# CDC-ATSDR
Lead Exposure Risk Index (LERI)

Lead Exposure and Prevention Advisory Committee (LEPAC) meeting, December 2021

Kathryn ("Katie") Egan, PhD, MPH, MPhil
Joseph Courtney, PhD, MPH

Lead Poisoning Prevention and Environmental Health Tracking Branch
Division of Environmental Health Science and Practice
National Center for Environmental Health

Risk

Lowest

Highest

Data unavailable

Quartile classification
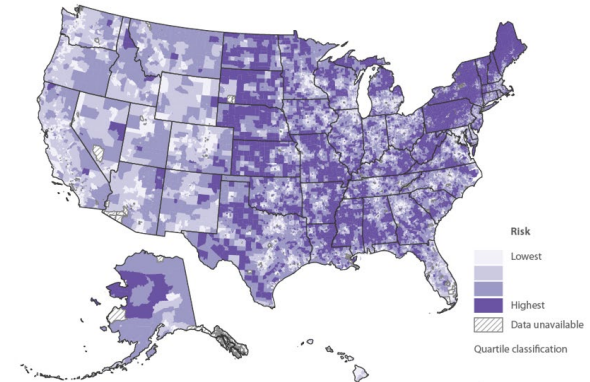
National Center for Environmental Health /
Agency for Toxic Substances and Disease Registry

Introduction

- Collaboration between CDC's Childhood Lead Poisoning Prevention Program (CLPPP) and ATSDR's Geospatial Research, Analysis, and Services Program (GRASP)

- To provide a **publicly available, interactive web-based tool** using **nationally consistent data** and approach to map **community-level risk** for lead exposure throughout the U.S.

- To assist health care providers and the general public identify small geographic areas at **high-risk for lead exposure** to guide **targeted blood lead testing & population-based interventions**

12 MOST COMMON POTENTIAL SOURCES
OF EXPOSURE INCLUDE THE FOLLOWING LEAD-CONTAINING ITEMS

Deteriorating lead-based paint in older homes and buildings

Renovations of older homes

Soil

Unintentional hand to mouth ingestion

Unintentional take-home lead exposure from a worksite

Cookware from international manufacturers

12 COMMON SOURCES OF LEAD EXPOSURE

Lead-contaminated water

Herbal remedies

Some imported toys

Some imported spices

Imported candy and candy wrappers

Traditional folk medicines and cosmetics

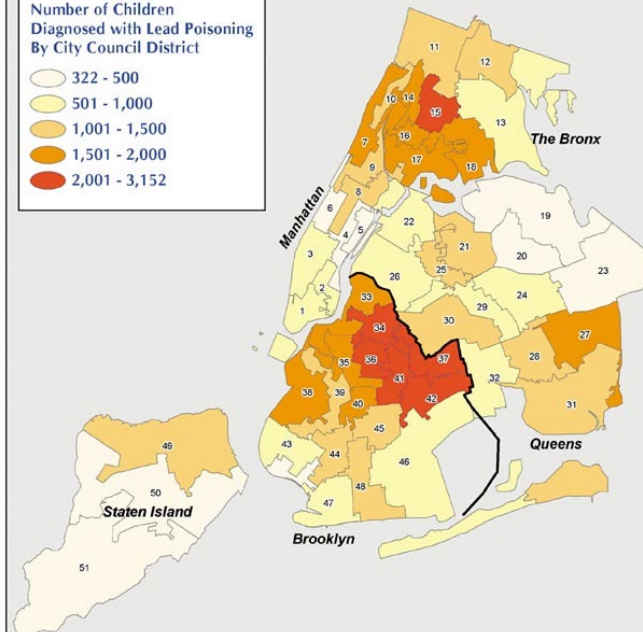**Using GIS to Assess and Direct Childhood Lead Poisoning Prevention**

Guidance for State and Local Childhood Lead Poisoning Prevention Programs

Mapping "Cases"

New Cases of Lead Poisoning in Children in NYC, 1995 - 2000

Number of Children Diagnosed with Lead Poisoning By City Council District
- 322 - 500
- 501 - 1,000
- 1,001 - 1,500
- 1,501 - 2,000
- 2,001 - 3,152

The Bronx
Manhattan
Queens
Staten Island
Brooklyn

Blood level tesing data obtained from the NYC Department of Health preliminary data, as of July, 2001 at the ZIP Code level. NYPIRG converted this data to the City Council District level. This might lead to some discrepancies between the numbers shown by the Dept. of Health, and those shown on this map.

