The Impact of Home Repairs and Services for Low-Income Homeowners on Pediatric Health Outcomes in Cincinnati, OH

Cole Brokamp, Erika Rasnick Manning, Carson S Hartlage, Aaron Grant, Diana Adams, Patrick H Ryan

Ohio Healthy Homes Network 2026 Annual Conference

Support

Research reported in this presentation was supported by People Working Cooperatively, Inc., a 501(c)(3) nonprofit charitable organization.

Research reported in this presentation was supported by the National Institute Of Environmental Health Sciences of the National Institutes of Health under Award Number R03ES037996. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Address-level linkage, healthy homes, and cross-sector collaboration in Cincinnati

Beyond the Paint: lead matters, but housing-health logic extends to a wider range of home conditions and interventions

Not ‘just’ research: model for evaluating healthy housing work → evidence to support partnerships, referrals, and investment

Risk is produced at level of home: data and interventions should work at same level

Connect housing conditions, housing interventions, and health outcomes at the scale where risk and intervention actually occur.

Today

➜ Why address-level linkage matters for healthy homes work

➜ Prior examples of how address-level linkage has changed what we can measure (pediatric elevated blood lead, housing infractions and asthma)

➜ People Working Cooperatively as a real-world housing intervention partner

➜ Study design linking PWC repairs to pediatric emergency department utilization to evaluate impact of interventions

➜ Preliminary results and future methods

➜ Conclusion

Why Address-Level Linkage Matters

Public health often works with tract- or ZIP-level averages because those data are easier to obtain, but children do not live in averages

Healthy homes interventions happen at homes, buildings, and parcels

Parcel-level linkage adds the missing ‘middle’ between the family and the neighborhood

If the intervention happens at the home, the evaluation should be able to see the home

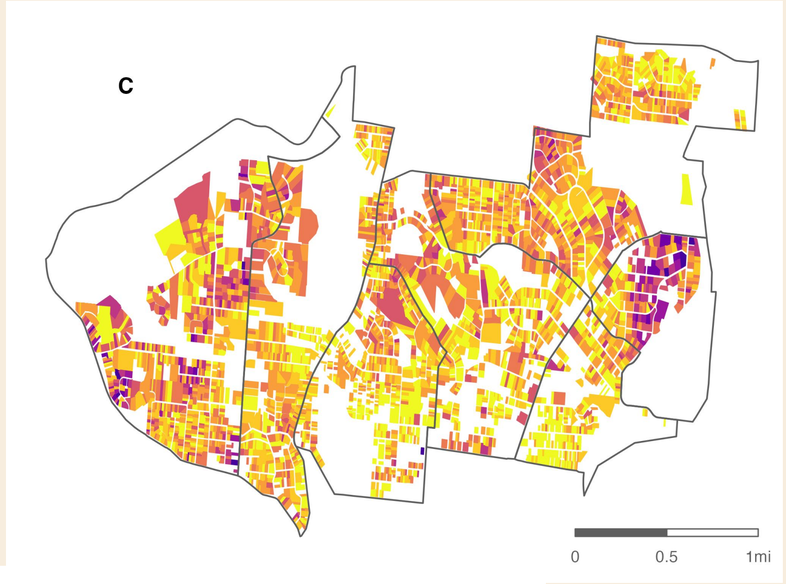
From Area-Based Risk to Home-Specific Risk

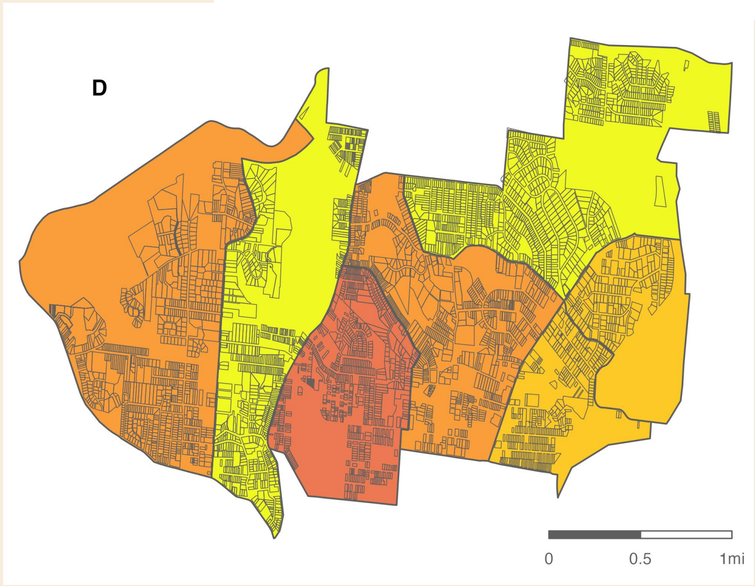
Tract- and ZIP-level summaries can hide sharp within-neighborhood heterogeneity

Two families can live in the same tract and still face very different housing-related risk

Housing conditions, property value, violation history, and nearby sources can change at the parcel boundary, not the tract boundary

Address-level linkage reveals housing-related risk that larger-area summaries miss





Geocoding ≠ Address Matching

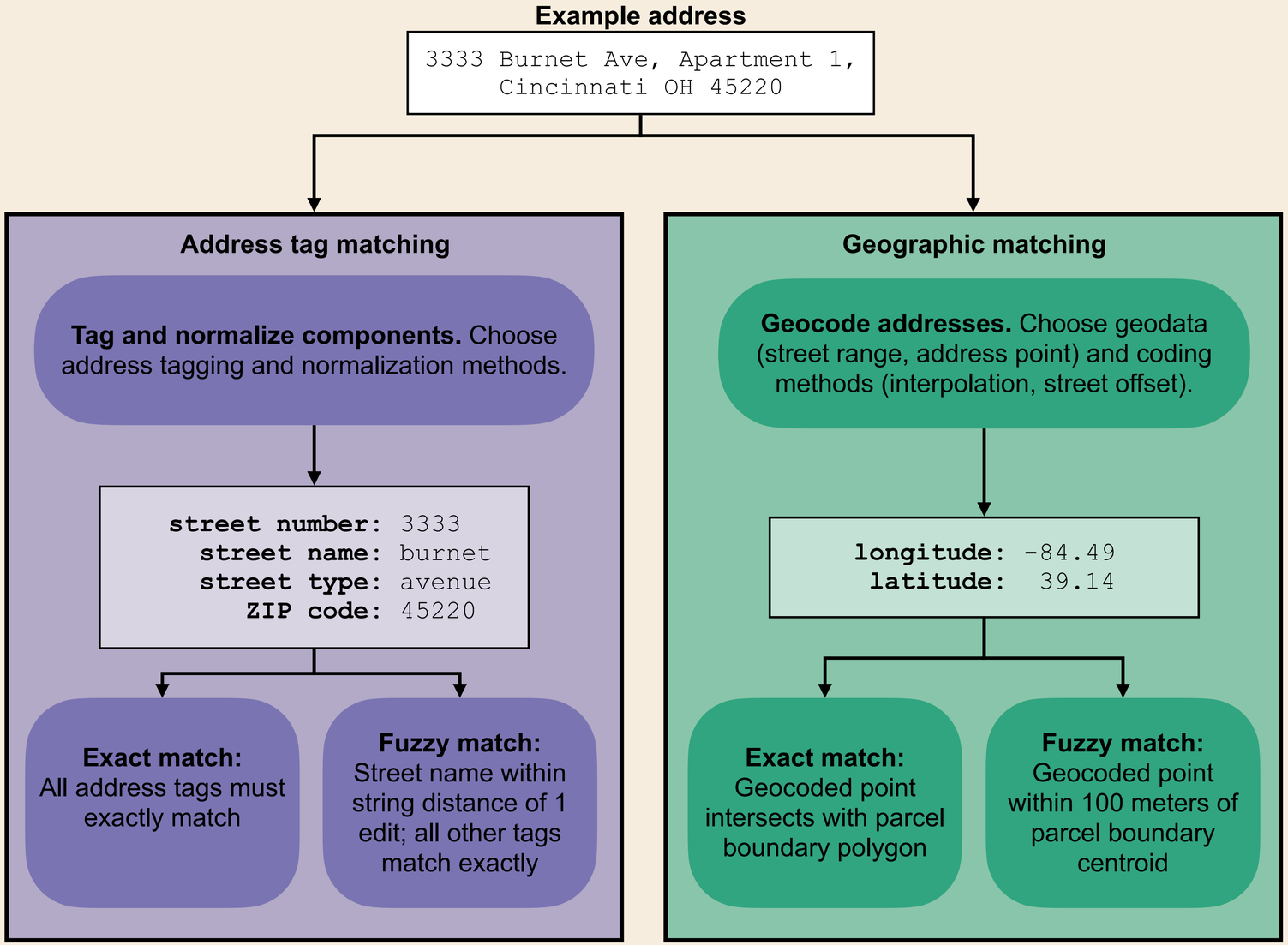
Geocoding:

