
3rd	32828	9541	29.1	15626	47.6	32726	10355	31.6	16909	51.7
4th										
Poverty quartile	29851	9265	31.0	14872	49.8	29919	9688	32.4	15551	52.0
1st	33061	9362	28.3	15483	46.8	32641	10387	31.8	16909	51.8
2nd	32703	10546	32.2	17057	52.2	31902	11027	34.6	17765	55.7
3rd	38392	13816	36.0	25172	65.6	37460	13822	36.9	24549	65.5
4th										
Old housing quartile	35754	8506	23.8	14482	40.5	35282	9291	26.3	15820	44.8
1st	31283	9476	30.3	15411	49.3	31026	10092	32.5	16299	52.5
2nd	31338	11101	35.4	18717	59.7	31019	11609	37.4	19391	62.5
3rd	35641	13908	39.0	23976	67.3	34601	13933	40.3	23265	67.2
4th	35820	12999	36.3	23598	65.9	34300	12909	37.6	22636	66.0

Abbreviation: BLL, blood lead level.

[a]The total number of children born in 2017 and 2018 by maternal and infant demographics and neighborhood characteristics.

[b]The percentage of children born in 2017 and 2018 with a blood lead test by the age of one or two year(s) by maternal and infant demographics and neighborhood characteristics.

[c]Other race includes all other races, unknown or missing race.

[d]Other maternal educational attainment includes unknown or missing maternal educational attainment.

[e]Other principal source of payment for delivery includes unknown or missing principal source of payment for delivery.

Table 3. Number and Percentage of EBLLs among Children Tested for BLLs Before Two Years of Age by Maternal and Infant Demographics and Neighborhood Characteristics, 2017 and 2018 Birth Cohorts

	2017 Birth Cohort					2018 Birth Cohort				
	Tested Children	Unconfirmed EBLLs		Confirmed EBLLs		Tested Children	Unconfirmed EBLLs		Confirmed EBLLs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Sex										
Female	35181	403	1.15	753	2.14	36336	343	0.94	617	1.70
Male	37447	429	1.15	830	2.22	38467	393	1.02	683	1.78
Race										
Hispanic	9954	126	1.27	255	2.56	10013	129	1.29	212	2.12
Non-Hispanic Asian	2929	42	1.43	80	2.73	2837	45	1.59	65	2.29
Non-Hispanic Black	11862	150	1.26	411	3.46	11449	119	1.04	288	2.52
Non-Hispanic white	43595	491	1.13	742	1.70	45915	425	0.93	661	1.44
Other[c]	4288	23	0.54	95	2.22	4589	18	0.39	74	1.61
Maternal educational attainment										
<High school	7774	156	2.01	306	3.94	7495	140	1.87	220	2.94
High school/some college	33672	490	1.46	850	2.52	33638	428	1.27	719	2.14
≥College	30696	182	0.59	406	1.32	33005	162	0.49	350	1.06
Other[d]	486	4	0.82	21	4.32	665	6	0.90	11	1.65
Payment source for delivery										
Private insurance	38674	288	0.74	588	1.52	40693	287	0.71	481	1.18
Medicaid	29088	455	1.56	867	2.98	29259	400	1.37	702	2.40
Self-payment	939	18	1.92	32	3.41	850	13	1.53	37	4.35
Other[e]	3927	71	1.81	96	2.44	4001	36	0.90	80	2.00
WIC enrollment										
Yes	30175	475	1.57	823	2.73	28648	359	1.25	621	2.17
No	40822	346	0.85	715	1.75	44340	357	0.81	648	1.46
Unknown	1631	11	0.67	45	2.76	1815	20	1.10	31	1.71
Maternal smoking										
Yes	11748	240	2.04	297	2.53	10959	191	1.74	230	2.10
No	59726	580	0.97	1257	2.10	62745	536	0.85	1047	1.67
Unknown	1117	12	1.07	29	2.60	1093	9	0.82	23	2.10
Maternal infection										
Yes	5060	73	1.44	141	2.79	5699	76	1.33	130	2.28
No	67568	759	1.12	1442	2.13	69104	660	0.96	1170	1.69
Maternal risk factor										
Yes	27316	308	1.13	617	2.26	29855	297	0.99	525	1.76
No	45312	524	1.16	966	2.13	44948	439	0.98	775	1.72

	2017 Birth Cohort					2018 Birth Cohort				
	Tested Children	Unconfirmed EBLLs		Confirmed EBLLs		Tested Children	Unconfirmed EBLLs		Confirmed EBLLs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Neighborhood characteristics										
Household income quartile	23598	416	1.76	860	3.64	22636	352	1.56	662	2.92
1st	17405	202	1.16	327	1.88	18342	180	0.98	302	1.65
2nd	15944	149	0.93	251	1.57	16885	140	0.83	208	1.23
3rd	15626	65	0.42	144	0.92	16909	63	0.37	127	0.75
4th										
Poverty quartile	14872	79	0.53	160	1.08	15551	76	0.49	124	0.80
1st	15483	123	0.79	225	1.45	16909	132	0.78	209	1.24
2nd	17057	204	1.20	337	1.98	17765	176	0.99	300	1.69
3rd	25172	426	1.69	861	3.42	24549	351	1.43	666	2.71
4th										
Old housing quartile	14482	81	0.56	163	1.13	15820	76	0.48	142	0.90
1st	15411	119	0.77	213	1.38	16299	147	0.90	195	1.20
2nd	18717	249	1.33	424	2.27	19391	221	1.14	340	1.75
3rd	23976	383	1.60	783	3.27	23265	291	1.25	622	2.67
4th	23598	416	1.76	860	3.64	22636	352	1.56	662	2.92

Abbreviation: EBLLs, elevated blood lead levels.

[a]The total number of children born in 2017 and 2018 with a blood lead test by the age of two years by maternal and infant demographics and neighborhood characteristics.

[b]The percentage of tested children under the age of two years who had unconfirmed or confirmed EBLLs by maternal and infant demographics and neighborhood characteristics.

[c]Other race includes all other races, unknown or missing race.

[d]Other maternal educational attainment includes unknown or missing maternal educational attainment.

[e]Other principal source of payment for delivery includes unknown or missing principal source of payment for delivery.