cmap

Factors Affecting Blood Lead Data Quality

- **Testing laws**
  - Universal vs. targeted
  - Age group(s)
  - Medicaid requirements
- **Reporting laws**
  - Blood lead level(s)
    - All or elevated only
  - Age group(s)
  - Electronic reporting required

- **Timeliness & Completeness**
- **Reporting Context**
  - Link to other databases
  - Staff resources
  - Available technology
 - Case definitions
- **Action levels for:**
  - Case management
  - Environmental assessment
  - Referrals

Blood lead surveillance data

- **Reliance on surveillance data alone as an indicator of lead risk is inadequate due to the differences in testing & reporting laws, reporting context and timeliness & completeness of the data**

- **LERI can help to identify areas which may be at risk but where few kids are being tested**

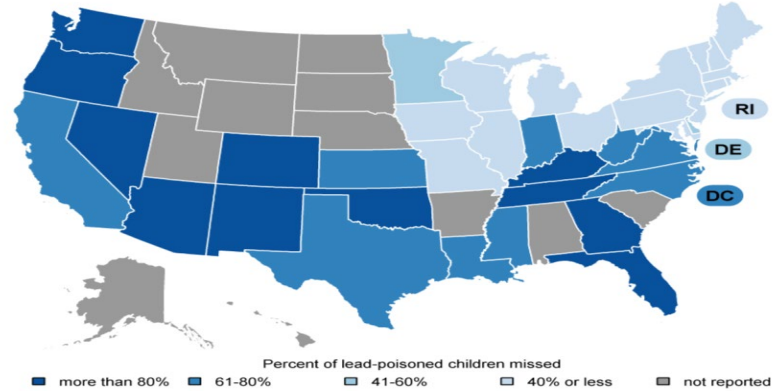# Every map inevitably presents a different story

Estimated number of children (aged 1-5 years) with blood

cases per 1,000 of blood lead 5.0 µg/dL and higher

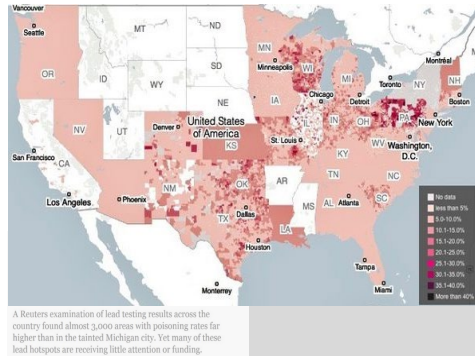< 6.8   6.8 - 8.2   8.3 - 9.7   9.8 - 11.2   >= 11.3
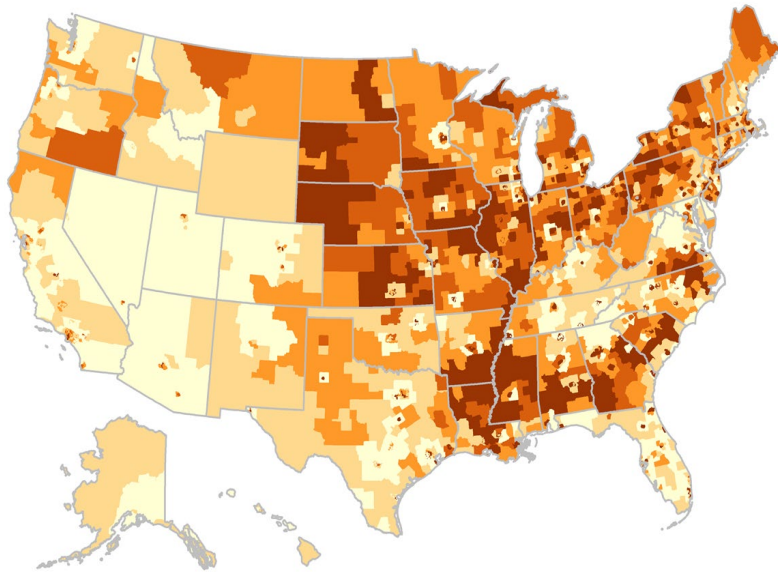
Source: A Hidden Problem: Lead Poisoned Children in the United States.
April 2017.

Percent of lead-poisoned children missed in the U.S., by state

Percent of lead-poisoned children missed

more than 80%   61-80%   41-60%   40% or less   not reported

www.cehtp.org/hiddenlead

A Reuters examination of lead testing results across the
country found almost 3,000 areas with poisoning rates far
higher than in the tainted Michigan city. Yet many of these
lead hotspots are receiving little attention and funding.

