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Redlining's Legacy on Blood Lead Levels and Abatement Spending in Lansing, MI

Summary

The historical discriminatory practice of "redlining" in the 1930s and 1940s led to socioeconomic and racial inequalities that still exist to this day. A study found that children in Michigan have detectable blood lead levels at a rate almost double the national average, making it critical to understand how historical redlining impacts current lead exposure and the allocation of Lead Safe Lansing abatement funds. This study aimed to determine if there is a statistically significant correlation between historical redlining and proportion of children with elevated blood lead levels and a statistically significant correlation between historical redlining and money spent by the City of Lansing's Lead Safe Lansing Remediation on lead abatement projects. A statistically significant correlation was found between ZIP codes with more Grade C labeled areas and proportion of children with elevated blood lead levels. There was no statistically significant correlation found between historical redlining categories and Lead Safe Lansing lead abatement rehabilitation costs.

Problem Statement

In 1934, the Federal Housing Authority prevented residents of neighborhoods with non-white families or where housing was deteriorated from receiving mortgage loans.[1] These neighborhoods were declared "hazardous" and labeled red on maps, hence the term "redlining".[2] The effects of this discriminatory practice are still felt in redlined neighborhoods across the

[1] Karp, Robert J. "Redlining and Lead Poisoning: Causes and Consequences." *Journal of Health Care for the Poor and Underserved* 34, no. 1 (2023): 431–46. https://doi.org/10.1353/hpu.2023.0028.
[2] Ibid.

country today. Research has found that those living in historically redlined neighborhoods have higher exposure rates to air, water, and noise pollutants as well as other health problems.[3]

Lead is heavy metal that can cause harm to human nervous, hematopoietic, endocrine, renal, and reproductive systems, with young children being especially vulnerable to the effects of lead.[4] The use of lead-based paint was banned in the U.S. in 1978, but still exists in many historic homes across the country.[5] Research has found that the risk of lead exposure is significantly higher for families living in older homes, families living in poverty, and non-hispanic Black households.[6] The socioeconomic and racial inequalities that exist because of lingering effects of redlining can act as a predictor of children with EBLLs.

There have also been many government initiatives to reduce lead exposure in homes across the country. However, government funding creates barriers, making it difficult to use government funds on certain properties, meaning that many cities see federal grants for lead removal go unused.[7] This is a problem that Erin Buitendorp and Tyler Blakey face at Lead Safe Lansing, a program designed to give Lansing, MI homeowners grants to remove lead from their homes.[8] Lead Safe Lansing has also faced funding issues, including unused funds being taken back by the government, making it important to know how and where funds have been used and can be used.[9]

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[3] Lathan, Nadia. "50 Years after Being Outlawed, Redlining Still Drives Neighborhood Health Inequities." UC Berkeley Public Health, September 20, 2023. https://publichealth.berkeley.edu/articles/spotlight/research/50-years-after-being-outlawed-redlining-still-drives-neighborhood-health-inequities.

[4] Chu, MyDzung T., Andrew Fenelon, Gary Adamkiewicz, and Ami R. Zota. "Federal Housing Assistance and Blood Lead Levels in a Nationally Representative US Sample Age 6 and Older: NHANES, 1999–2018." *Environmental Health Perspectives* 132, no. 3 (2024): 037004. https://doi.org/10.1289/EHP12645.

[5] Ibid.

[6] Ibid.

[7] Fortner, Sarah. "Erasing the Redline." AAC&U, Winter 2021. https://www.aacu.org/liberaleducation/articles/erasing-the-redline.

[8] Erin Buitendorp, Tyler Blakey, "L16: Erin Buitendorp Visit," October 23, 2025.

[9] Erin Buitendorp, "L04: Erin Buitendorp Visit," September 4, 2025.

Lead abatement is a particularly pressing issue in Michigan where a study found that out of children tested for blood lead levels between October 1st, 2018 and February 29, 2020, 78% of children had detectable blood lead levels and 4.5% of children had elevated blood lead levels, almost double the national average EBLL of 1.9%.[10] Lead Safe Lansing is doing a small part in fixing decades of disinvestment and discrimination that have led to lead exposure, so it's important to Buitendorp and Blakey to understand how redlining impacts their work, and how their funds are being allocated and used.[11]

Research Questions

1. Is there significant correlation between historical redlining categories in Lansing, MI and the proportion of children with elevated blood lead levels in 2024?
2. Is there significant correlation between historical redlining categories in Lansing, MI and Lead Safe Lansing money spent on lead abatement projects?