Table 4. Number and Percentage of Children Tested for BLLs Before Two Years of Age by County of Residence, 2017 and 2018 Birth Cohorts

	2017 Birth Cohort					2018 Birth Cohort				
	Total	BLL Test <1 yr		BLL Test <2 yrs		Total	BLL Test <1 yr		BLL Test <2 yrs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
County										
Adams	939	405	43.1	507	54.0	855	468	54.7	594	69.5
Allegheny	12907	6407	49.6	9433	73.1	12835	7407	57.7	9720	75.7
Armstrong	626	446	71.2	510	81.5	558	416	74.6	474	84.9
Beaver	1551	694	44.7	868	56.0	1568	641	40.9	822	52.4
Bedford	426	217	50.9	294	69.0	424	239	56.4	297	70.0
Berks	4716	432	9.2	1953	41.4	4592	397	8.6	2239	48.8
Blair	1201	507	42.2	737	61.4	1210	537	44.4	718	59.3
Bradford	556	108	19.4	278	50.0	542	87	16.1	355	65.5
Bucks	4876	1093	22.4	1833	37.6	4796	936	19.5	1671	34.8
Butler	1728	985	57.0	1172	67.8	1779	1186	66.7	1352	76.0
Cambria	1264	594	47.0	825	65.3	1203	742	61.7	889	73.9
Cameron	42	5	11.9	35	83.3	37	4	10.8	23	62.2
Carbon	580	168	29.0	251	43.3	543	187	34.4	259	47.7
Centre	1165	515	44.2	569	48.8	1169	464	39.7	503	43.0
Chester	5099	1792	35.1	2436	47.8	5142	1857	36.1	2549	49.6
Clarion	390	123	31.5	177	45.4	368	141	38.3	178	48.4
Clearfield	749	349	46.6	462	61.7	695	332	47.8	418	60.1
Clinton	391	136	34.8	194	49.6	417	128	30.7	209	50.1
Columbia	530	92	17.4	182	34.3	523	91	17.4	200	38.2
Crawford	941	310	32.9	395	42.0	905	281	31.0	377	41.7
Cumberland	2599	215	8.3	689	26.5	2584	334	12.9	861	33.3
Dauphin	3392	564	16.6	1321	38.9	3385	764	22.6	1619	47.8
Delaware	6450	2394	37.1	4015	62.2	6332	2321	36.7	3938	62.2
Elk	272	83	30.5	131	48.2	262	75	28.6	133	50.8
Erie	2986	1143	38.3	1840	61.6	2764	1126	40.7	1777	64.3
Fayette	1126	358	31.8	571	50.7	1143	387	33.9	584	51.1
Forest	23	8	34.8	11	47.8	19	6	31.6	8	42.1
Franklin	1604	124	7.7	688	42.9	1576	90	5.7	903	57.3
Fulton	121	34	28.1	63	52.1	117	15	12.8	64	54.7
Greene	259	43	16.6	192	74.1	203	22	10.8	153	75.4
Huntingdon	374	182	48.7	236	63.1	417	193	46.3	245	58.8
Indiana	769	339	44.1	415	54.0	807	391	48.5	523	64.8
Jefferson	476	136	28.6	211	44.3	478	160	33.5	234	49.0
Juniata	278	89	32.0	112	40.3	292	99	33.9	140	47.9
Lackawanna	2058	582	28.3	864	42.0	2015	602	29.9	921	45.7
Lancaster	7204	863	12.0	2293	31.8	6931	849	12.2	2250	32.5
Lawrence	871	350	40.2	458	52.6	839	391	46.6	494	58.9

	2017 Birth Cohort					2018 Birth Cohort				
	Total	BLL Test <1 yr		BLL Test <2 yrs		Total	BLL Test <1 yr		BLL Test <2 yrs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Lebanon	1591	107	6.7	608	38.2	1551	113	7.3	645	41.6
Lehigh	4250	1024	24.1	1883	44.3	4355	1123	25.8	2093	48.1
Luzerne	3269	1130	34.6	1787	54.7	3301	1173	35.5	1899	57.5
Lycoming	1166	357	30.6	622	53.3	1206	294	24.4	581	48.2
McKean	309	142	46.0	241	78.0	292	156	53.4	243	83.2
Mercer	1056	442	41.9	545	51.6	1037	461	44.5	535	51.6
Mifflin	588	159	27.0	249	42.3	609	170	27.9	253	41.5
Monroe	1445	174	12.0	451	31.2	1458	263	18.0	514	35.3
Montgomery	8628	2637	30.6	4537	52.6	8494	2891	34.0	4628	54.5
Montour	209	13	6.2	86	41.1	195	10	5.1	80	41.0
Northampton	2725	264	9.7	982	36.0	2803	373	13.3	1148	41.0
Northumberland	932	257	27.6	498	53.4	894	235	26.3	481	53.8
Perry	519	140	27.0	197	38.0	506	142	28.1	207	40.9
Philadelphia	21073	8442	40.1	15450	73.3	20447	7879	38.5	15015	73.4
Pike	282	100	35.5	143	50.7	277	86	31.0	120	43.3
Potter	135	11	8.1	111	82.2	125	12	9.6	101	80.8
Schuylkill	1321	726	55.0	854	64.6	1273	707	55.5	879	69.0
Snyder	448	84	18.8	136	30.4	432	91	21.1	146	33.8
Somerset	642	291	45.3	391	60.9	697	409	58.7	480	68.9
Sullivan	47	15	31.9	24	51.1	41	5	12.2	18	43.9
Susquehanna	267	33	12.4	74	27.7	283	36	12.7	82	29.0
Tioga	288	25	8.7	121	42.0	258	24	9.3	90	34.9
Union	401	73	18.2	132	32.9	401	75	18.7	124	30.9
Venango	476	152	31.9	193	40.5	470	174	37.0	221	47.0
Warren	379	167	44.1	190	50.1	352	195	55.4	224	63.6
Washington	1877	688	36.7	1121	59.7	1964	891	45.4	1360	69.2
Wayne	372	123	33.1	172	46.2	376	160	42.6	203	54.0
Westmoreland	3001	1481	49.4	1854	61.8	2901	1448	49.9	1737	59.9
Wyoming	288	39	13.5	96	33.3	237	34	14.3	87	36.7
York	4589	839	18.3	1659	36.2	4419	941	21.3	1915	43.3
All counties	134112	43020	32.1	72628	54.2	131979	44937	34.0	74803	56.7

Abbreviation: BLL, blood lead level.

[a]The total number of children born in 2017 and 2018 by county of residence.

[b]The percentage of children born in 2017 and 2018 with a blood lead test by the age of one or two year(s) by county of residence.

