# Overlapping Risk Factors: Housing Characteristics Predictive of Childhood Lead Exposure (Boston, MA)

## Introduction

Despite conclusive evidence regarding the harmful health effects of childhood lead exposure, lead poisoning remains a significant public health problem. Healthy People 2020 goals include the elimination of blood levels ≥ 10µg/dL (CDC, 2015). Risk factors associated with lead poisoning are multifaceted and overlapping. Children who are at particular risk for exposure to lead are those who are poor and are African American or Hispanic (CDC, 2004). Housing also plays a significant role in likelihood of exposure, as children who live in pre-1979 housing (the law banning the use of lead paint was passed in 1978) (CDC, 2004), in lesser-valued housing (Kim, 2002), or in rental units (CDC, 2004) are more likely to be exposed. Unsurprisingly, many of these risk factors have been well-demonstrated to be correlated with one another. Boston has been identified as a "high risk community" for lead poisoning, although some neighborhoods experience a disproportionately high burden (Knorr, 2015).

Identifying current housing characteristics in Boston that raise the risk of lead exposure may facilitate the effective targeting of lead exposure prevention efforts at a regional level. As described above, certain housing characteristics are demonstrated to be associated with lead exposure. In order to further our understanding of neighborhood risk as well as inter-correlated risk factors for lead exposure in children, this project aims to:

- Visually assess whether one (or more) of these variables is an effective predictor of Boston neighborhood risk.
- Visually assess inter-relationships and overlapping risk between identified housing status predictors with poverty and racial/ethnic status within Boston neighborhoods.

## Methodology

Data for lead incidence was obtained from the Massachusetts Department of Public Health. Data was for blood samples drawn January 1, 2011-December 31, 2015 for children ages 0 to 71 months. Incidence of confirmed blood lead levels was defined as ≥ 5µg/dL (venous and confirmed capillary). Census tracts with screening counts below 50 were not shown. Data related to housing value (percent below the Boston median value of $486,500), housing age (percent built before 1979), housing rental status (percent rented), poverty status (percent below the poverty line), and racial/ethnic status (percent non-White) were collected from the U.S Census Bureau American FactFinder's 2014 American Community Survey (5-year estimate). Data was joined to a Boston census tract shapefile (obtained from American FactFinder) and displayed as a choropleth map. Boston neighborhoods (shapefile obtained from the City of Boston) were identified as having disproportionately high lead incidence based on a visual assessment of levels of incidence by census tracts (contained within each neighborhood). The housing characteristics most geographically correlated with higher incidence of lead was identified based on a visual assessment of the overlap between each housing characteristic with incidence of lead exposure (for each neighborhood). The identified geographically correlated housing characteristics was displayed on a choropleth map with poverty status and racial/ethnic status. Maps were created in ArcGIS, version 10.2.2 (Esri, Redlands, CA).

**Figure 1:**

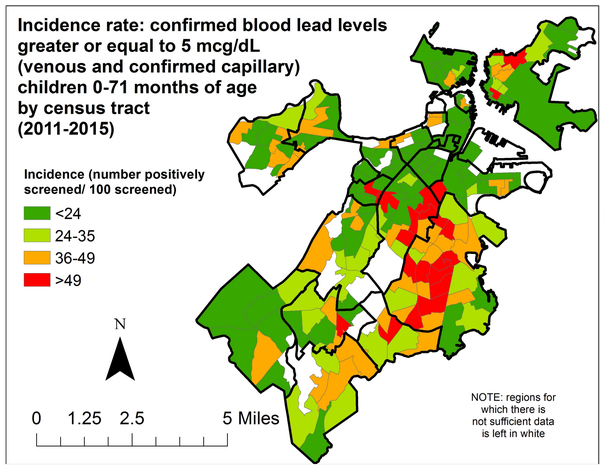
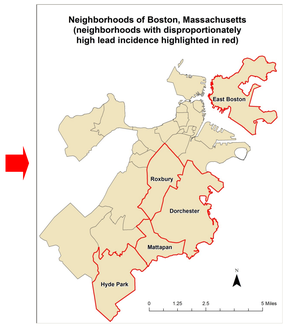



**Figure 2:**




## Results

Reviewing Figure 1, census tracts with higher incidence rates (number of positively screened children per 100 children screened) of lead exposure seem to be clustered mainly in East Boston, Hyde Park, Roslindale, Mattapan, and (especially) Dorchester. Reviewing Figures 3-5, a visual assessment finds that housing characteristic risk factors are generally correlated with high-risk neighborhoods. However, the housing value variable seems to be most strongly correlated with neighborhood risk, with the greatest proportion of homes under the median home value clustered in high-risk neighborhoods. Figures 6-7 visually display how different levels of lead exposure risk overlap with one another. Poverty levels and non-White racial/ethnic makeup are highest in high-risk neighborhoods. Census tracts with >90% of homes below the median home value also tend to overlap with high poverty levels as well as non-White racial/ethnic makeup.