RQ1 Analysis: Is there significant correlation between historical redlining categories in Lansing, MI and the proportion of children with elevated blood lead levels in 2024?

Analysis

The childhood lead testing data gathered by MiTracking contains blood lead results for Michigan children under 6 years of age. The data contains information about total number of children tested and number of children with elevated blood lead levels (EBLL) at two different thresholds (3.5 and 5 µg/dL) aggregated by year tested and ZIP code. I made the decision to only look at data from 2024 to avoid violating independence assumptions that would occur from including the same children multiple times if they had tests across multiple years. I also decided

[10] Hauptman, Marissa, Justin K. Niles, Jeffrey Gudin, and Harvey W. Kaufman. "Individual- and Community-Level Factors Associated With Detectable and Elevated Blood Lead Levels in US Children: Results From a National Clinical Laboratory." *JAMA Pediatrics* 175, no. 12 (2021): 1252. https://doi.org/10.1001/jamapediatrics.2021.3518.
[11] Erin Buitendorp, Tyler Blakey, "L16: Erin Buitendorp Visit," October 23, 2025.

to look at the number of children with EBLLs above 3.5 μg/dL because research has shown that even low blood lead levels increase risk for lead-related health complications.[12] For privacy reasons, MiTracking suppresses counts between 1 and 5. In the Lansing data, this only affected one ZIP code, 48933, and I chose to deal with this by replacing the suppressed number of children with an EBLL with the midpoint (3), the consequences of this decision will be discussed below.

GeoJSON data was used to map ZIP code boundaries and historical redlining in Lansing. The ZIP code area covers a larger area than the historical redlining map, and multiple historical redlining categories cover one ZIP code. To deal with this, I chose to find the percentage of ZIP code that each redlining grade covers. The consequence of this decision is that there are large swaths of land organized by ZIP code that are not included in the historical redlining maps.

Findings

A binomial logistic regression was run with the number of children with EBLLs as successes and the number without EBLLs as failures, using the percent of ZIP code area covered by each historical redlining grade (A: Best, B: Still Desirable, C: Definitely Declining, D: Hazardous) as predictors. Due to data suppression in ZIP code 48933 (range: 1-5 children with EBLL), the binomial logistic regression was run multiple times as a sensitivity analysis, testing each possible value (1, 2, 3, 4, and 5) for this suppressed count. Across this range, Grade C's correlation remained statistically significant at $p<0.5$. Grade D's correlation remained statistically significant at $p<0.5$ for values 1-3, statistically significant at $p<0.10$ for value 4, and non-significant for value 5. These findings show Grade C's correlation to be more robust than Grade D's correlation. All five models had an $R^2>0.97$, indicating a strong model fit. However,

[12] Chu, MyDzung T., Andrew Fenelon, Gary Adamkiewicz, and Ami R. Zota. "Federal Housing Assistance and Blood Lead Levels in a Nationally Representative US Sample Age 6 and Older: NHANES, 1999–2018." *Environmental Health Perspectives* 132, no. 3 (2024): 037004. https://doi.org/10.1289/EHP12645.

the robustness of these findings may be affected by the small sample size (only 8 ZIP codes in Lansing).