Table 5. Number and Percentage of EBLLs among Children Tested for BLLs Before Two Years of Age by County of Residence, 2017 and 2018 Birth Cohorts

	2017 Birth Cohort					2018 Birth Cohort				
	Tested Children	Unconfirmed EBLLs		Confirmed EBLLs		Tested Children	Unconfirmed EBLLs		Confirmed EBLLs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
County										
Adams	507	3	0.59	10	1.97	594	3	0.51	3	0.51
Allegheny	9433	111	1.18	146	1.55	9720	91	0.94	120	1.23
Armstrong	510	6	1.18	9	1.76	474	2	0.42	4	0.84
Beaver	868	16	1.84	5	0.58	822	10	1.22	10	1.22
Bedford	294	2	0.68	5	1.70	297	1	0.34	3	1.01
Berks	1953	47	2.41	105	5.38	2239	87	3.89	83	3.71
Blair	737	11	1.49	15	2.04	718	9	1.25	21	2.92
Bradford	278	2	0.72	8	2.88	355	4	1.13	12	3.38
Bucks	1833	5	0.27	17	0.93	1671	3	0.18	11	0.66
Butler	1172	11	0.94	9	0.77	1352	14	1.04	15	1.11
Cambria	825	36	4.36	7	0.85	889	17	1.91	16	1.80
Cameron	35	0	0.00	4	11.43	23	1	4.35	0	0.00
Carbon	251	6	2.39	8	3.19	259	3	1.16	5	1.93
Centre	569	6	1.05	3	0.53	503	0	0.00	1	0.20
Chester	2436	19	0.78	20	0.82	2549	16	0.63	19	0.75
Clarion	177	1	0.56	9	5.08	178	3	1.69	5	2.81
Clearfield	462	6	1.30	5	1.08	418	0	0.00	4	0.96
Clinton	194	2	1.03	5	2.58	209	1	0.48	4	1.91
Columbia	182	2	1.10	3	1.65	200	0	0.00	10	5.00
Crawford	395	14	3.54	8	2.03	377	6	1.59	6	1.59
Cumberland	689	4	0.58	11	1.60	861	12	1.39	13	1.51
Dauphin	1321	17	1.29	32	2.42	1619	16	0.99	26	1.61
Delaware	4015	28	0.70	54	1.34	3938	25	0.63	33	0.84
Elk	131	1	0.76	2	1.53	133	1	0.75	3	2.26
Erie	1840	45	2.45	32	1.74	1777	23	1.29	28	1.58
Fayette	571	1	0.18	3	0.53	584	5	0.86	6	1.03
Forest	11	0	0.00	1	9.09	8	0	0.00	0	0.00
Franklin	688	11	1.60	15	2.18	903	16	1.77	9	1.00
Fulton	63	0	0.00	3	4.76	64	1	1.56	1	1.56
Greene	192	1	0.52	3	1.56	153	0	0.00	6	3.92
Huntingdon	236	0	0.00	4	1.69	245	2	0.82	5	2.04
Indiana	415	7	1.69	7	1.69	523	7	1.34	7	1.34
Jefferson	211	3	1.42	3	1.42	234	4	1.71	8	3.42
Juniata	112	1	0.89	8	7.14	140	1	0.71	4	2.86
Lackawanna	864	22	2.55	24	2.78	921	5	0.54	21	2.28
Lancaster	2293	17	0.74	91	3.97	2250	18	0.80	79	3.51
Lawrence	458	5	1.09	8	1.75	494	3	0.61	10	2.02

	2017 Birth Cohort					2018 Birth Cohort				
	Tested Children	Unconfirmed EBLLs		Confirmed EBLLs		Tested Children	Unconfirmed EBLLs		Confirmed EBLLs	
	N[a]	N	%[b]	N	%[b]	N[a]	N	%[b]	N	%[b]
Lebanon	608	11	1.81	22	3.62	645	8	1.24	12	1.86
Lehigh	1883	29	1.54	34	1.81	2093	42	2.01	27	1.29
Luzerne	1787	37	2.07	35	1.96	1899	35	1.84	41	2.16
Lycoming	622	4	0.64	17	2.73	581	2	0.34	20	3.44
McKean	241	7	2.90	4	1.66	243	1	0.41	5	2.06
Mercer	545	11	2.02	9	1.65	535	7	1.31	9	1.68
Mifflin	249	1	0.40	7	2.81	253	0	0.00	3	1.19
Monroe	451	2	0.44	3	0.67	514	0	0.00	4	0.78
Montgomery	4537	21	0.46	74	1.63	4628	15	0.32	50	1.08
Montour	86	1	1.16	1	1.16	80	1	1.25	1	1.25
Northampton	982	18	1.83	18	1.83	1148	14	1.22	19	1.66
Northumberland	498	5	1.00	21	4.22	481	6	1.25	17	3.53
Perry	197	3	1.52	5	2.54	207	8	3.86	1	0.48
Philadelphia	15450	121	0.78	493	3.19	15015	95	0.63	370	2.46
Pike	143	0	0.00	2	1.40	120	0	0.00	1	0.83
Potter	111	0	0.00	1	0.90	101	0	0.00	0	0.00
Schuylkill	854	26	3.04	26	3.04	879	23	2.62	17	1.93
Snyder	136	3	2.21	1	0.74	146	2	1.37	2	1.37
Somerset	391	4	1.02	9	2.30	480	3	0.63	6	1.25
Sullivan	24	0	0.00	2	8.33	18	1	5.56	0	0.00
Susquehanna	74	0	0.00	1	1.35	82	1	1.22	1	1.22
Tioga	121	2	1.65	0	0.00	90	0	0.00	0	0.00
Union	132	1	0.76	3	2.27	124	0	0.00	3	2.42
Venango	193	3	1.55	9	4.66	221	6	2.71	12	5.43
Warren	190	6	3.16	8	4.21	224	4	1.79	4	1.79
Washington	1121	11	0.98	13	1.16	1360	17	1.25	13	0.96
Wayne	172	1	0.58	4	2.33	203	3	1.48	3	1.48
Westmoreland	1854	19	1.02	17	0.92	1737	15	0.86	13	0.75
Wyoming	96	1	1.04	1	1.04	87	1	1.15	3	3.45
York	1659	15	0.90	41	2.47	1915	16	0.84	32	1.67
All counties	72628	832	1.15	1583	2.18	74803	736	0.98	1300	1.74

Abbreviation: EBLLs, elevated blood lead levels.

[a]The total number of children born in 2017 and 2018 with a blood lead test by the age of two years by county of residence.

[b]The percentage of tested children under the age of two years who had unconfirmed or confirmed EBLLs by county of residence.