The federal government doesn't require states to submit lead
exposure data — and sometimes the data it displays is wrong

Percent of children with EBLLs between 5 µg/dL and 9 µg/dL

n/a   < 5 tested   0%   < 0.3%   < 0.8%   > 0.8%

Source: Centers for Disease Control and Prevention, 2014
Credit: Sarah Frostenson

Vox
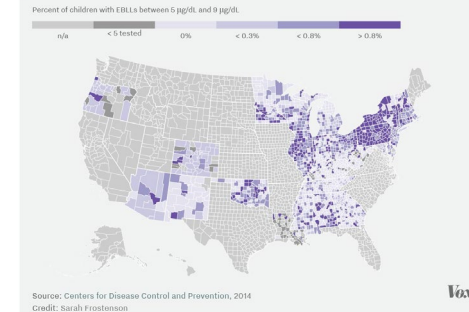
Methods Development

Objectives

- 1: provide a population-based lead exposure risk assessment tool for public health agencies, healthcare providers, and the public to assist in identifying census tracts at high risk for childhood lead exposure.

- 2: to evaluate these potential lead exposure risk factors for inclusion and appropriate weights in the model.

- The LERI will be available on an interactive web-based dashboard that enables users to explore community-level risk for lead exposure across the entire United States and on a state-by-state basis by census tract (72,830 in 2016).

Methods

- **Scientific literature review for lead exposure risk factor identification**

- **The LERI is an <u>index,</u> which is a composite indicator that collapses numerous variables into a single variable on the basis of an underlying model of the multi-dimensional concept that is being measured (e.g., lead exposure risk)**

- **An example of an index is the Social Vulnerability Index (SVI)**

  - **SVI uses 15 U.S. Census variables at tract level and has four domains (themes):**

    - **Socioeconomic Status**

    - **Household Composition**

    - **Race/Ethnicity/Language**

    - **Housing/Transportation**

    https://svi.cdc.gov/

Lead Exposure Risk Index (LERI)

Uses estimates from the U.S. Census American Community Survey (2012-2016) and data from the U.S. Environmental Protection Agency (2011, 2016) to develop an **overall composite indicator*** for lead exposure in the U.S. based on risk factors for four themes:

- Sociodemographic
- Housing
- Environmental
- Geographic
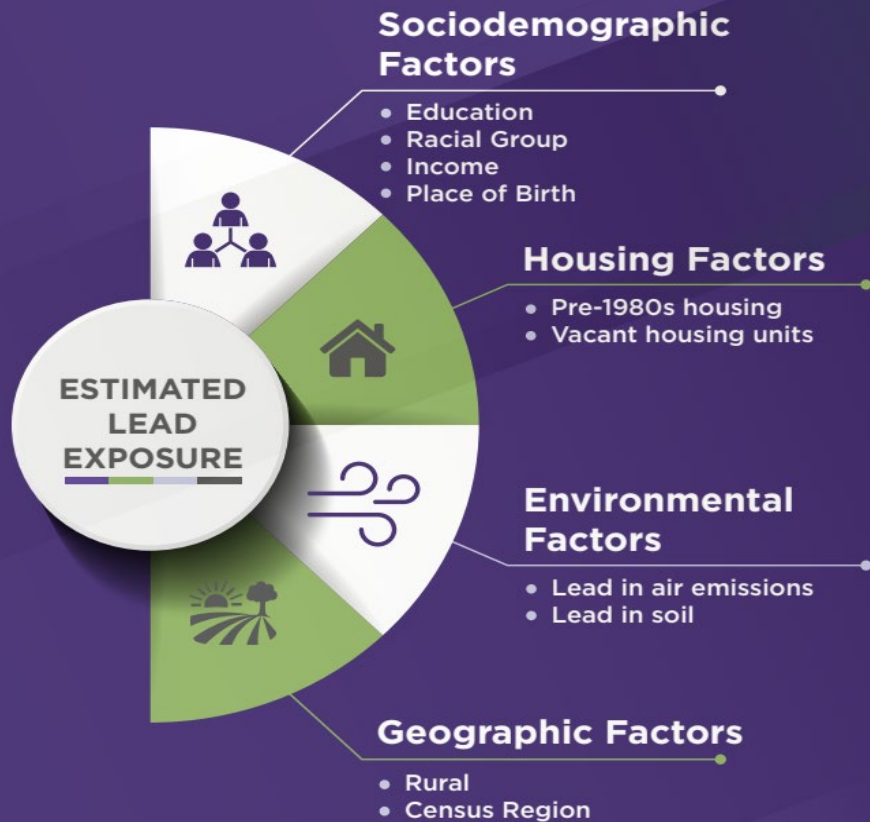
Employed BLLs from NHANES to weight variables

- **To examine the strength and direction of associations between individual components with the LERI, the sociodemographic, housing and environmental variables were linked with NHANES BLLs from the 2005-2016 survey cycles**
  - NHANES is a population-based survey in the United States that occurs each year and survey cycles comprise a two-year period.
- **Modeling with the NHANES data included only children <6 years of age with valid BLLs (n=4,918). All analyses were performed incorporating the strata, cluster and sample weights respecting the complex sample design of NHANES.**

Weighing the Model

- Linear regression models assessed the LERI score as a predictor of BLL, controlling for any potential confounders and using the appropriate NHANES sample weights.