Visualizations

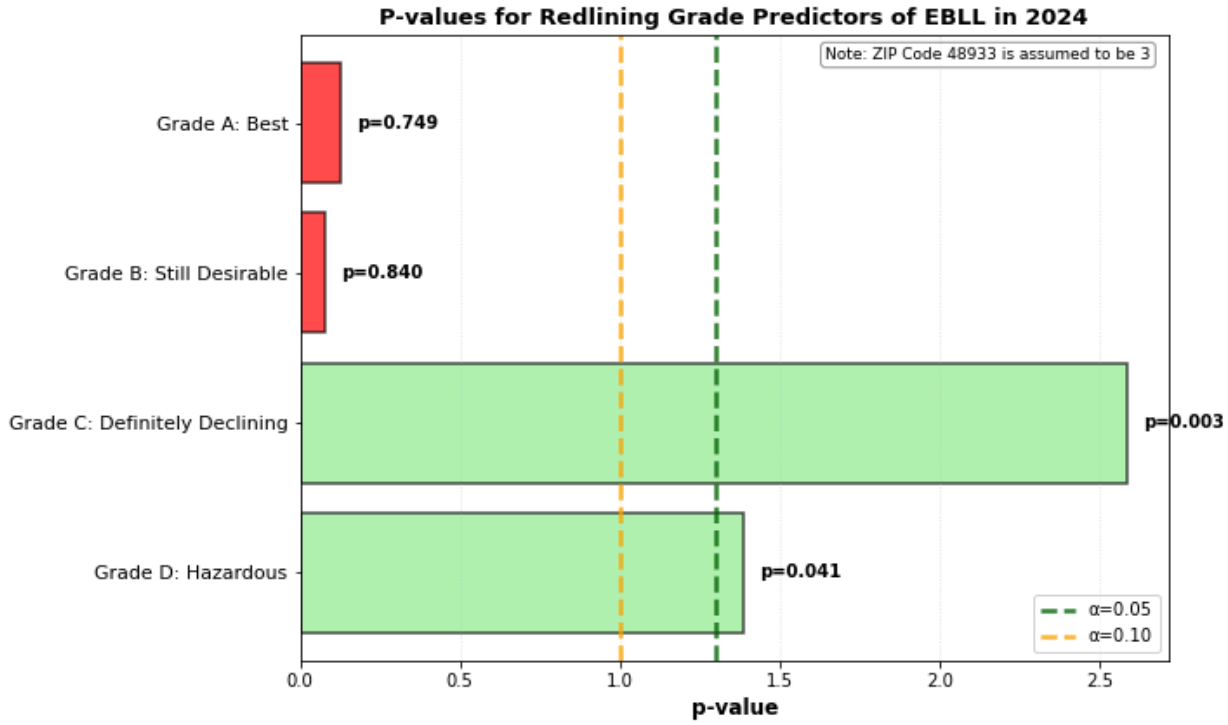

Figure 1: Statistical significance (p-values) of historical redlining grades as predictors of childhood EBLL in binomial logistic regression analysis.