Table 6. Trend in The Percentage of Children Tested for BLLs Before Two Years of Age in Each County of Residence by Birth Cohort, 2015–2018

	Birth Cohort					
	2015	2016	2017	2018	Trend[a]	*p*
County						
Adams	45.2	48.3	54.0	69.5	+	<.0001*
Allegheny	57.7	64.7	73.1	75.7	+	<.0001*
Armstrong	67.4	75.3	81.5	84.9	+	<.0001*
Beaver	44.1	46.6	56.0	52.4	+	<.0001*
Bedford	60.1	62.9	69.0	70.0	+	0.0005*
Berks	42.0	38.1	41.4	48.8	+	<.0001*
Blair	52.3	52.4	61.4	59.3	+	<.0001*
Bradford	48.7	54.2	50.0	65.5	+	<.0001*
Bucks	34.9	35.9	37.6	34.8	+	0.560
Butler	50.3	53.3	67.8	76.0	+	<.0001*
Cambria	53.0	52.3	65.3	73.9	+	<.0001*
Cameron	75.6	71.8	83.3	62.2	-	0.403
Carbon	42.3	40.9	43.3	47.7	+	0.051
Centre	46.2	43.7	48.8	43.0	-	0.490
Chester	38.8	39.9	47.8	49.6	+	<.0001*
Clarion	42.5	49.1	45.4	48.4	+	0.207
Clearfield	59.5	59.7	61.7	60.1	+	0.620
Clinton	53.7	49.0	49.6	50.1	-	0.355
Columbia	38.6	42.3	34.3	38.2	-	0.323
Crawford	37.9	43.4	42.0	41.7	+	0.172
Cumberland	20.9	21.4	26.5	33.3	+	<.0001*
Dauphin	32.6	28.7	38.9	47.8	+	<.0001*
Delaware	56.6	60.0	62.2	62.2	+	<.0001*
Elk	57.6	43.6	48.2	50.8	-	0.204
Erie	54.7	55.4	61.6	64.3	+	<.0001*
Fayette	51.5	48.2	50.7	51.1	+	0.890
Forest	41.2	40.0	47.8	42.1	+	0.786
Franklin	39.3	39.2	42.9	57.3	+	<.0001*
Fulton	47.6	50.9	52.1	54.7	+	0.291
Greene	66.1	59.4	74.1	75.4	+	0.002*
Huntingdon	56.0	53.7	63.1	58.8	+	0.122
Indiana	46.2	49.6	54.0	64.8	+	<.0001*
Jefferson	45.3	45.4	44.3	49.0	+	0.329
Juniata	46.4	43.9	40.3	47.9	+	0.903
Lackawanna	37.0	36.5	42.0	45.7	+	<.0001*
Lancaster	28.6	24.8	31.8	32.5	+	<.0001*
Lawrence	40.4	44.8	52.6	58.9	+	<.0001*
Lebanon	33.0	32.0	38.2	41.6	+	<.0001*

	Birth Cohort					
	2015	2016	2017	2018	Trend[a]	*p*
Lehigh	39.0	38.1	44.3	48.1	+	<.0001*
Luzerne	49.7	52.0	54.7	57.5	+	<.0001*
Lycoming	50.2	50.9	53.3	48.2	-	0.576
McKean	72.7	75.5	78.0	83.2	+	0.001*
Mercer	46.0	44.2	51.6	51.6	+	0.0004*
Mifflin	48.7	42.4	42.3	41.5	-	0.017*
Monroe	27.1	29.5	31.2	35.3	+	<.0001*
Montgomery	47.9	50.0	52.6	54.5	+	<.0001*
Montour	47.0	40.6	41.1	41.0	-	0.254
Northampton	29.7	32.4	36.0	41.0	+	<.0001*
Northumberland	57.3	52.4	53.4	53.8	-	0.198
Perry	34.3	38.8	38.0	40.9	+	0.045*
Philadelphia	67.9	68.0	73.3	73.4	+	<.0001*
Pike	49.8	46.8	50.7	43.3	-	0.251
Potter	72.5	69.8	82.2	80.8	+	0.024*
Schuylkill	59.5	61.3	64.6	69.0	+	<.0001*
Snyder	39.6	31.8	30.4	33.8	-	0.053
Somerset	46.8	46.3	60.9	68.9	+	<.0001*
Sullivan	48.8	39.1	51.1	43.9	-	0.975
Susquehanna	30.8	30.2	27.7	29.0	-	0.523
Tioga	43.6	39.1	42.0	34.9	-	0.075
Union	34.8	34.8	32.9	30.9	-	0.195
Venango	38.9	41.5	40.5	47.0	+	0.019*
Warren	50.0	51.8	50.1	63.6	+	0.001*
Washington	48.5	50.1	59.7	69.2	+	<.0001*
Wayne	41.7	42.4	46.2	54.0	+	0.0003*
Westmoreland	48.9	51.8	61.8	59.9	+	<.0001*
Wyoming	33.9	28.4	33.3	36.7	+	0.329
York	36.8	35.5	36.2	43.3	+	<.0001*

Note: The percentage of children tested for BLLs before two years of age for the 2015 and 2016 birth cohorts were calculated in the previous Childhood Lead Testing and Poisoning Report: Pennsylvania Birth Cohort Analysis[5]

[a]Trend = +, increasing trend; Trend = -, decreasing trend.

*$p < 0.05$.

Table 7. Trend in The Percentage of Confirmed EBLLs among Children Tested for BLLs Before Two Years of Age in Each County of Residence by Birth Cohort, 2015–2018

	Birth Cohort					
	2015	2016	2017	2018	Trend[a]	*p*
County						
Adams	0.48	1.60	1.97	0.51	+	0.953
Allegheny	2.17	1.88	1.55	1.23	-	<.0001*
Armstrong	2.54	1.96	1.76	0.84	-	0.059
Beaver	0.67	1.03	0.58	1.22	+	0.429
Bedford	2.68	3.73	1.70	1.01	-	0.067
Berks	6.23	6.44	5.38	3.71	-	<.0001*
Blair	2.62	3.76	2.04	2.92	-	0.777
Bradford	2.99	3.04	2.88	3.38	+	0.798
Bucks	1.19	1.26	0.93	0.66	-	0.075
Butler	0.75	0.94	0.77	1.11	+	0.456
Cambria	2.58	2.00	0.85	1.80	-	0.125
Cameron	2.94	3.57	11.43	0.00	-	0.803
Carbon	2.39	1.65	3.19	1.93	+	0.982
Centre	0.85	0.76	0.53	0.20	-	0.143
Chester	2.06	1.19	0.82	0.75	-	<.0001*
Clarion	0.56	3.08	5.08	2.81	+	0.119
Clearfield	0.68	0.22	1.08	0.96	+	0.354
Clinton	3.52	3.02	2.58	1.91	-	0.292
Columbia	3.17	2.07	1.65	5.00	+	0.332
Crawford	4.25	3.24	2.03	1.59	-	0.016*
Cumberland	2.01	0.88	1.60	1.51	-	0.780
Dauphin	3.01	3.03	2.42	1.61	-	0.009*
Delaware	2.34	2.02	1.34	0.84	-	<.0001*
Elk	0.59	1.54	1.53	2.26	+	0.241
Erie	2.70	2.02	1.74	1.58	-	0.015*
Fayette	2.22	2.08	0.53	1.03	-	0.019*
Forest	7.14	0.00	9.09	0.00	-	0.694
Franklin	0.92	1.36	2.18	1.00	+	0.751
Fulton	0.00	5.08	4.76	1.56	+	0.775
Greene	3.31	1.34	1.56	3.92	+	0.823
Huntingdon	0.87	1.00	1.69	2.04	+	0.227
Indiana	1.39	1.23	1.69	1.34	+	0.929
Jefferson	1.77	2.44	1.42	3.42	+	0.356
Juniata	0.81	2.38	7.14	2.86	+	0.150
Lackawanna	2.84	2.95	2.78	2.28	-	0.444
Lancaster	4.27	5.23	3.97	3.51	-	0.075
Lawrence	1.91	1.31	1.75	2.02	+	0.749
Lebanon	4.02	4.10	3.62	1.86	-	0.031*