address string → location estimate

Address matching:

address string → authoritative address or parcel record

Parcel characteristics, code violations, ownership, value, intervention history, cleaner longitudinal person-place-time linkage require more than map points.



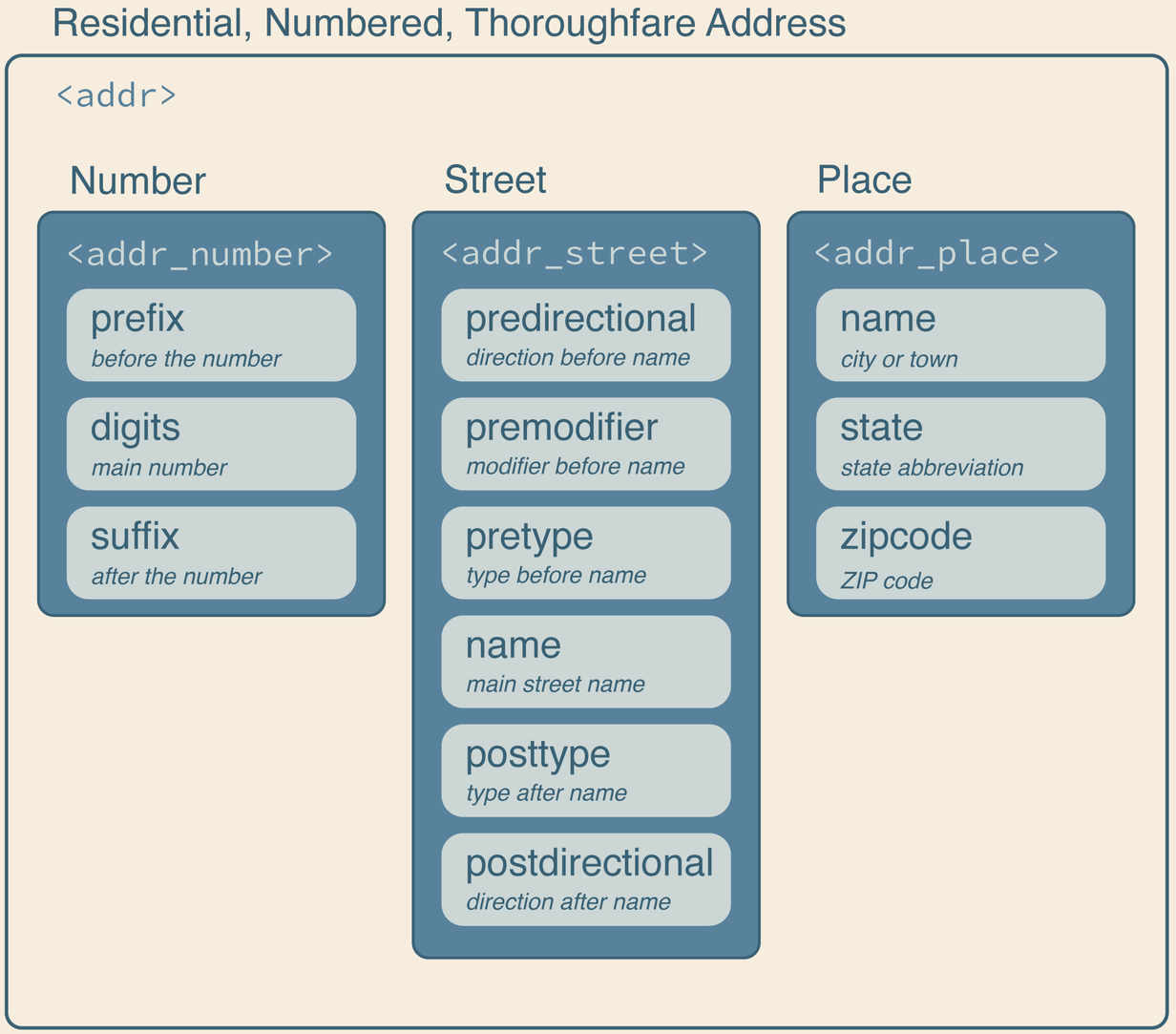
Address Matching

clean, tag, standardize → addr

match street names with string edit distance, phonetic distance

match on standardized street types and directionals

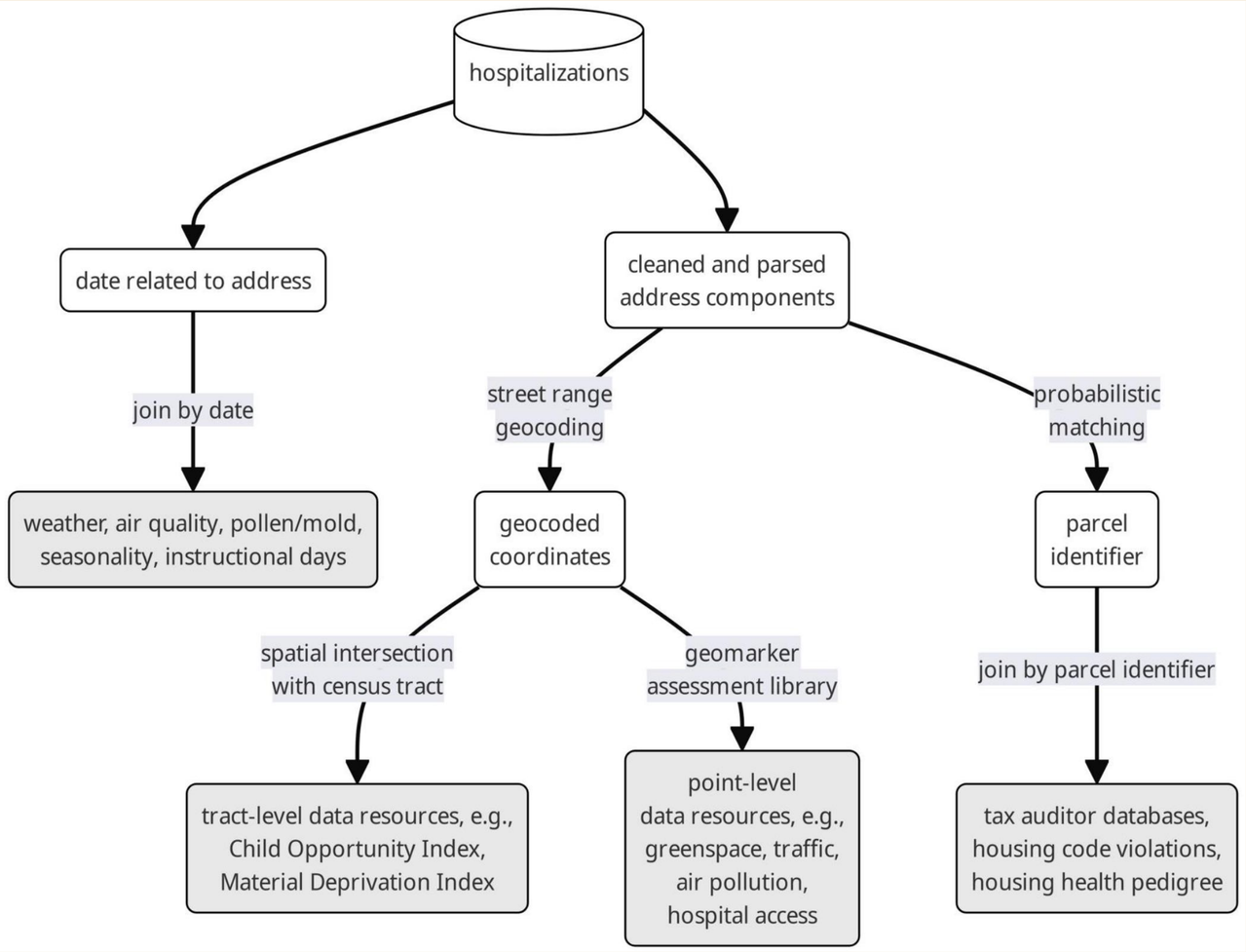
match on geographically and typographically nearby ZIP codes and places

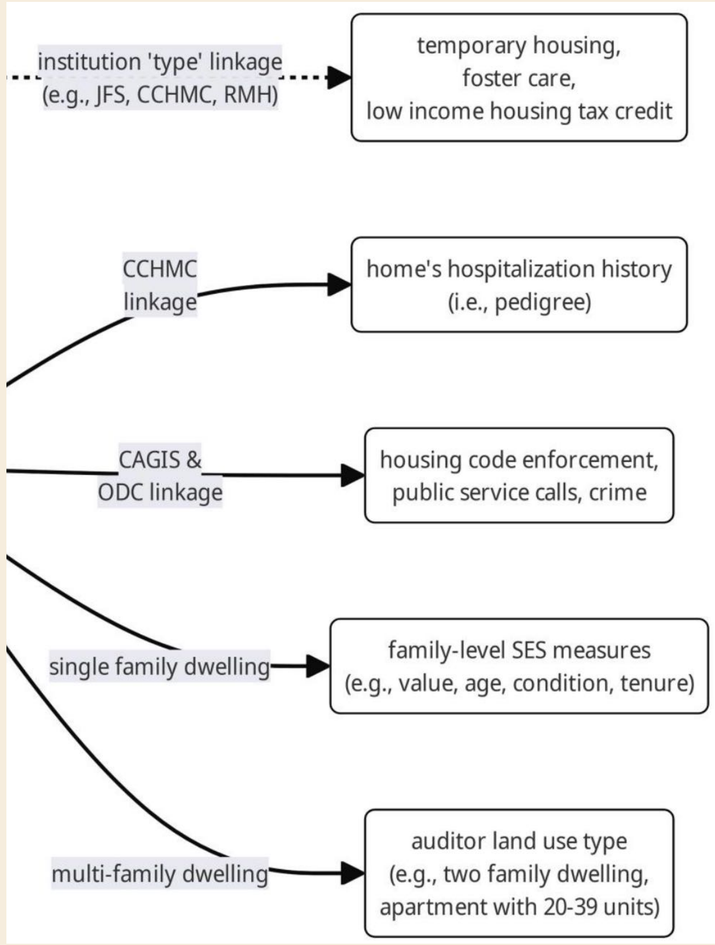


https://geomarker.io/addr

US Thoroughfare, Landmark, and Postal Address Data Standard:
https://www.fgdc.gov/standards/projects/address-data

Development of a Multimodal Geomarker Pipeline to Assess the Impact of Social, Economic, and Environmental Factors on Pediatric Health Outcomes.