### Housing characteristics:

**Figure 3:**

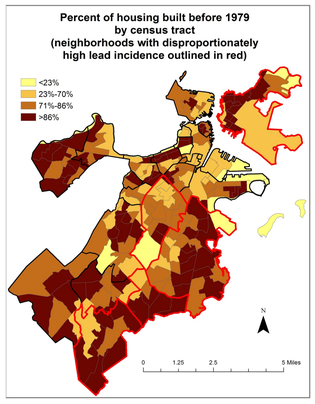
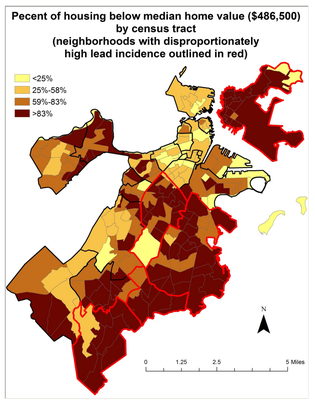



**Figure 4:**

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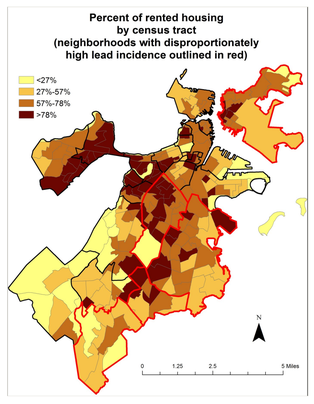



## Discussion

The finding of higher incidence rates in the Dorchester, East Boston, Hyde Park, Roslindale, and Mattapan neighborhoods is consistent with exiting research (Knorr, 2015). That housing value, rental status, and housing age are all correlated with high-risk neighborhoods is also consistent with the literature citing these variables as risk factors for exposure (CDC, 2004a, Kim 2002). The identification of housing value as being an especially strong predictor of lead exposure incidence indicates that assessment of median home value is an efficient predictor of lead exposure risk at a neighborhood level. Figures 6-7 illustrate how poverty levels and racial/ethnic makeup (respectively) are predictors of neighborhood risk for lead exposure, and yet also are correlated with regional median home value.

Risk factors of lead exposure in children are not singular or straightforward. While certain housing characteristics have been identified as being efficient predictors of lead exposure risk, both in the literature as well as in this analysis, other societal factors need to be taken into account as well. Housing value is unsurprisingly also correlated with neighborhood poverty status and racial/ethnic makeup. The implication that minority and low-income populations are therefore at the highest risk for childhood lead exposure is worrisome. Considering that lower value homes tend to be situated in low income, diverse neighborhoods, policy and preventative efforts need to take these overlapping risk factors into account. While Massachusetts offers tax incentives and interest free loans to homeowners to delead their homes, this requires a substantial initial investment. Those who are most in need of assistance with reducing lead exposure may not have the resources to make such an investment. Further research is important to help further understand the interrelationships between lead exposure risk factors, as well as the implication of these on public health policy and prevention efforts.

An important limitation of this analysis is that lead incidence and housing characteristic data was not available at a neighborhood level. Instead, census tract-based data had to be used. As neighborhood boundaries are created based on multiple factors, including census tract boundaries, the overlap between neighborhood and census tract boundaries was not precise. As such, census tracts that span across two neighborhoods may mask inter-neighborhood disparities in that region. However, the overlap was deemed close enough to warrant visual analysis assessments performed in this analysis.

**Figure 6:**

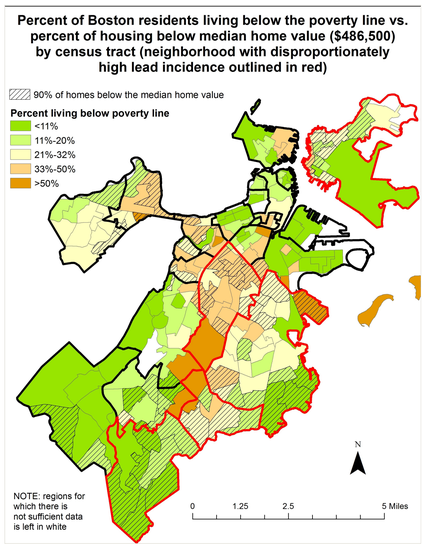
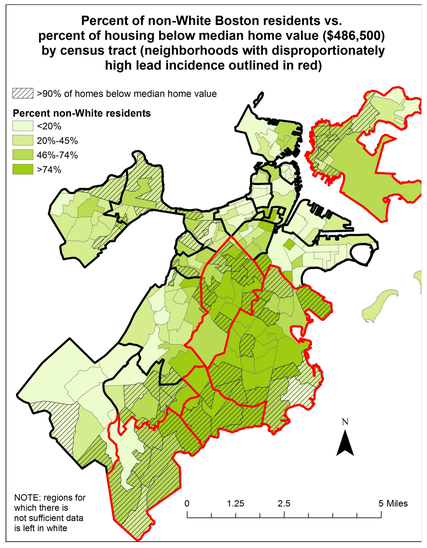



**Figure 7:**




## Citations


Centers for Disease Control and Prevention: Childhood Lead Poisoning Prevention Program Geographical Information System Workgroup. (December 2004). Using GIS to assess and direct childhood lead poisoning prevention: guidance for state and local childhood lead poisoning prevention programs. Retrieved from: http://www.cdc.gov/nceh/lead/publications/UsingGIS.pdf

Knorr, Robert. (2013). Massachusetts Department of Public Health: Preventing Childhood Lead Poisoning in Massachusetts. [PowerPoint slides]. Retrieved from: https://www.cityofboston.gov/images_documents/Robert%20Knorr,%20Preventing%20Childhood%20Lead%20Posioning%20in%20MA_tcm3-48543.pdf

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Kim D.Y., Staley F., Curtis G., Buchanan S. (2002). Relation between housing age, housing value, and childhood blood lead levels in children in Jefferson County, Ky. *American Journal of Public Health*, 92, 769–70.



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