	Birth Cohort					
	2015	2016	2017	2018	Trend[a]	*p*
Lehigh	3.22	2.37	1.81	1.29	-	<.0001*
Luzerne	1.72	1.45	1.96	2.16	+	0.198
Lycoming	2.50	2.42	2.73	3.44	+	0.299
McKean	3.80	1.80	1.66	2.06	-	0.193
Mercer	2.12	1.61	1.65	1.68	-	0.619
Mifflin	2.73	3.83	2.81	1.19	-	0.225
Monroe	0.28	0.48	0.67	0.78	+	0.310
Montgomery	2.18	1.44	1.63	1.08	-	0.0002*
Montour	1.98	2.27	1.16	1.25	-	0.595
Northampton	1.86	1.57	1.83	1.66	-	0.862
Northumberland	3.88	4.29	4.22	3.53	-	0.792
Perry	1.64	1.94	2.54	0.48	-	0.447
Philadelphia	3.86	3.63	3.19	2.46	-	<.0001*
Pike	0.75	0.00	1.40	0.83	+	0.612
Potter	5.56	1.11	0.90	0.00	-	0.004*
Schuylkill	3.48	2.39	3.04	1.93	-	0.116
Snyder	2.72	2.86	0.74	1.37	-	0.222
Somerset	3.82	1.32	2.30	1.25	-	0.043*
Sullivan	15.00	0.00	8.33	0.00	-	0.140
Susquehanna	3.66	2.70	1.35	1.22	-	0.241
Tioga	0.69	0.85	0.00	0.00	-	0.284
Union	2.16	5.56	2.27	2.42	-	0.721
Venango	5.83	4.05	4.66	5.43	-	0.955
Warren	2.34	1.61	4.21	1.79	+	0.919
Washington	1.72	1.83	1.16	0.96	-	0.054
Wayne	1.84	2.23	2.33	1.48	-	0.791
Westmoreland	0.91	1.42	0.92	0.75	-	0.352
Wyoming	2.33	0.00	1.04	3.45	+	0.521
York	3.17	3.88	2.47	1.67	-	0.0006*

Note: The percentage of confirmed EBLLs among children tested for BLLs before two years of age for the 2015 and 2016 birth cohorts were calculated in the previous Childhood Lead Testing and Poisoning Report: Pennsylvania Birth Cohort Analysis[5]

[a]Trend = +, increasing trend; Trend = -, decreasing trend.

*$p < 0.05$.

Figure 1.1. Percentage of Children Tested for BLLs Before Two Years of Age by County of Residence, 2017 Birth Cohort

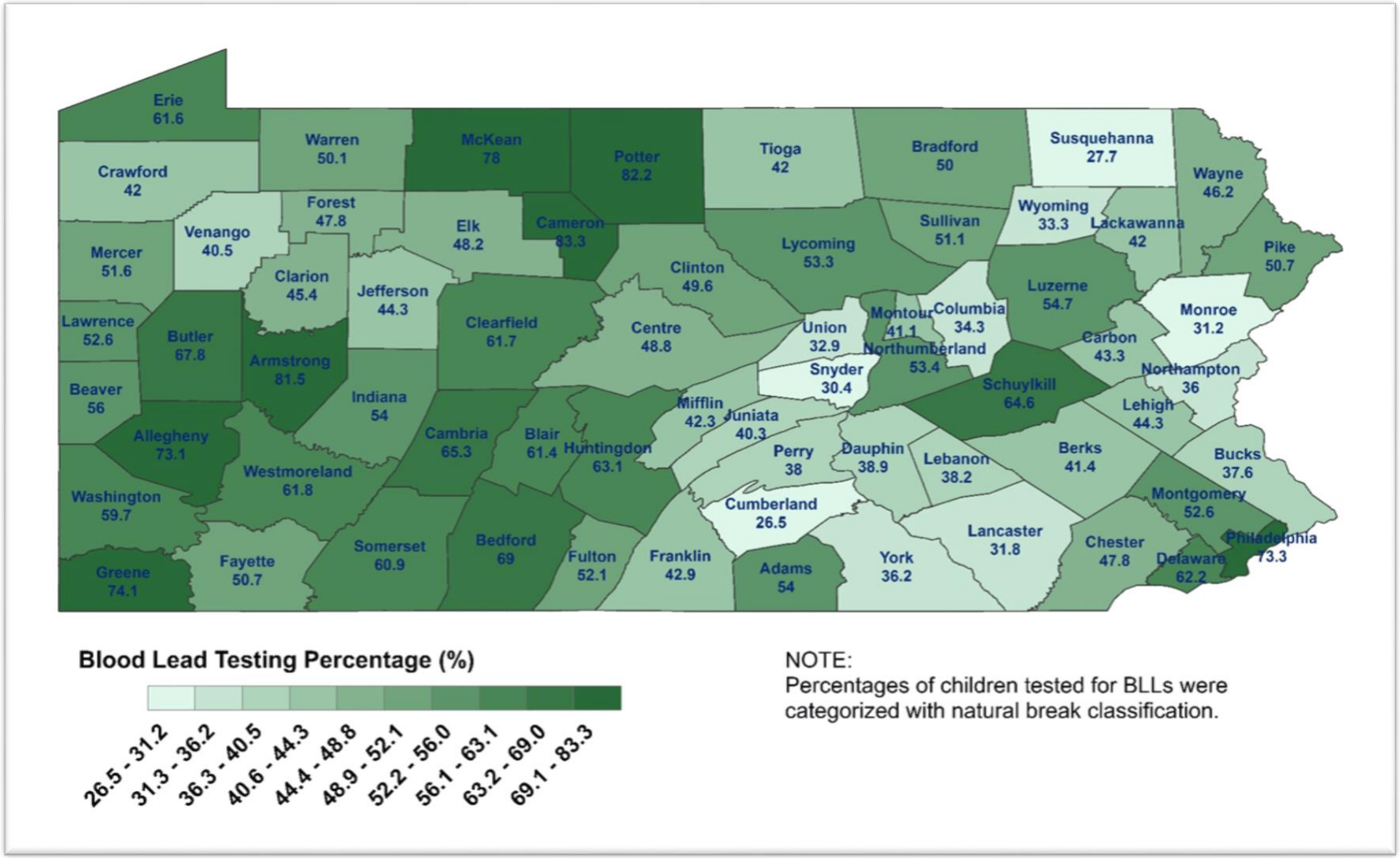


Figure 1.2. Percentage of Children Tested for BLLs Before Two Years of Age by County of Residence, 2018 Birth Cohort