Manning, Duan, Taylor, Ray, Corley, Gillette, Unaka, Hartley, Beck, Brokamp. Development of a multimodal geomarker pipeline to assess the impact of social, economic, and environmental factors on pediatric health outcomes. Journal of the American Medical Informatics Association. 31(7), 1471–1478. 2024. https://doi.org/10.1093/jamia/ocae093

Linkage Quality

Linkage quality is not just data cleaning, it changes the science

Misclassification can change effect estimates, targeting, and intervention decisions

The places where public health work matters most are often the places where sloppy linkage performs worst

Linkage error is worse in denser communities with greater material deprivation and higher hyperlocal address densities

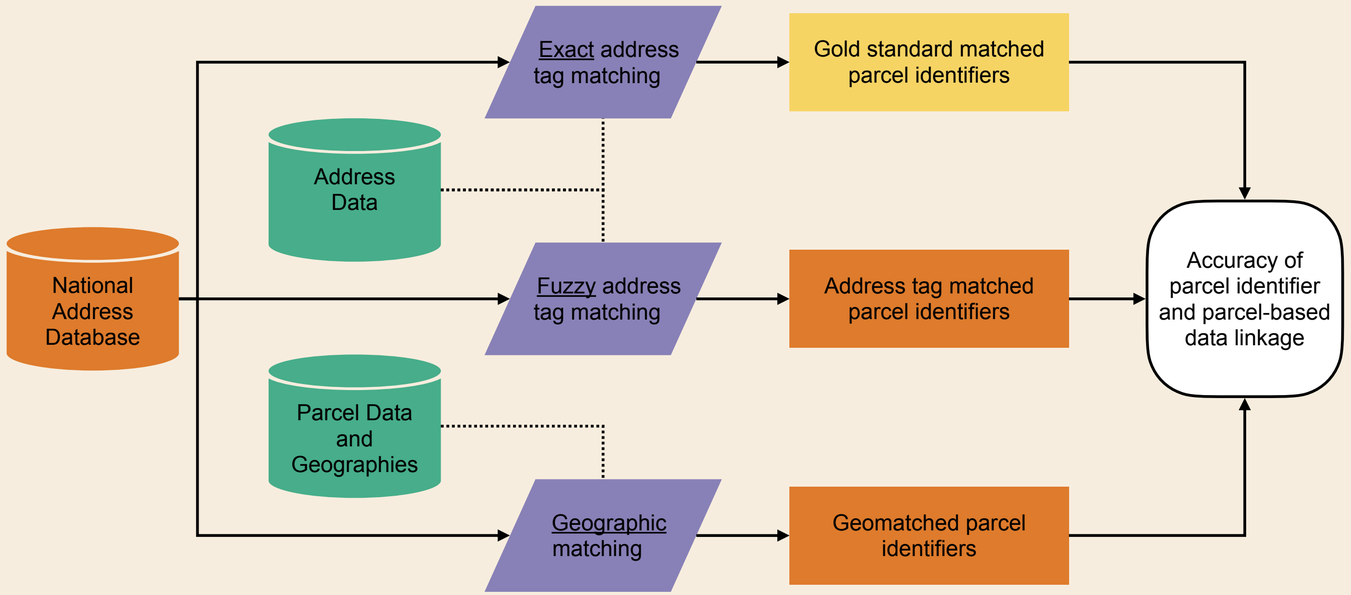
Linkage Quality and Bias

Agreement with parcel identifier using different linkage methods with 853,255 residential National Address Database records in Cincinnati and Columbus, OH