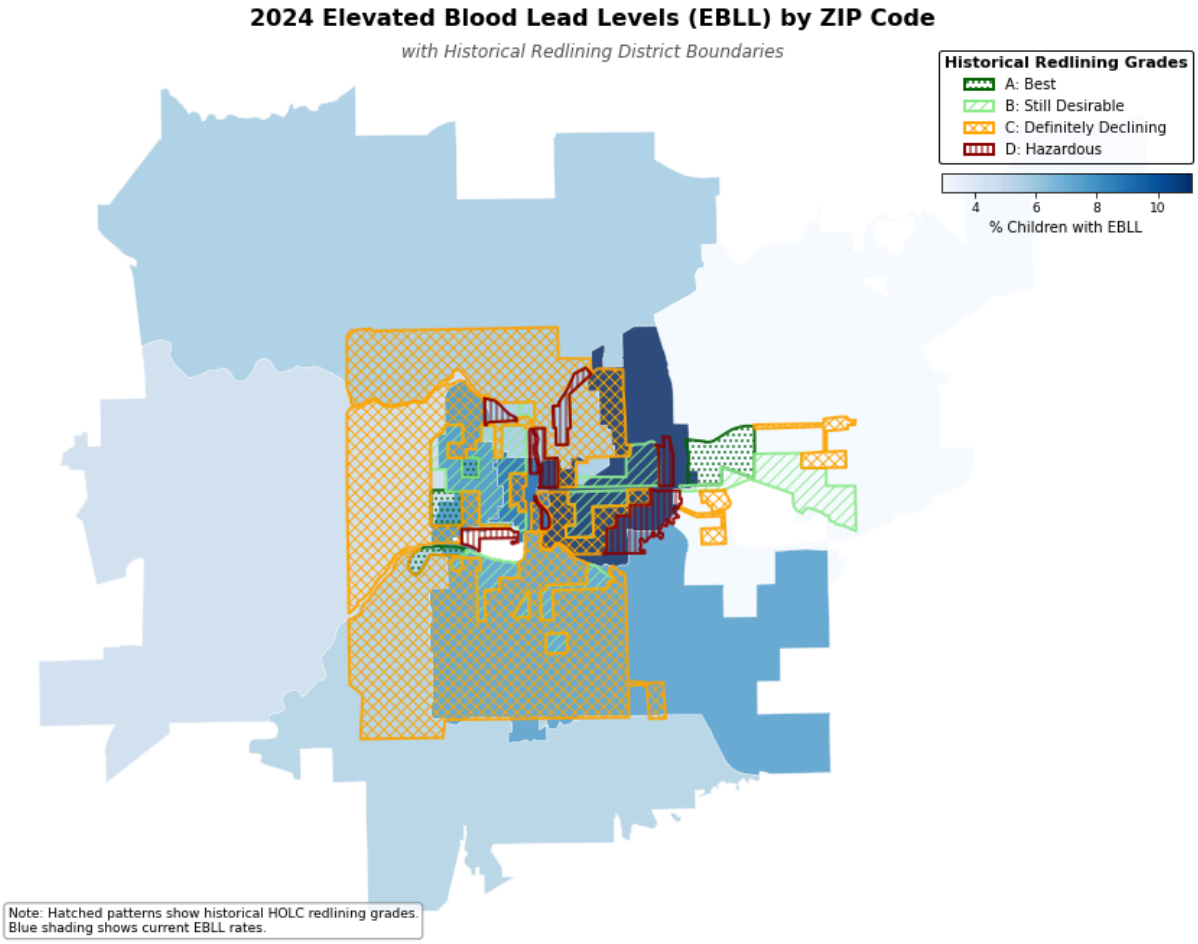

Figure 2: Percentage of children with EBLLs in 2024 by ZIP code in Lansing, MI, overlaid with historical redlining district boundaries.

Interpretations

The analysis finds statistical significance for neighborhoods graded 'C: Definitely Declining' across all values, and tentative statistical significance for neighborhoods graded 'D: Hazardous'. These findings align with existing research that found historically redlined communities experience ongoing socioeconomic inequalities that contribute to elevated rates of lead exposure. However, there are several limitations that may affect the accuracy of the model. First, the small sample size and reliance on a single suppressed data point introduces uncertainty,

particularly for the Grade D association. Secondly, using ZIP codes to organize the data into historical redlining categories leaves room for misinterpretation. ZIP codes often encompass both historically redlined and non-redlined neighborhoods. Future research would benefit from more geographic specificity to more precisely link children to historical redlined neighborhoods.

RQ2 Analysis: Is there significant correlation between historical redlining categories in Lansing, MI and Lead Safe Lansing money spent on lead abatement projects?

Analysis

Data collected by Lead Safe Lansing contains information for single family and rental abatement projects. To get information on properties with lead, only properties where the lead test results were 'ABATE' (Abatement (lead)), 'BOTH' (both abate and interim), and 'INTERIM' (lower-level of lead containment). This decision was made based on research that found that any lead exposure can be a risk.[13] The data contains a column for address, street, and direction that was aggregated into one column. I used the U.S. Census Geocoder API To get the coordinates of each property. Each coordinate was then overlaid on the historical redlining map used in RQ1 to determine the grade of the neighborhood each property was in. There were originally 522 properties that tested for lead. After dropping any properties with no coordinates, rehabilitation cost information, and redline grade, there were 496 properties used in the final model.

Findings

An ordinary least squares (OLS) regression was conducted to examine the relationship between historical redlining grade and total property rehabilitation costs. There was no statistically significant relationship between historical redlining grade and total property

[13] Chu, MyDzung T., Andrew Fenelon, Gary Adamkiewicz, and Ami R. Zota. "Federal Housing Assistance and Blood Lead Levels in a Nationally Representative US Sample Age 6 and Older: NHANES, 1999–2018." *Environmental Health Perspectives* 132, no. 3 (2024): 037004. https://doi.org/10.1289/EHP12645.

rehabilitation costs. However, the model did not meet assumptions of constant variance and normality. The residuals vs. fitted values shows heteroscedasticity and the Q-Q plot shows a severe violation of normality. When a log transformation was applied, the model still did not meet assumptions of constant variance and normality. A box plot (Figure 3) of the rehabilitation cost by redline grade shows that the median rehabilitation cost is slightly more for properties in historically Grade B and C neighborhoods. This plot also shows numerous outliers that may be affecting the model. There would have to be further exploration of the data to create a model that met the assumptions needed to draw statistical conclusions about the relationship between historical redlining grade and total property rehabilitation costs.