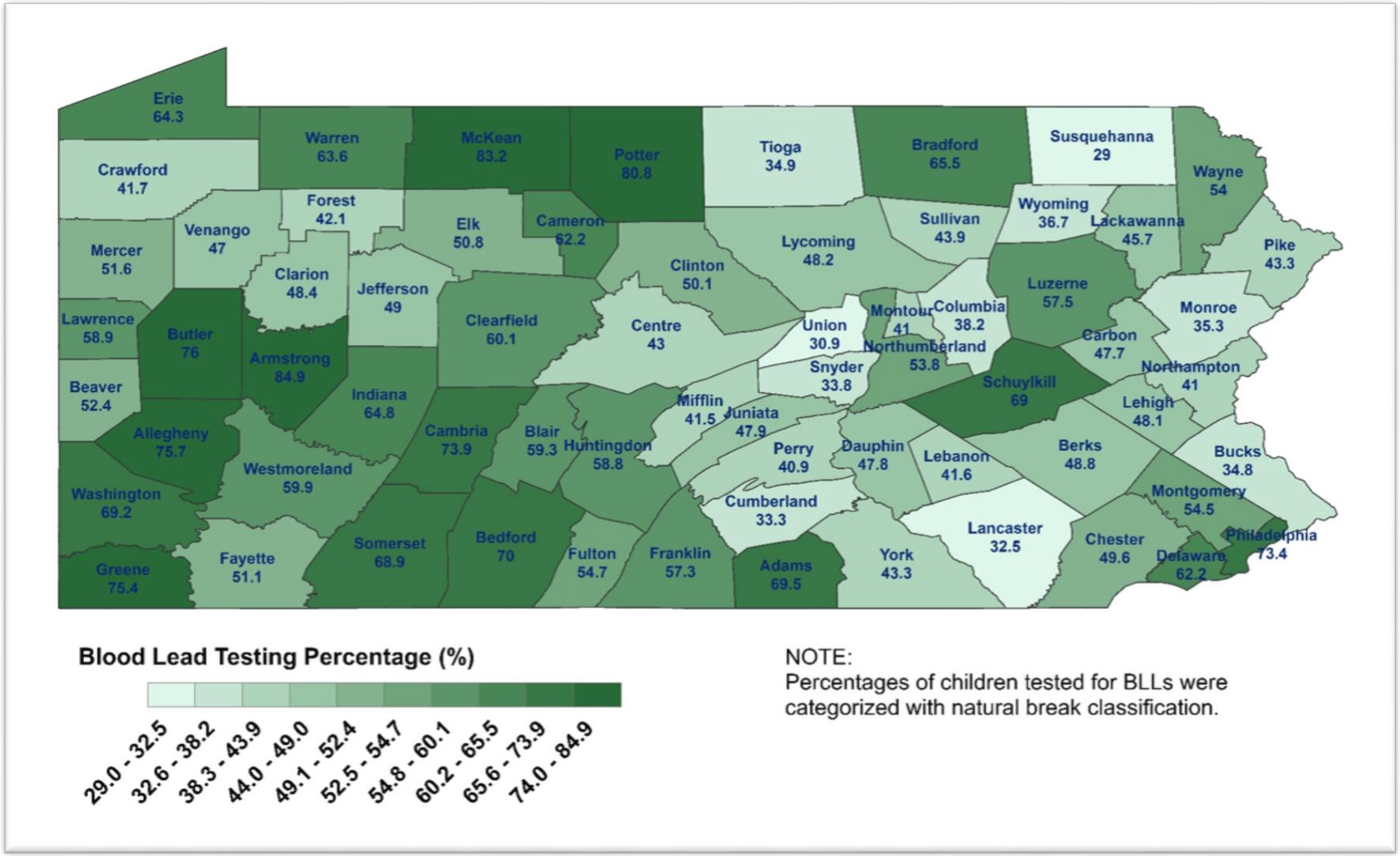


Figure 2.1. Percentage of Confirmed EBLLs among Children Tested for BLLs Before Two Years of Age by County of Residence, 2017 Birth Cohort