fuzzy tag match: 100%

point geomatch: 65.1% - 76.1%

range geomatch: 7.2% - 59.2%



Hartlage, Manning, Brokamp. Evaluating Linkage Approaches for Address-Level Socioenvironmental Exposure Assessment. AMIA Summits on Translational Science Proceedings. In Press. 2026. preprint: https://doi.org/10.64898/2025.12.02.25341378

Why Lead Was a Natural Starting Point

Foundational to healthy homes work in Ohio and most natural bridge to OHHN's history

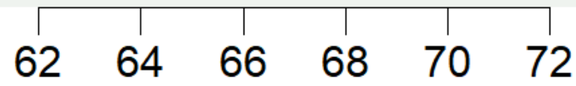
Strongly tied to housing age, condition, and surrounding environmental sources

Strongest example of research translating into practice

More precise identification of children with elevated blood lead

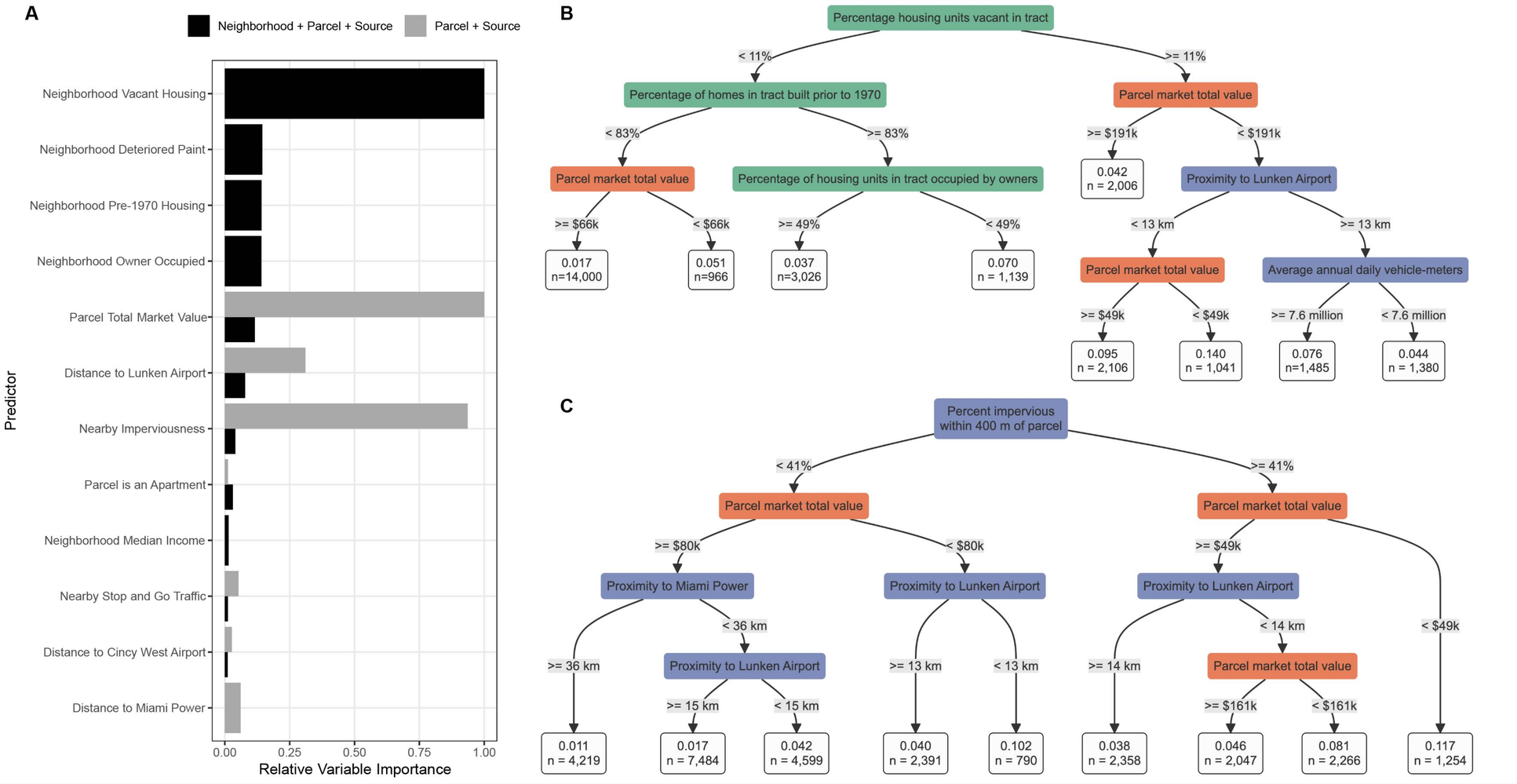
Machine learning model training place-based characteristics on 27,782 blood lead tests matched to residential parcels in Hamilton County

Model	Specificity	Sensitivity	%AUC (95% CI)
Neighborhood	63.9	63.5	66.7 (66.2-67.2)
Parcel	68.8	50.4	63.3 (62.7-63.8)
Source	66.7	61.0	68.7 (68.2-69.2)
Neighborhood + Individual	59.6	65.8	65.3 (64.8-65.8)
Neighborhood + Individual + Parcel	67.6	62.5	69.7 (69.2-70.3)
Neighborhood + Individual + Source	66.5	60.9	67.9 (67.4-68.4)
Neighborhood + Individual + Parcel + Source	67.4	64.0	70.5 (70.0-71.1)
Parcel + Source	67.8	63.4	70.8 (70.3-71.3)
Neighborhood + Parcel + Source	64.3	66.8	70.3 (69.8-70.8)



