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
- Herbal remedies
- Some imported toys
- Some imported spices
- Imported candy and candy wrappers
- Lead-contaminated water
- Traditional folk medicines and cosmetics
Mapping “Cases”

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

Guidance for State and Local Childhood Lead Poisoning Prevention Programs
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 lead levels ≥5 µg/dL in 2010 by Public Use Microdata Area


www.cehtp.org/hiddenlead
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 index, 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
10 KEY FACTORS WERE USED TO CREATE THE LEAD EXPOSURE RISK INDEX

**Sociodemographic Factors**
- Education
- Racial Group
- Income
- Place of Birth

**Housing Factors**
- Pre-1980s housing
- Vacant housing units

**Environmental Factors**
- Lead in air emissions
- Lead in soil

**Geographic Factors**
- Rural
- Census Region
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
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

[Image of a map showing lead exposure risk in the United States]

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 **blood lead screening** and to focus **primary prevention interventions**
  - HUD aims to identify neighborhoods where policy makers can focus **lead remediation**
  - EPA aims to identify areas to focus resources to **reduce lead-based paint exposures** and **eligibility for federal or state lead mitigation programs**

- LERI uses nationally representative BLLs from NHANES to weight the covariates included in the model

- LERI **predicts the lead exposure risk for children in a census tract**
  - HUD predicts the **percentage of occupied housing units at risk of containing large areas of deteriorated paint within a given jurisdiction**
  - EPA’s regression model predicts **BLLs for children aged 1-2y 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/

For more information, contact NCEH/ATSDR
1-800-CDC-INFO (232-4636)
Follow us on Twitter  @CDCEnvironment

The findings and conclusions in this presentation have not been formally disseminated by [the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry] and should not be construed to represent any agency determination or policy.