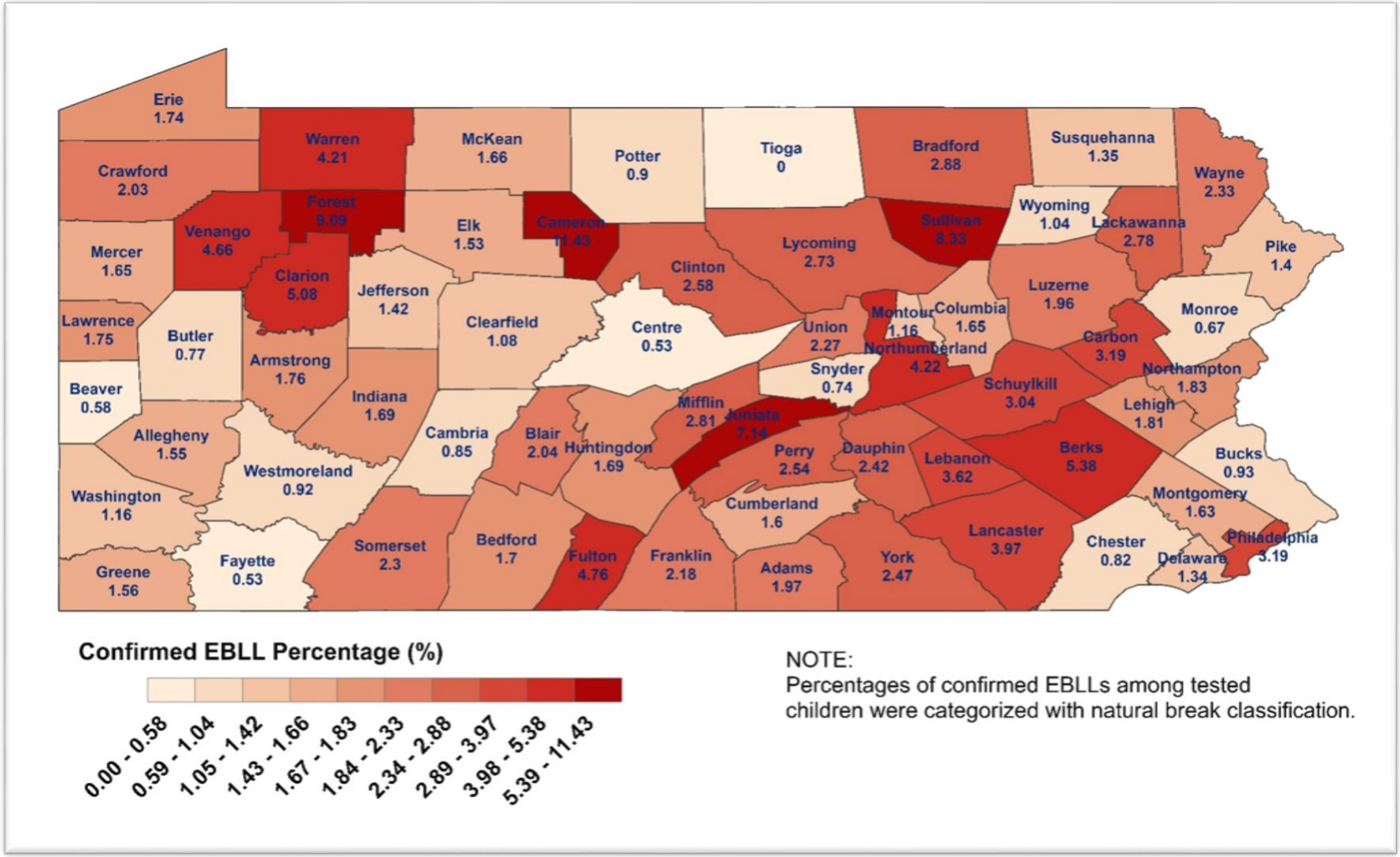


Figure 2.2. Percentage of Confirmed EBLLs among Children Tested for BLLs Before Two Years of Age by County of Residence, 2018 Birth Cohort

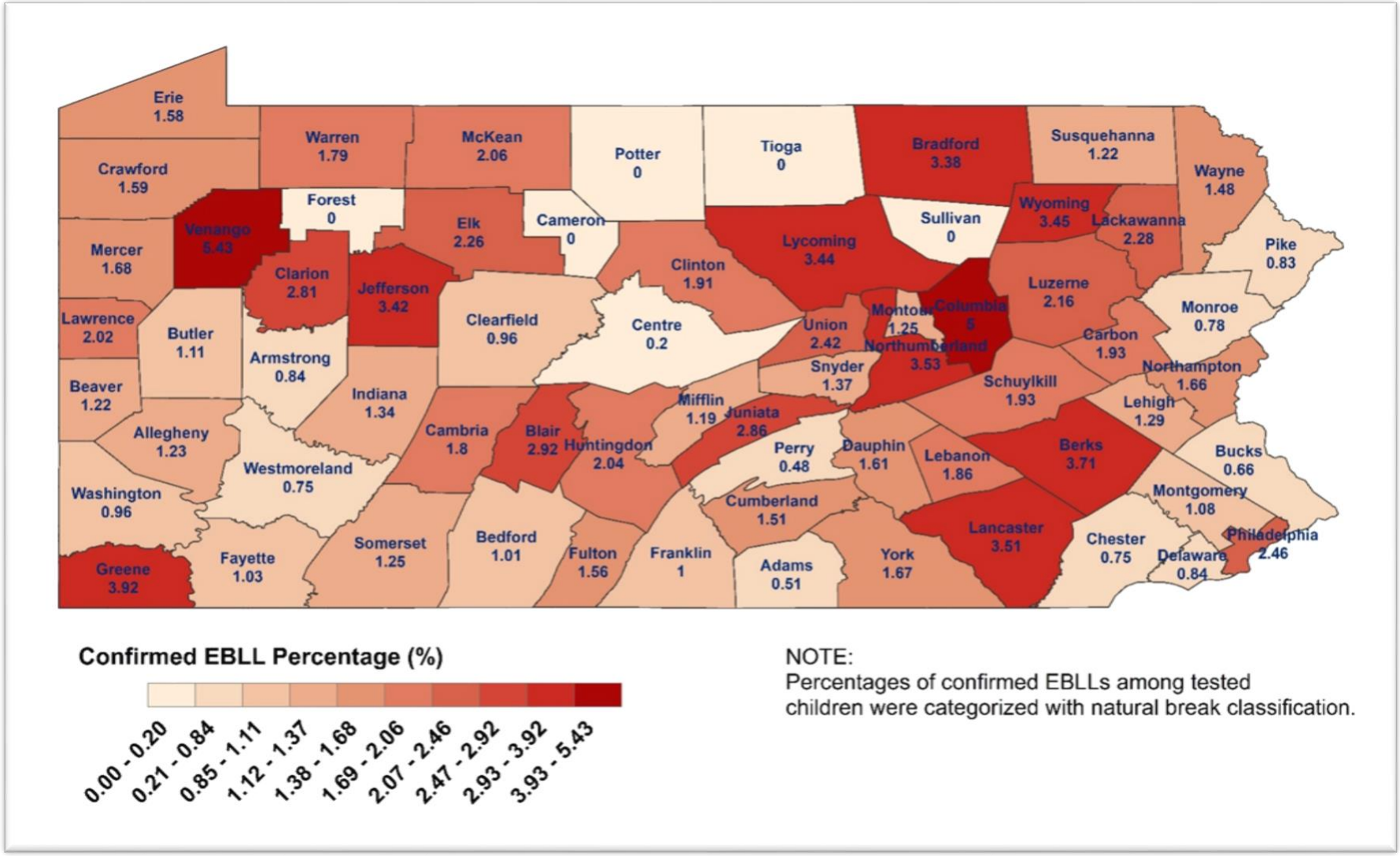


Figure 3. Percentage of Children Tested for BLLs Before Two Years of Age by Municipality of Residence (with Total Number of Births ≥50), 2017−2018 Birth Cohort