- All variables were first modeled individually, then the overall LERI score variable was modeled.

- After modeling all eight variables, stratified linear regression models were assessed for potential confounding or effect modifiers such as the rural/urban variable and region of the country.

- We concluded that the LERI should be adjusted for each of the four geographic regions as well as by the rural/urban variable. These two variables were added to the model to round out the 10 variables that compose the LERI.

Results

- Index values were created to rank estimated lead exposure risk at the census tract level using the ten sociodemographic, housing, environmental, and geographic factors.

- Variable weights were based on the underlying multivariate model using NHANES data.

- The final model presents an overall composite indicator for lead exposure risk.

- Each tract receives a separate national and state-specific percentile ranking value, with higher values indicating greater lead exposure risk.

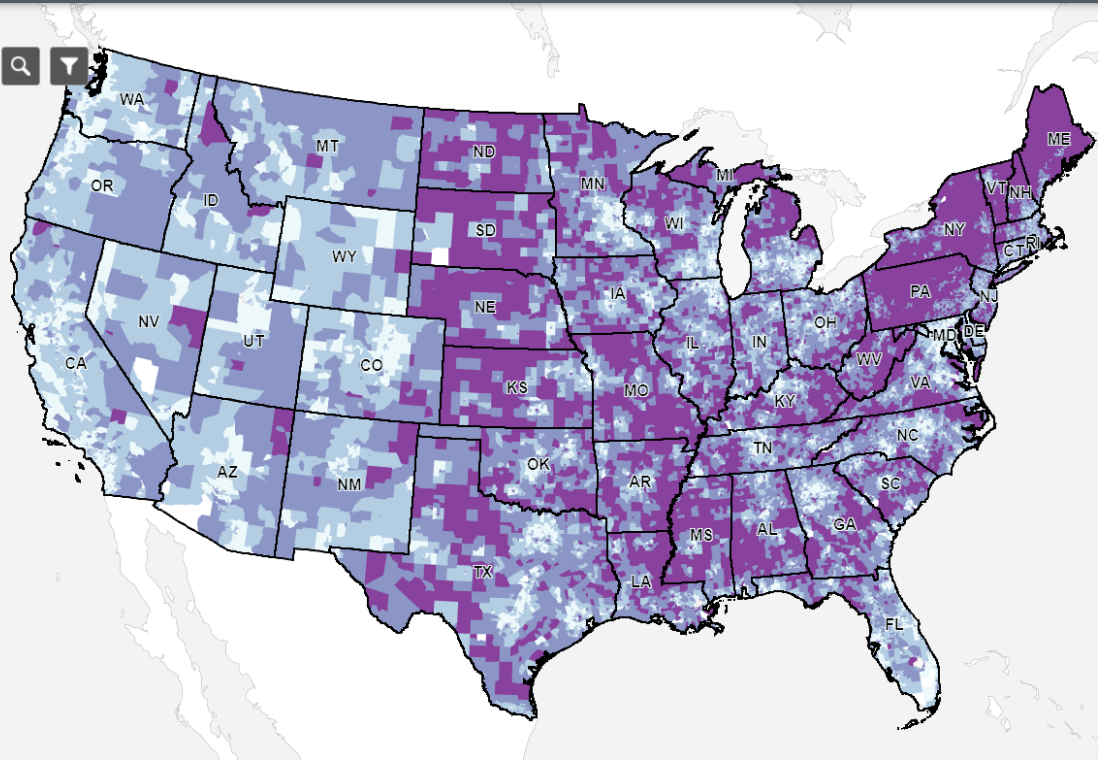# Lead Exposure Risk Index (LERI) Map
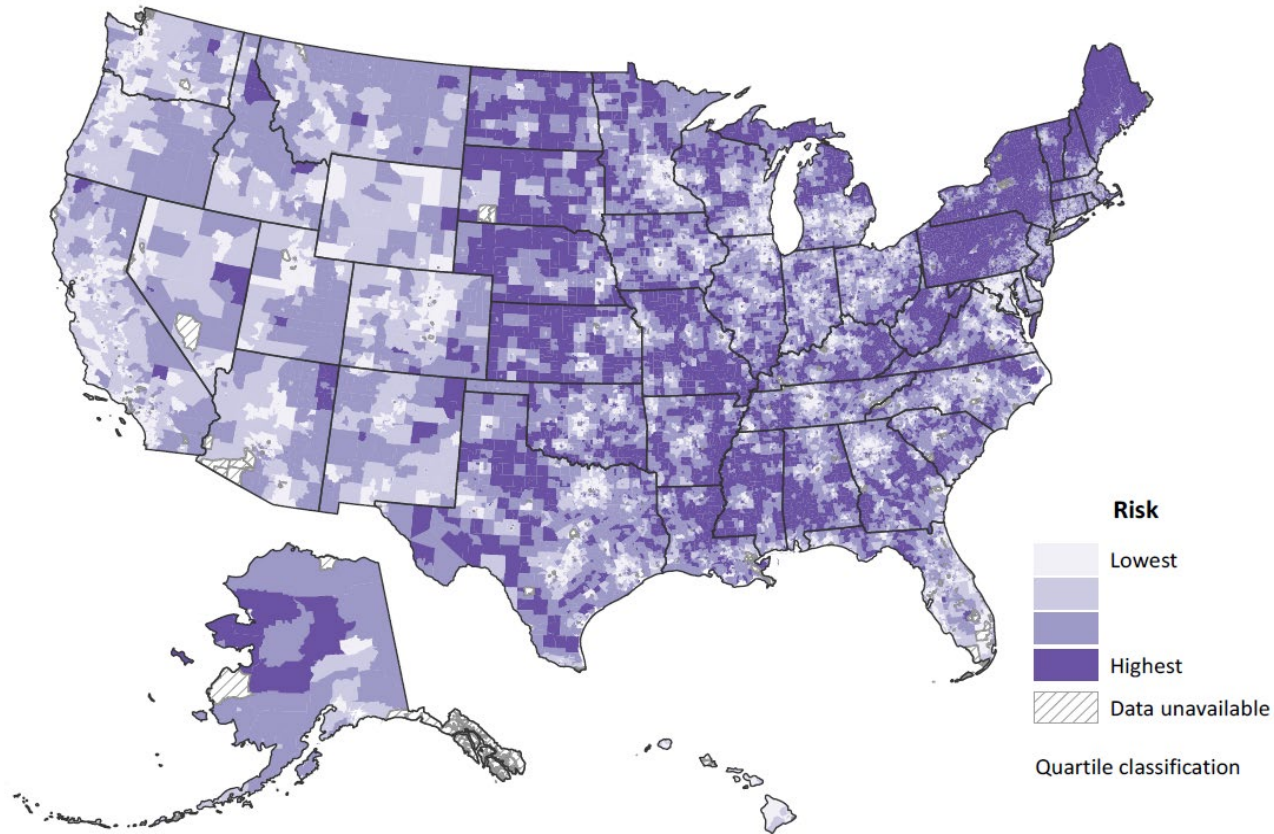
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The National Dashboard