Visualizations

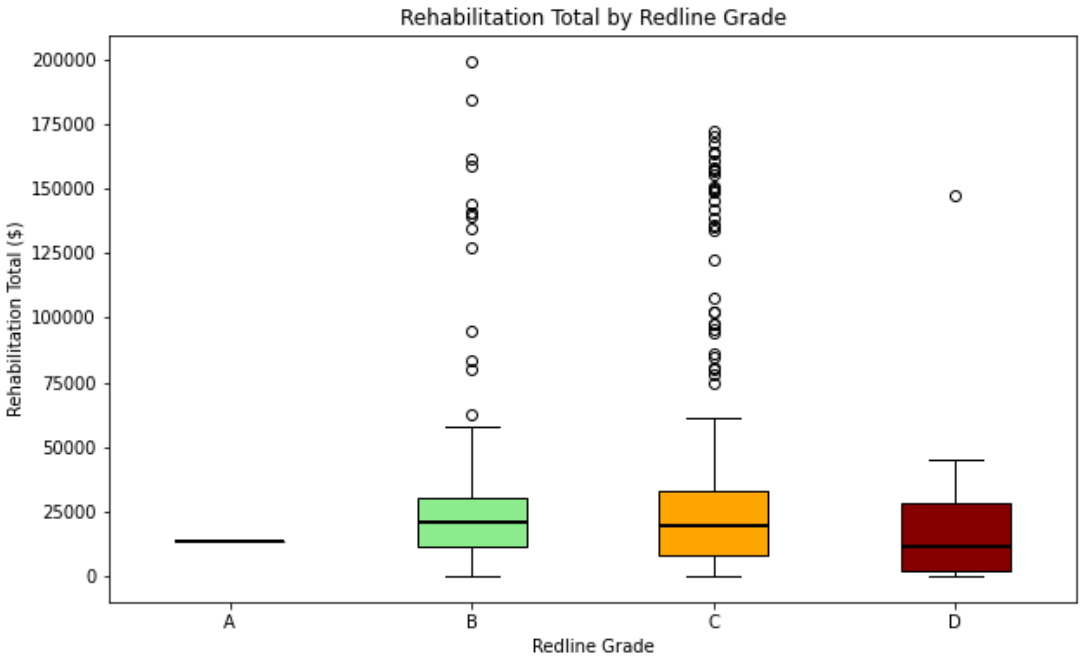

Figure 3: Box plot of rehabilitation costs by historical redlining grade.