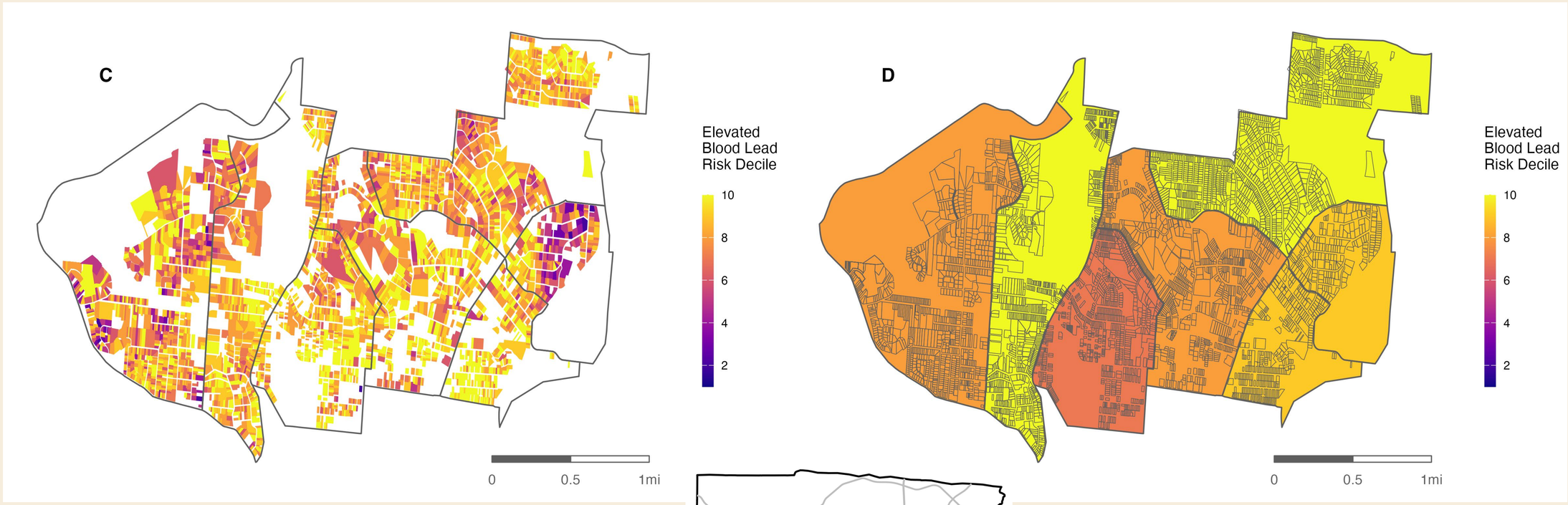
Manning, Duan, Brokamp. Incorporating Parcel-Based Housing Conditions to Increase the Precision of Identifying Children With Elevated Blood Lead. Journal of Public Health Management and Practice. 31(4), 621–630. 2025. https://doi.org/10.1097/PHH.0000000000002109

More precise identification of children with elevated blood lead



Manning, Duan, Brokamp. Incorporating Parcel-Based Housing Conditions to Increase the Precision of Identifying Children With Elevated Blood Lead. Journal of Public Health Management and Practice. 31(4), 621–630. 2025. https://doi.org/10.1097/PHH.0000000000002109

More precise identification of children with elevated blood lead



Manning, Duan, Brokamp. Incorporating Parcel-Based Housing Conditions to Increase the Precision of Identifying Children With Elevated Blood Lead. Journal of Public Health Management and Practice. 31(4), 621–630. 2025. https://doi.org/10.1097/PHH.0000000000002109

What Parcel-Level Precision Changed

Revealed heterogeneity within the same tract → identification of risk hidden in low risk tracts

Tract-, neighborhood-, or ZIP code-based screening strategies can miss children in risky homes

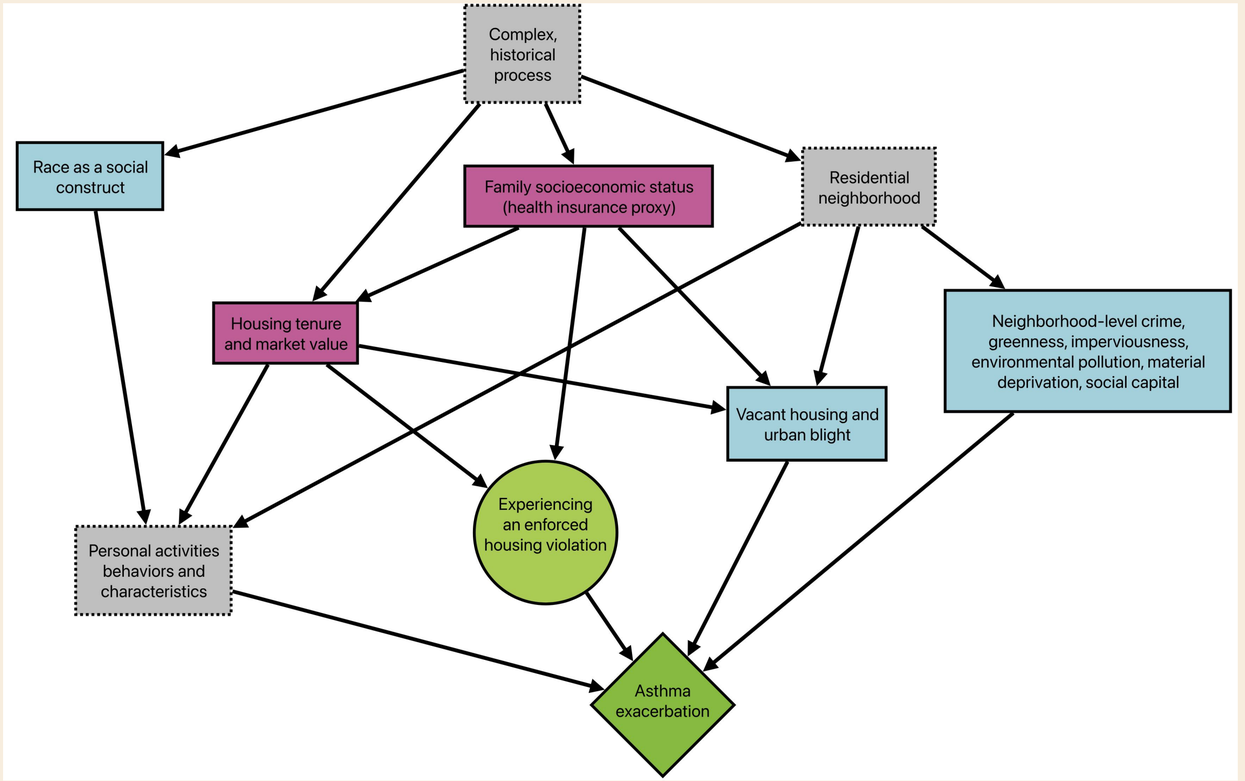
Parcel-level risk supports better targeting of screening, outreach, inspection, and remediation

Housing Infractions and Asthma Exacerbations

Housing conditions create or worsen exposures to indoor environmental exposures that can exacerbate respiratory problems

Pediatric asthma encounters linked to failed housing inspections at an area-level, but never before at an address-level at scale

Causal framework: block confounding by family- and community-level socioeconomic status



Brokamp, Ray, Duan, Hartlage, Taylor, Manning, Unaka, Jones, Henize, Beck. Parcel-Level Housing Conditions and Pediatric Asthma Hospital Utilization. Pediatrics, 156(1), e2024069375. 2025. https://doi.org/10.1542/peds.2024-069375