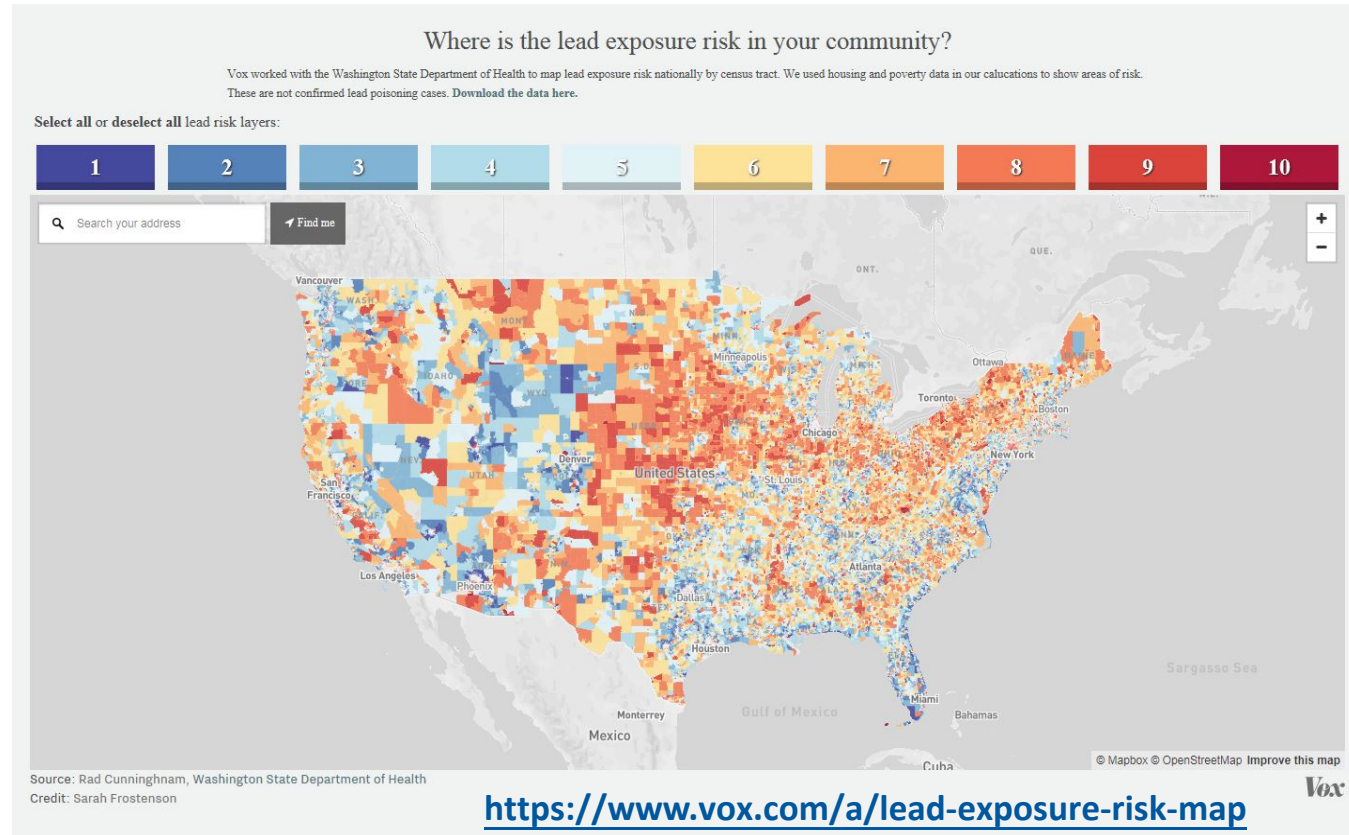# An example state dashboard: Georgia