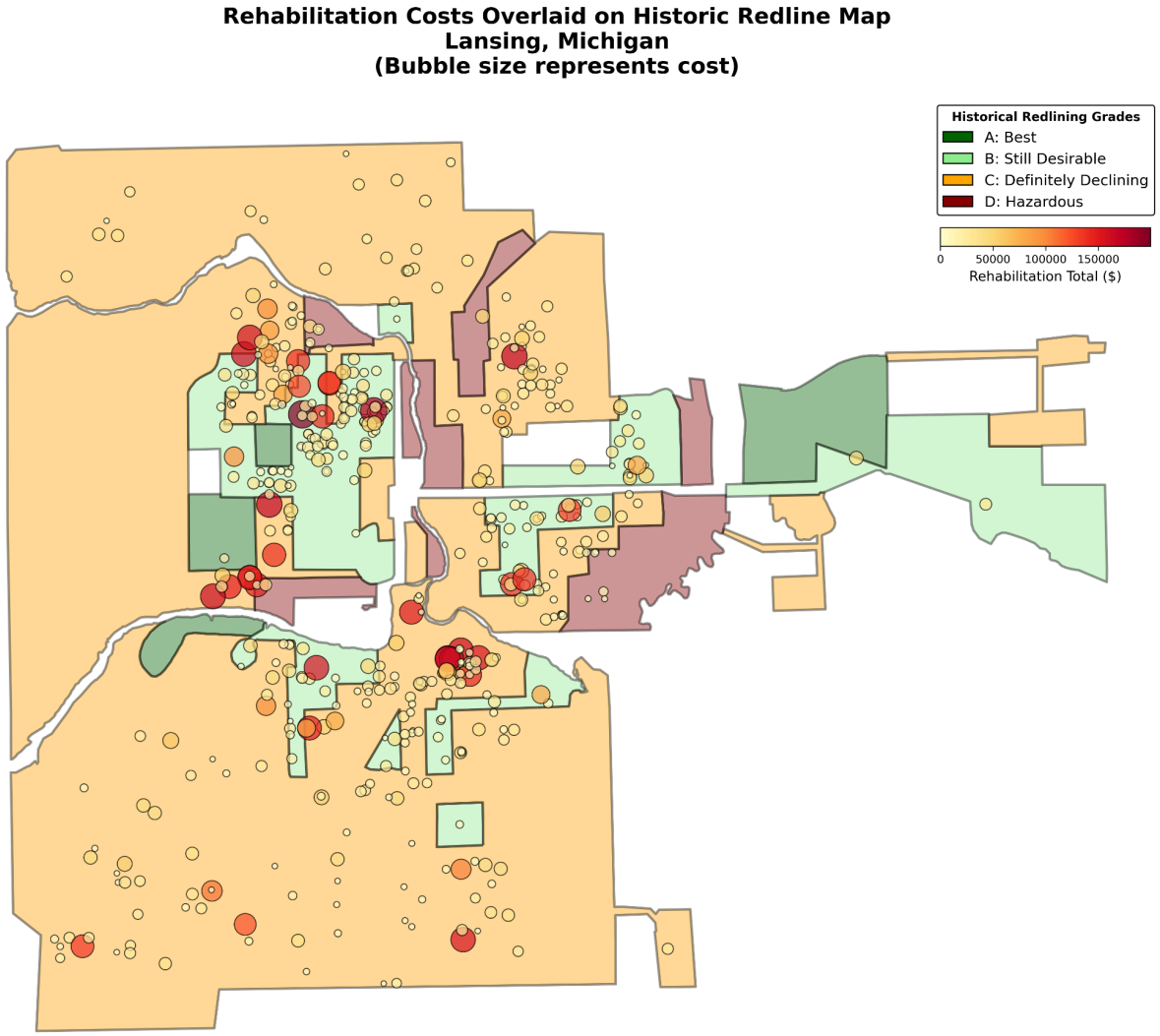

Figure 4: Geographic distribution of rehabilitation costs in Lansing, MI overlaid on historical redlining boundaries where bubble size represents cost.

Interpretations

The analysis found no statistically significant relationship between historical redlining grade and total property rehabilitation costs. My expectation was that there would be a statistically significant relationship because my finding in RQ1 showed possible evidence of more lead exposure in historically redlined neighborhoods which would lead to more costs in lead abatement projects. However, visual analysis of Figure 4 shows that there are very few

projects that have been in neighborhoods that were historically categorized as ‘Hazardous’. The research shows that these neighborhoods are at higher risk for lead exposure. Further exploration of properties in these neighborhoods is needed to determine if there are properties that are at high risk of lead contamination. Homeowners and renters in these neighborhoods may not be aware of the dangers of lead or Lead Safe Lansing. There may be an opportunity for Lead Safe Lansing to connect with homeowners and renters in these areas to initiate lead abatement projects.

Conclusion

Recommendation 1: Census tract or block group-level blood lead data collection and reporting

Audience: Michigan Environmental Public Health Tracking Program (MiTracking)

The analysis done for research question 1 was largely hindered by data aggregation at the ZIP code level, removing the specificity needed to analyze the relationship between historical redlining practices and proportion of children with EBLLs. It is important for MiTracking to collect EBLL data on a census tract or census block group-level in order to better understand the current impacts of historical redlining. More specificity in the aggregation of data would enable more accurate identification of high-risk areas, increasing understanding of the ongoing effects of discriminatory practices. This will also help Michigan government officials understand how policies can impact community health decades later, and how to prevent harmful policies from being put in place.

Recommendation 2: Targeted outreach to historically ‘Hazardous’ redlined neighborhoods

Audience: Erin Buitendorp and Tyler Blakey at Lead Safe Lansing

Visual analysis of Figure 4 shows that there are few Lead Safe Lansing lead abatement projects in neighborhoods that were historically categorized as ‘Hazardous’ despite research showing that these areas are at high risk for lead exposure. Additionally, the binomial logistic

regression model found a possibly statistically significant correlation between Grade D neighborhoods and an increase in proportion of children with EBLLs. This suggests that residents in these neighborhoods, despite high likelihood of lead exposure, may face barriers to accessing Lead Safe Lansing services, whether due to lack of awareness, trust issues with government programs, or administrative obstacles. Lead Safe Lansing should prioritize community outreach efforts in Grade D neighborhoods through partnerships with local community organizations, churches, and schools to build trust and raise awareness about lead dangers and available remediation services.