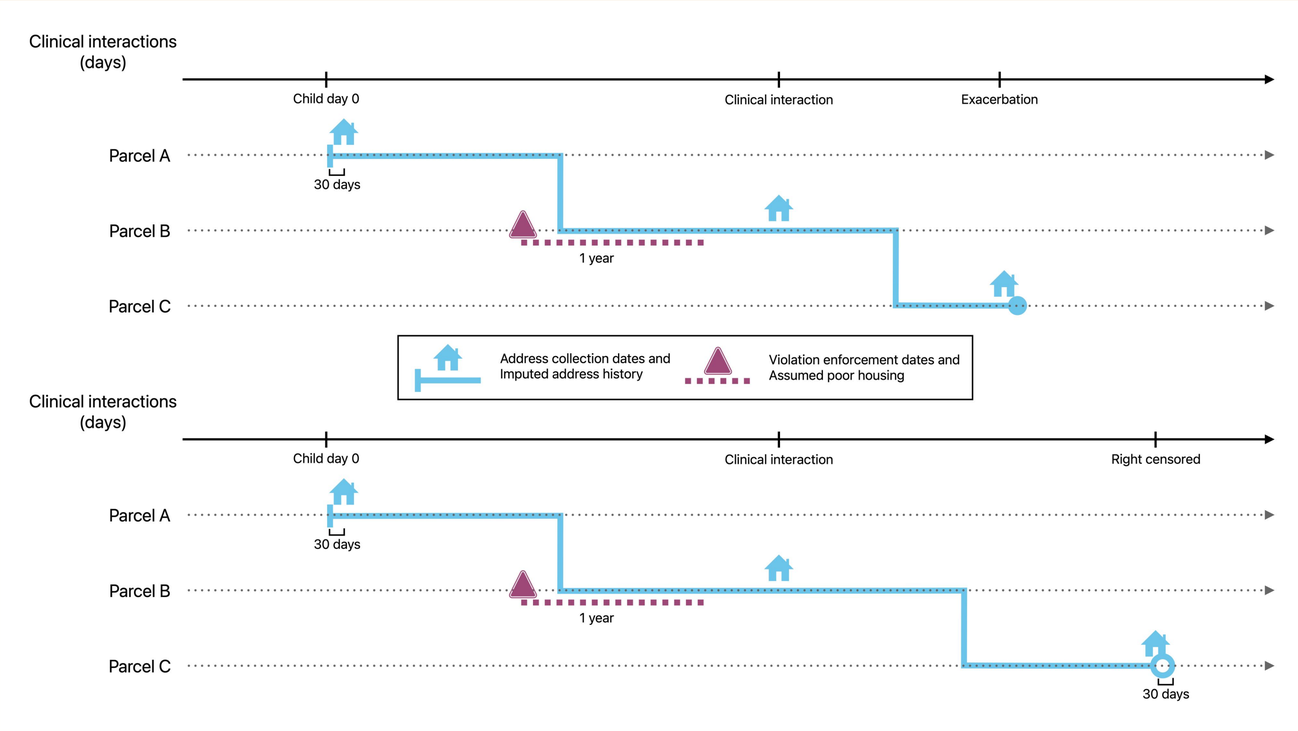
Housing Infractions and Asthma Exacerbations

Prospective follow up via electronic health records

13,404 children with asthma living across 22,762 unique addresses

About 11 million cumulative patient-days of followup between July 2016 and July 2022

12% exposed to poor housing conditions defined by a housing code infraction linked at the address level within the last year



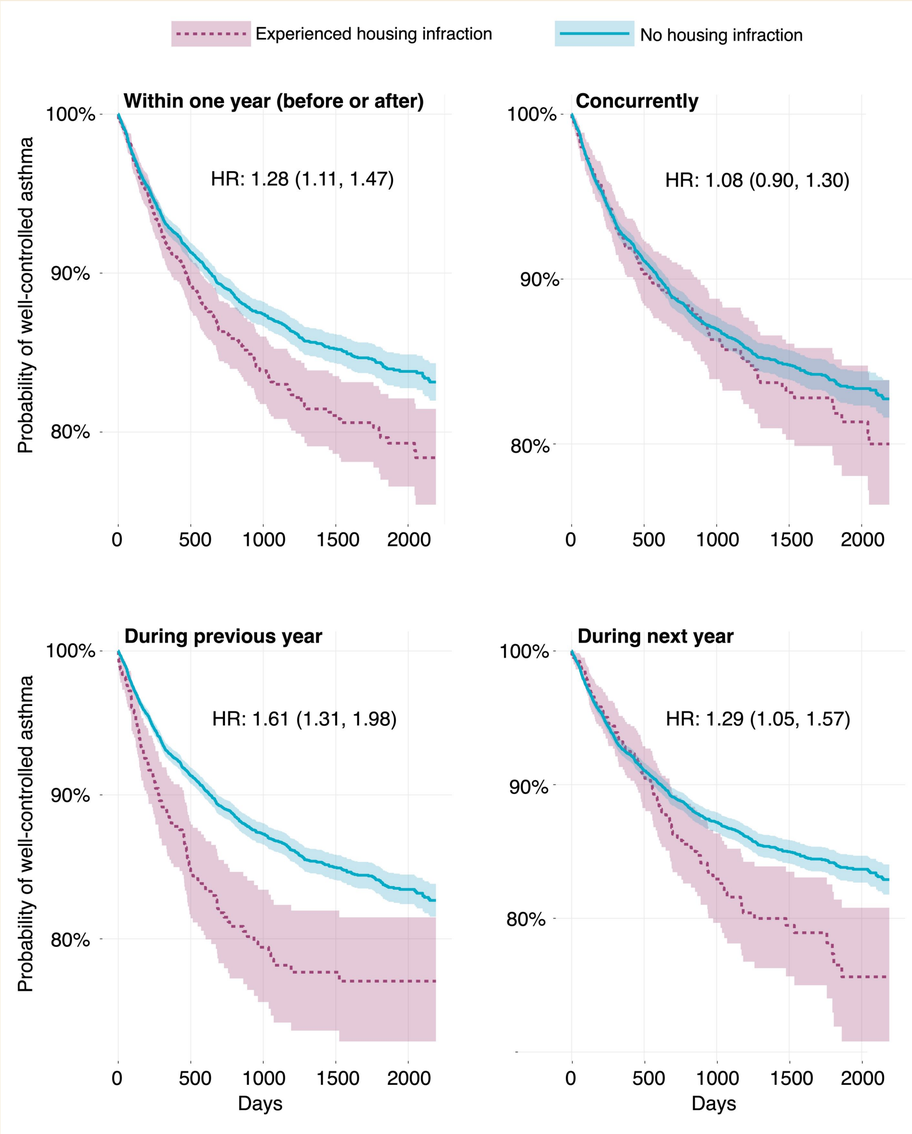
Brokamp, Ray, Duan, Hartlage, Taylor, Manning, Unaka, Jones, Henize, Beck. Parcel-Level Housing Conditions and Pediatric Asthma Hospital Utilization. Pediatrics, 156(1), e2024069375. 2025. https://doi.org/10.1542/peds.2024-069375

Housing Infractions and Asthma Exacerbations

About 10% of asthma patients experienced an exacerbation during the follow-up period

Proportional hazards models adjusted for public insurance and total market value by housing type

Living at parcel with housing code violation in the previous year associated with **33% increased risk** (95% CI: [8, 67]) of asthma exacerbation



Brokamp, Ray, Duan, Hartlage, Taylor, Manning, Unaka, Jones, Henize, Beck. Parcel-Level Housing Conditions and Pediatric Asthma Hospital Utilization. Pediatrics, 156(1), e2024069375. 2025. https://doi.org/10.1542/peds.2024-069375

Fairness and Responsible Use

Data are people

Address-level linkage can improve equity, but only if the linkage itself is fair; precision is not automatically equitable!