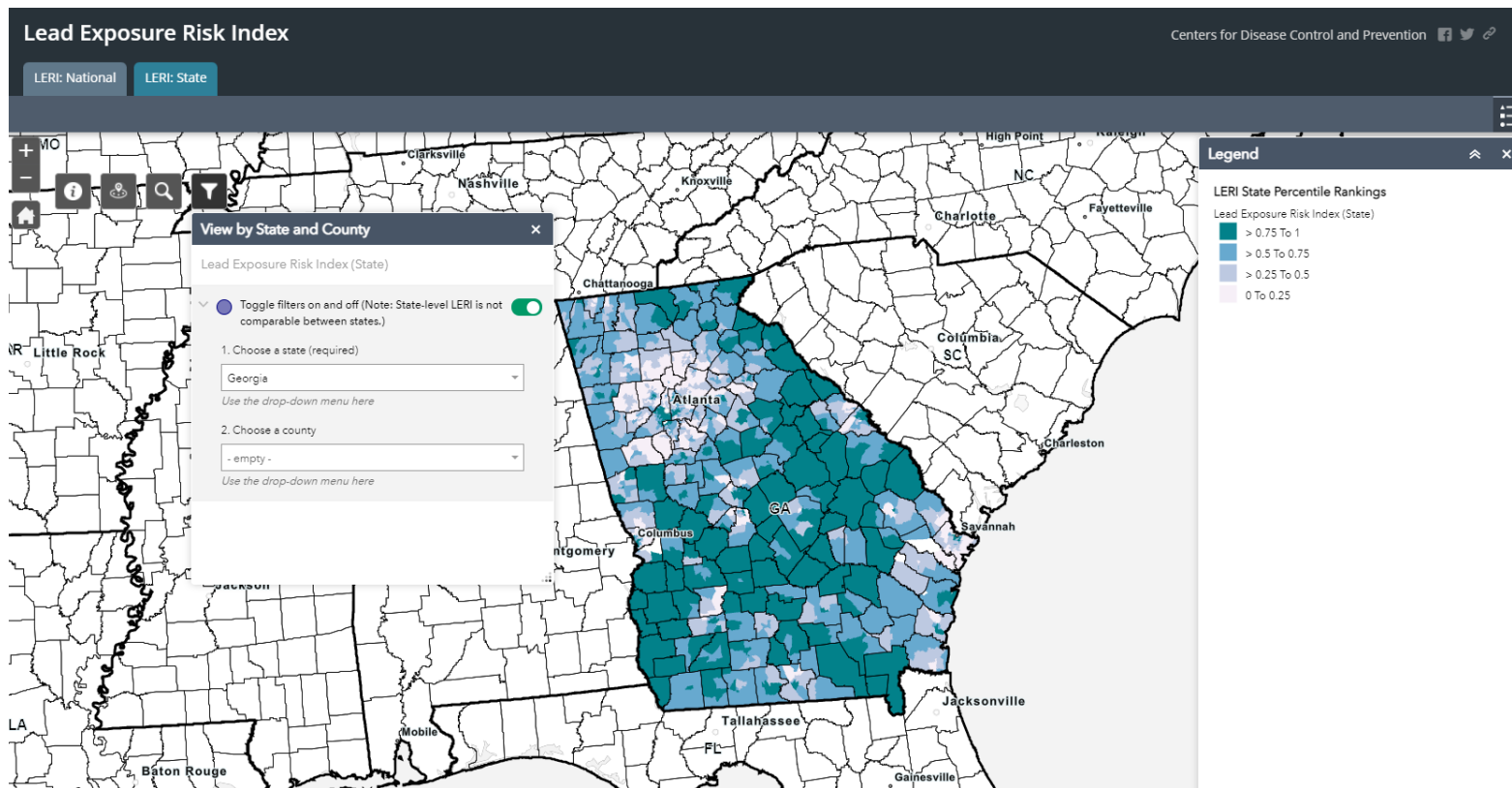
Validation Efforts and Points to Note