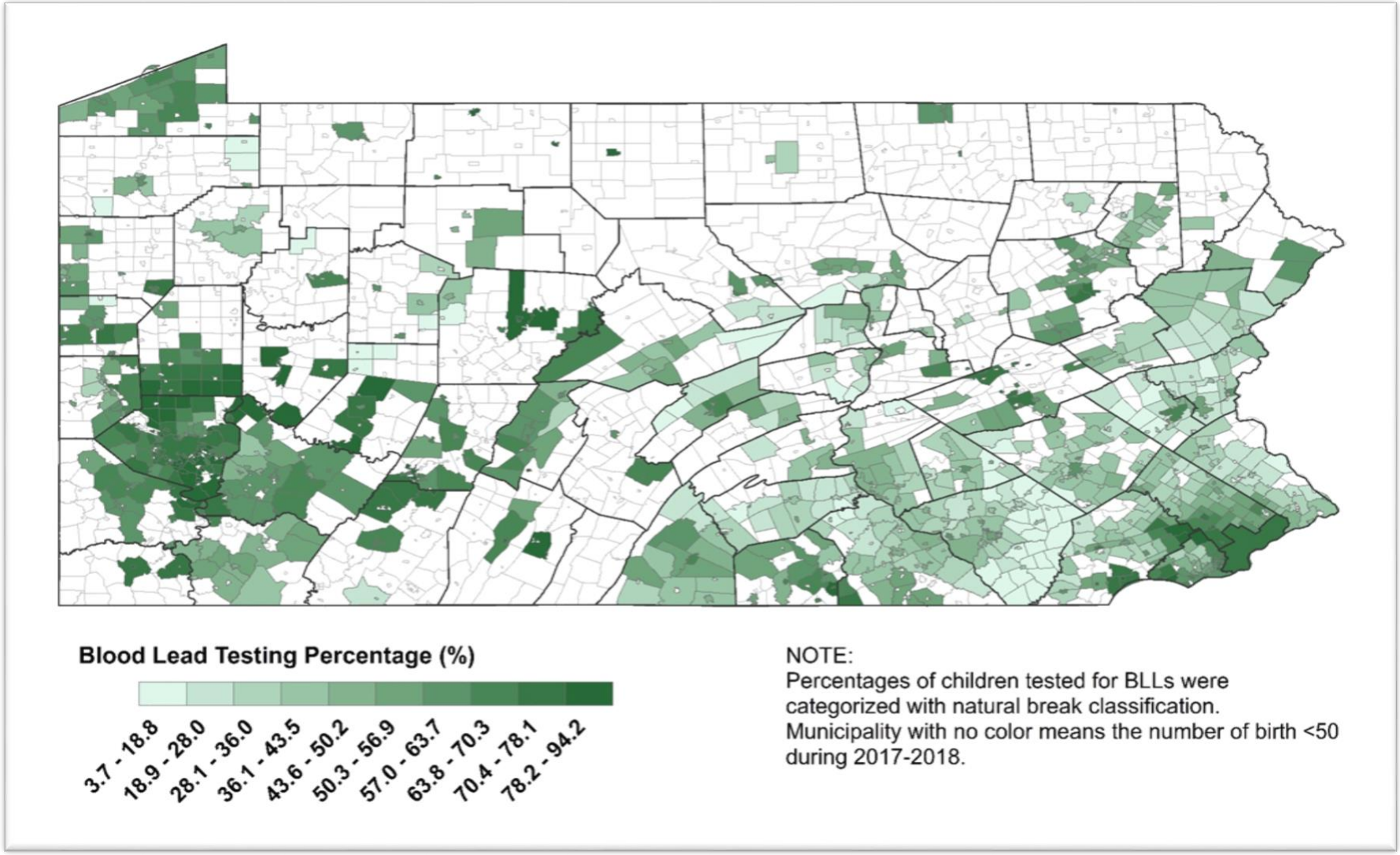
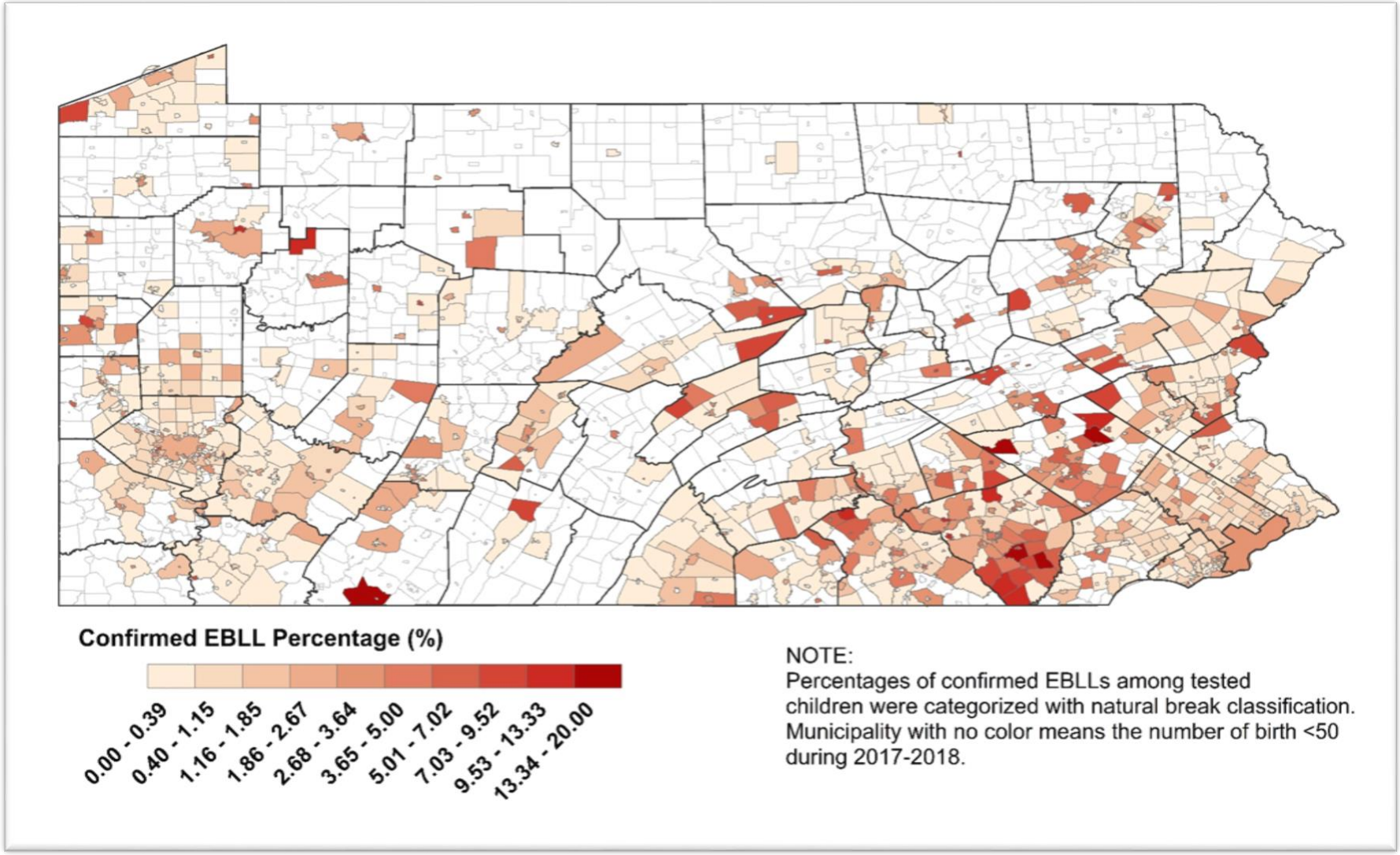


Figure 4. Percentage of Confirmed EBLLs among Children Tested for BLLs Before Two Years of Age by Municipality of Residence (with Total Number of Births ≥50), 2017–2018 Birth Cohort



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This report can be found at: https://www.health.pa.gov/Pages/default.aspx.