Detailed models should support action, not stigma

Privacy and governance still matter even when findings are de-identified

People Working Cooperatively (PWC)

www.pwchomerepairs.org

Serve low-income families with home repairs and services to help them remain independent and healthy in their homes

Have served in over a dozen counties in OH-KY-IN area for 51 years

PWC Work

Emergency home repairs: non-functional or unsafe heat, water, sewer, security, egress, electrical, roof

Mobility modifications: ramps, grab bars, handrails, stair lifts, bathrooms

Energy Conservation: weatherization, making homes more energy efficient

Volunteer Services: minor home maintenance, annual volunteer events & more

Study Question and Outcomes

PWC services plausibly affect indoor environmental quality, housing safety, injury risk, accessibility, and independent functioning.

PWC was not designed as a clinical trial or as a health intervention program and our observational methods do not rely on this.

Hypothesis: PWC services are associated with improved childhood asthma, mental health, and injury morbidity, as measured by emergency department visits and hospitalizations at Cincinnati Children's.

Setting: Cincinnati Children's serves about 180,000 kids in Hamilton County, OH and has a market share of 98% of pediatric hospitalizations.

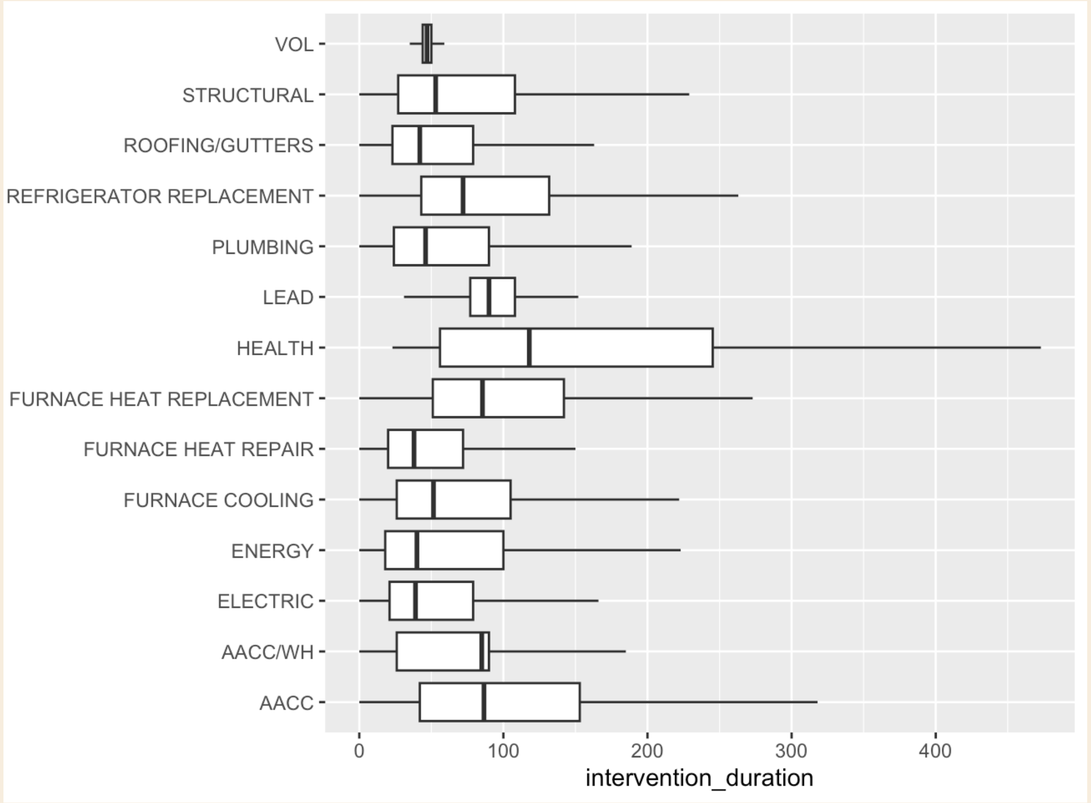
Intervention Assessment

Intervention address: receipt of PWC services, matched to National Address Database

Intervention type: category of work derived by combining > 88 administrative types of interventions

Intervention date: midpoint of job start and end dates used to impute effective date of work completion by type

Intervention assessment: temporally overlapping services at the same intervention address combined into one, categorized by earliest type



Reminder: fuzzy address matching = identical zip code, within one string edit street name, exact type/directional, exact number

Electronic Health Record Data

ED encounters or hospitalizations at Cincinnati Children's Hospital Medical Center from October 1, 205 to February 3, 2026 from OH (Hamilton, Butler, Warren, Clermont), KY (Boone, Kenton, Campbell), IN (Dearborn)

Outcomes identified using first or second billing diagnosis ICD-10 codes grouped based on the Children's Hospital Association's Pediatric Clinical Classification System (PECCS).

34,875 billing codes across 44 PECCS categories harmonized into three clinical categories: asthma (18 codes in 1 category), mental health (1,444 in 22), and injury (33,413 in 21)

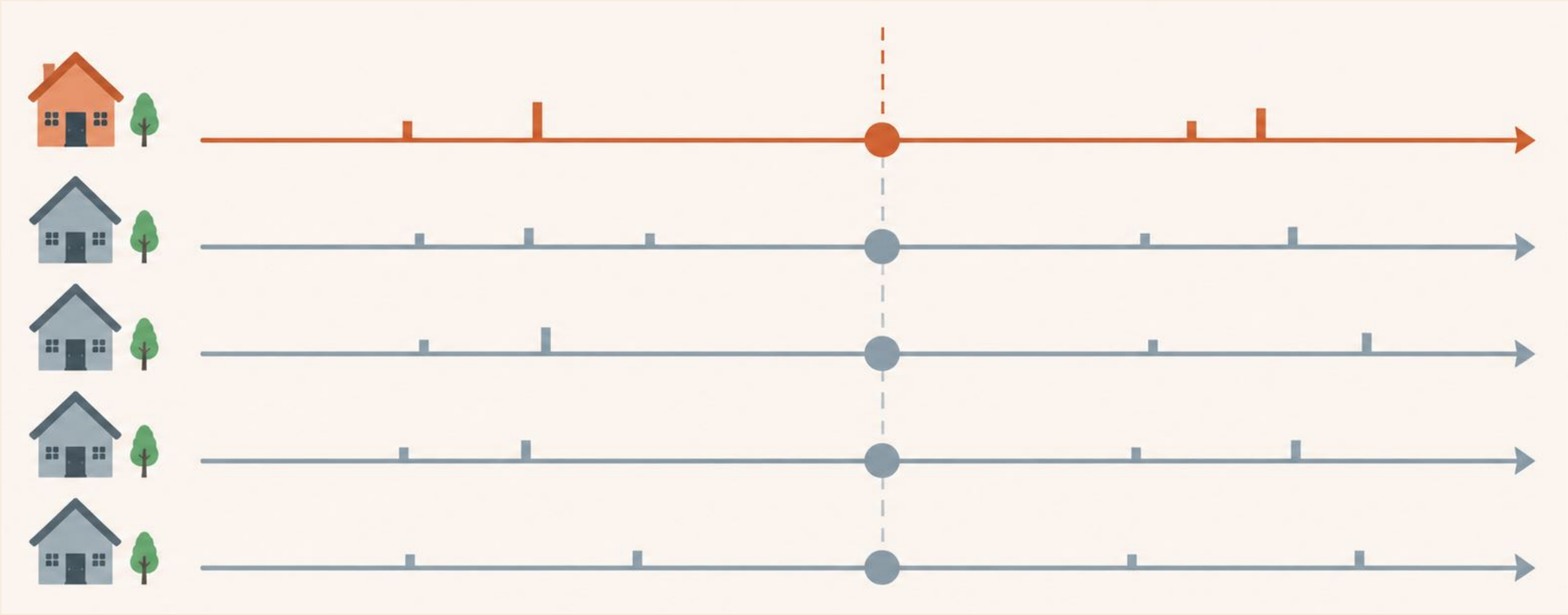
Residential address at time of hospitalization matched to National Address Database