Validation Efforts

- **Ongoing validation and calibrating to identify opportunities for improvements through:**
  - **Childhood Lead Poisoning Prevention Programs (CLPPPs) comparisons to existing surveillance data**

  - **Predictive modeling**
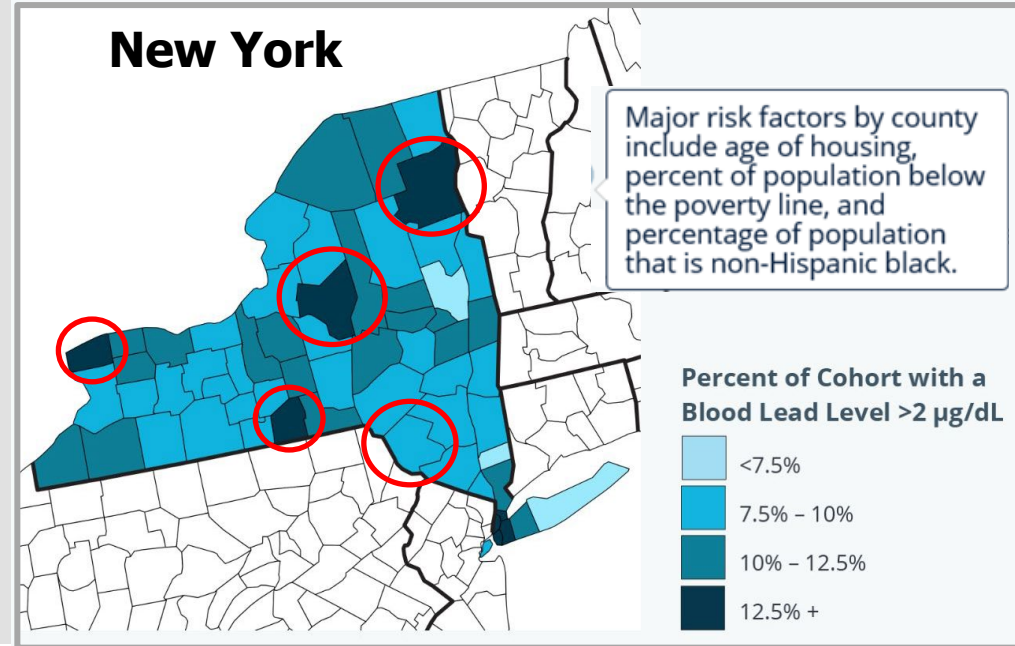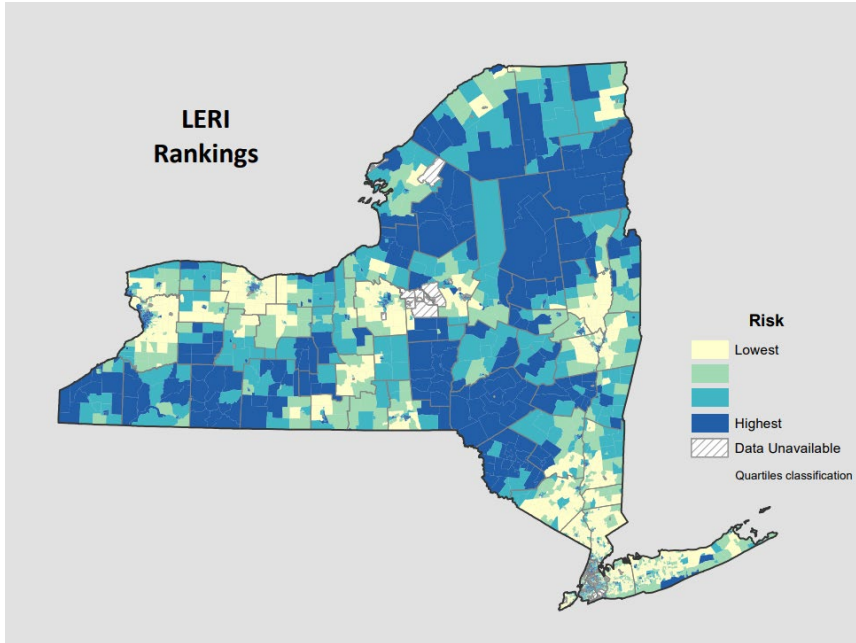   - To estimate blood lead levels based on existing data