Reminder: fuzzy address matching = identical zip code, within one string edit street name, exact type/directional, exact number

Study design

Matched address-level difference-in-differences

Link ED encounters in the 12 months before and after each intervention at each address, along with four similar, non-intervention addresses.



similar homes = same census tract; within Hamilton County on type/value

Did outcomes *change differently* after interventions in PWC addresses than in similar addresses that did not receive interventions?

Study design

Matched address-level difference-in-differences

Model number of encounters using negative binomial regression as a function of the interaction between (1) intervention status, (2) before/after status, and (3) intervention category. Include random intercepts for (1) intervention to account for shared temporal trends among groups of intervention and matched non-interventions, and (2) intervention address to account for multiple interventions happening within the same address over time.

$$number = intervention \times after \times category + (1 \mid address) + (1 \mid intervention)$$

Use estimated marginal means to compute ratio of expected counts to estimate ratio of expected number of encounters per intervention category.

Preliminary Linkage Results

50,602 PWC interventions across 20,917 unique intervention addresses

- NAD linkage matched 86% of interventions (81% of unique intervention addresses)

335,200 CCHMC emergency encounters and admissions related to asthma, mental health, or injury encounters across 188,448 unique addresses

- NAD linkage matched 87% of encounters (85% of unique encounter addresses)

In the preliminary address-based linkage, **9% of matched interventions had at least one qualifying encounter within the 12-month before/after window**

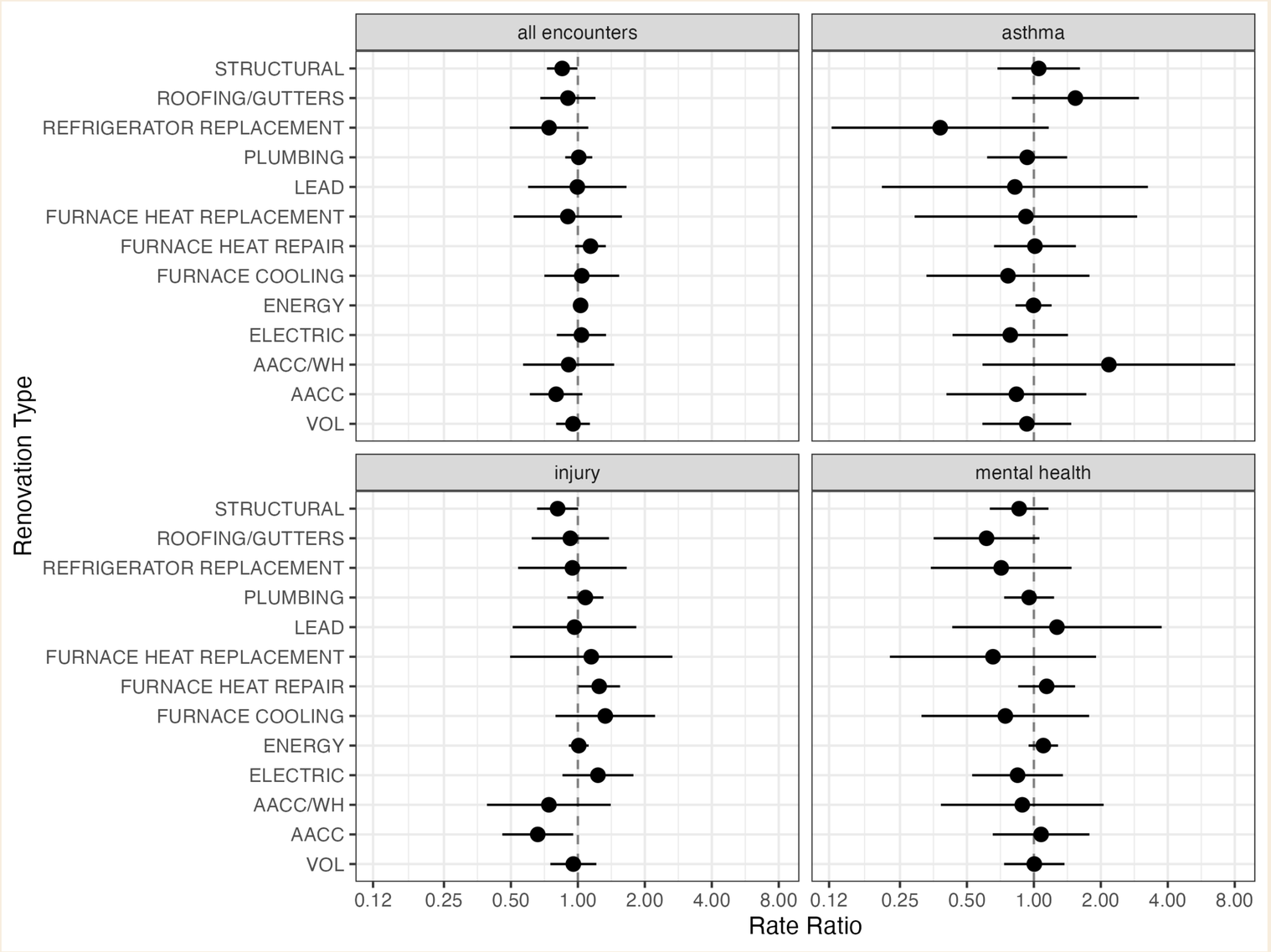
Preliminary Results

Eight County Region

19,545 (7%) encounters at address within 12 months of PWC services

Structural interventions reduce all types of ED encounters, with the most impact on encounters related to injuries.

Accessibility modifications also reduced pediatric emergency department utilization specifically related to injuries.



Future Analyses

Methods

- More address matching improvements
- Sensitivity of choices required for job classification and timing; combining overlapping jobs into one bundled intervention
- Further matching on Ohio Code land use type and market total value of parcel in Hamilton County to better match similar addresses
- Consider monthly effects from monthly baselines using a patient-level panel study design
- Characteristics of encounters as further effect modifiers (admission, age, chronic/complex care)

Address-level Linkage…

… changes what we can see

… better connects housing work to measurable health outcomes

… creates a credible framework for evaluating real-world housing interventions

With the right linked data, healthy homes work and community partnership can be made more visible, more defensible, and more actionable.

Thank you to Erika Manning, Carson Hartlage, Patrick Ryan at CCHMC and Aaron Grant, Diana Adams, Nina Creech at PWC.