Points to Note

- Selection and Specification of variables matters

Where is the lead exposure risk in your community?

Vox worked with the Washington State Department of Health to map lead exposure risk nationally by census tract. We used housing and poverty data in our calucations to show areas of risk. These are not confirmed lead poisoning cases. **Download the data here.**

Select all or **deselect all** lead risk layers:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Source: Rad Cunninghnam, Washington State Department of Health
Credit: Sarah Frostenson

© Mapbox © OpenStreetMap **Improve this map**

Vox

https://www.vox.com/a/lead-exposure-risk-map

Points to Note (2)

- **Geographic Scale Size Differences Matter**

Comparison to other mapping initiatives: EPA's and HUD's lead mapping initiatives

- **LERI aims to identify census tracts where children may need <u>blood lead screening and to focus primary prevention interventions</u>**
  - HUD aims to identify neighborhoods where policy makers can focus <u>lead remediation</u>
  - EPA aims to identify areas to focus resources to <u>reduce lead-based paint exposures</u> and <u>eligibility for federal or state lead mitigation programs</u>
- **LERI uses nationally representative BLLs from NHANES to weight the covariates included in the model**
- **LERI <u>predicts the lead exposure risk</u> for children in a census tract**
  - HUD predicts the <u>percentage of occupied housing units at risk of containing large areas of deteriorated paint</u> within a given jurisdiction
  - EPA's regression model predicts <u>BLLs for children aged 1-2y</u> at the census tract level
- **Each census tract in LERI has two scores:**
  - One in comparison to all other census tracts nationally, and
  - One in comparison to other tracts within their state

Challenges

- Limited availability of national datasets for environmental lead hazards (e.g., lead service lines, regional airports)
- Reliance on variables with substantial measurement error increases model uncertainty
- Data distribution required complex exposures to be presented as dichotomous variables (e.g., air emissions NATA data)
- Limited ability to capture contextual constructs that change over time (e.g., housing and neighborhood gentrification)
- NHANES data to create weights are based on small sample sizes

Summary

- LERI will be a publicly available, interactive web-based tool using nationally consistent data and approach to map U.S. community-level risk for lead exposure

- Evaluation of the LERI is an important step to ensure that the national level data is applicable at local/regional level

- Assessment and evaluation of the LERI requires high quality data and a variety of methods engaging communities with different housing stock, demographics, and environmental hazards

Acknowledgements

- **CDC Childhood Lead Poisoning Prevention Colleagues**
- **LERI Project Development Team:**
  - Katie Egan, Elaine Hallisey, Ginger Chew, Marissa Grossman, Stella Chuke, Perri Ruckart, Joseph Courtney, Cheryl Cornwell, Grete Wilt, Amy Lavery, Paul Allwood, Andrew Dent, Adrienne Ettinger
- **LERI Dashboard Development Team:**
  - Elizabeth Pembleton, Katie Egan, Elaine Hallisey, Joseph Courtney, David Rickless, Angela Walker, and Ginger Chew
- **Collaborators in other agencies, including:**
  - HUD
  - EPA
  - U.S. Geological Survey

For more information:
https://www.cdc.gov/nceh/lead/

Childhood Lead Poisoning Prevention Program