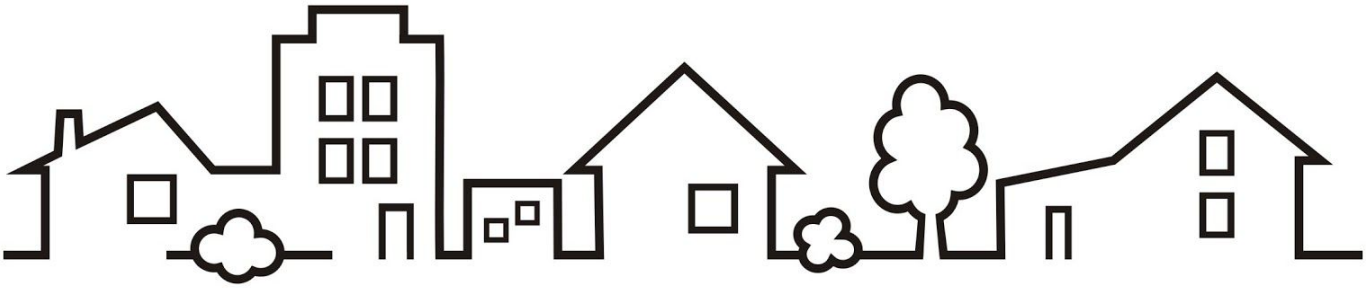

Health in Hartford's Neighborhoods

An examination into the relationship between housing and health in Hartford's neighborhoods

CT data collaborative

ACTION LAB

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Table of Contents

Table of Contents **3**
Table of Charts and Figures **5**
Executive Summary **6**
Construction of the Indices 8
Introduction **12**
About the 500 Cities Data Challenge **12**
Methodology and Data Limitations **13**
Data Sources 14
500 Cities Data 14
Municipal and Federal Public Data on Housing Stability and Property Conditions 15
Analysis of Spatial Distribution of Health Measures **17**
Analysis of Spatial Distribution of Housing Measures **19**
Housing Stability & Property Conditions Indices 22
Housing Stability Index 23
Housing Conditions Index 24
Bringing it Together: Housing Quality & Health Measures **26**
Key Drivers of Health in the Neighborhoods **27**
Foreclosure 29
Price per Square Foot 32
Calls for Essential Services 33
Neighborhood Level Analysis **35**
Selecting Neighborhoods for Analysis 36
Barry Square 37
Northeast Neighborhood 40
Next Steps and Recommendations **42**
Data collection improvements 42
Policy 42
Public Education 43
Appendices **44**
Appendix A: Opportunities in Using Cross Sector Data 44
Appendix B: Hotspot Analysis Technical Details 46
Annotated Citations **53**
Master List of Housing and Health Citations 53
Housing Stability and Health: Affordability, Frequent Moves, Forced Relocation, and Tenure 58
Housing Conditions: Interior and Exterior Physical Property Conditions and Health 59
Overview: Social Determinants of Health and Housing 61

Table of Charts and Figures

Table 1. Comparison between Hartford and the Hartford Metropolitan Statistical Area 12
Table 2. 500 Cities Data Measures 14
Table 3. Data indicators and sources 15
Figure 1. Map 1: Individuals Reporting Mental Health Not Good for 2+ Two Weeks 17
Figure 2. Map 2: Individuals Reporting Physical Health Not Good for 2+ Weeks 18
Figure 3. Map 3. Neighborhoods with High and Low Housing Stability Indices Health Outcomes Highlights 20
Figure 4. Map 4: Optimized Hot Spot Analysis of Essential Services Violations 21
Figure 5. Map 5: Essential Service Calls, 2011-2015 compared to Essential Services Calls Hotspot Map 22
Figure 6. Map 6: Housing Stability Index 24
Figure 7. Map 7: Housing Conditions Index 25
Figure 8: Health Measures: Low Stability Tracts vs. High Stability Tracts 26
Figure 9. Health Measures: Worst Conditions vs. Best Conditions 27
Table 4. Correlation Coefficients for Housing Measures 28
Figure 10. Map 8. Foreclosures, 2011-2015 and Foreclosures Hotspot Map 29
Figure 11. Health Measures Compared to High Foreclosure Tracts vs. Low Foreclosure Tracts 30
Figure 12. Map 9. Evictions Hot Spot Map 31
Figure 13. Health Measures Compared to Low Price per Square Foot vs. High Price per Square Foot 32
Figure 14. Map 10: Price per Square Foot and Historic Redlining 33
Figure 15. Health Measures Compared to Most Essential Service Calls vs. Least Essential Service Calls 34
Figure 16. Map 11. Essential Services Calls Hotspot Map next to Affordable Housing Map 35
Figure 17. Map 12: Hartford's Neighborhoods 36
Figure 18. Property Conditions and Stability Index: Barry Square vs. Hartford 37
Figure 19. Health Measures: Comparison of Barry Square and Hartford 39
Figure 20. Health Measures: Barry Square (removing Trinity College) and Hartford 40
Figure 21. Property Conditions and Stability Index: Northeast vs. Hartford 41
Figure 22. Health Measures: Northeast vs. Hartford 42
Table 5. Housing Code Violation Complaints 46
Figure 23. Map 13: Housing Code Violation Complaints & Essential Services Complaints - per unit 47
Figure 24. Map 14. Hotspot and Optimized Maps 48
Figure 25. Map 15. Final Hotspot Analysis: Housing Code Enforcement & Essential Service Calls 49
Figure 26. Map 16. Difference Between Hotspot Analysis 50
Table 6. Correlation Coefficients for Essential Service Calls and Health Measures 51
Figure 27. High and Low tracts with Essential Service Calls 52

Executive Summary

Intuitively one might guess that housing conditions could cause poor health outcomes; if one does not have stable housing, it could also lead to undue stress and therefore impact health. In particular, residents of large cities are faced with challenges surrounding the connection between these two issues.

In 2018, the Robert Wood Johnson Foundation and the Urban Institute awarded us with the 500 Cities Data Challenge grant to investigate the relationship between health and housing in the city of Hartford, Connecticut. We understand that the level of disinvestment in Hartford has yielded deleterious outcomes for city residents, but to date, we have not seen locally-specific research that connects the relationship between housing conditions, health outcomes and neighborhood disparities.

In this story, we explore three questions:

- In general, are housing conditions – including measures of housing affordability, stability, and physical characteristics – related to health outcomes?
- Where in the city are housing conditions likely to be a factor contributing to health disparities?
- More specifically, which neighborhoods could benefit from targeted intervention?

Our Innovative Approach:

- Examined neighborhood level health data with local open data sources, enabling the exploration and examination of the relationship between health and housing in a concrete way for Hartford's most disinvested neighborhoods.
- Created housing indices, one on housing conditions and one on housing stability, and used them to compare the differences in health outcomes amongst the most and least stable census tracts in the city and amongst the census tracts with the best and worst housing conditions in the city.

Findings:

- There is a robust connection between both housing quality and housing stability measures and health outcomes.
    - The most stable tracts had better health measures than the least stable tracts on almost every health measure under study, a surprisingly robust pattern given the diversity of health measures that we included here.
- Two drivers are the leading causes of poor health outcomes.
    - Foreclosures
    - Calls for essential (emergency) services

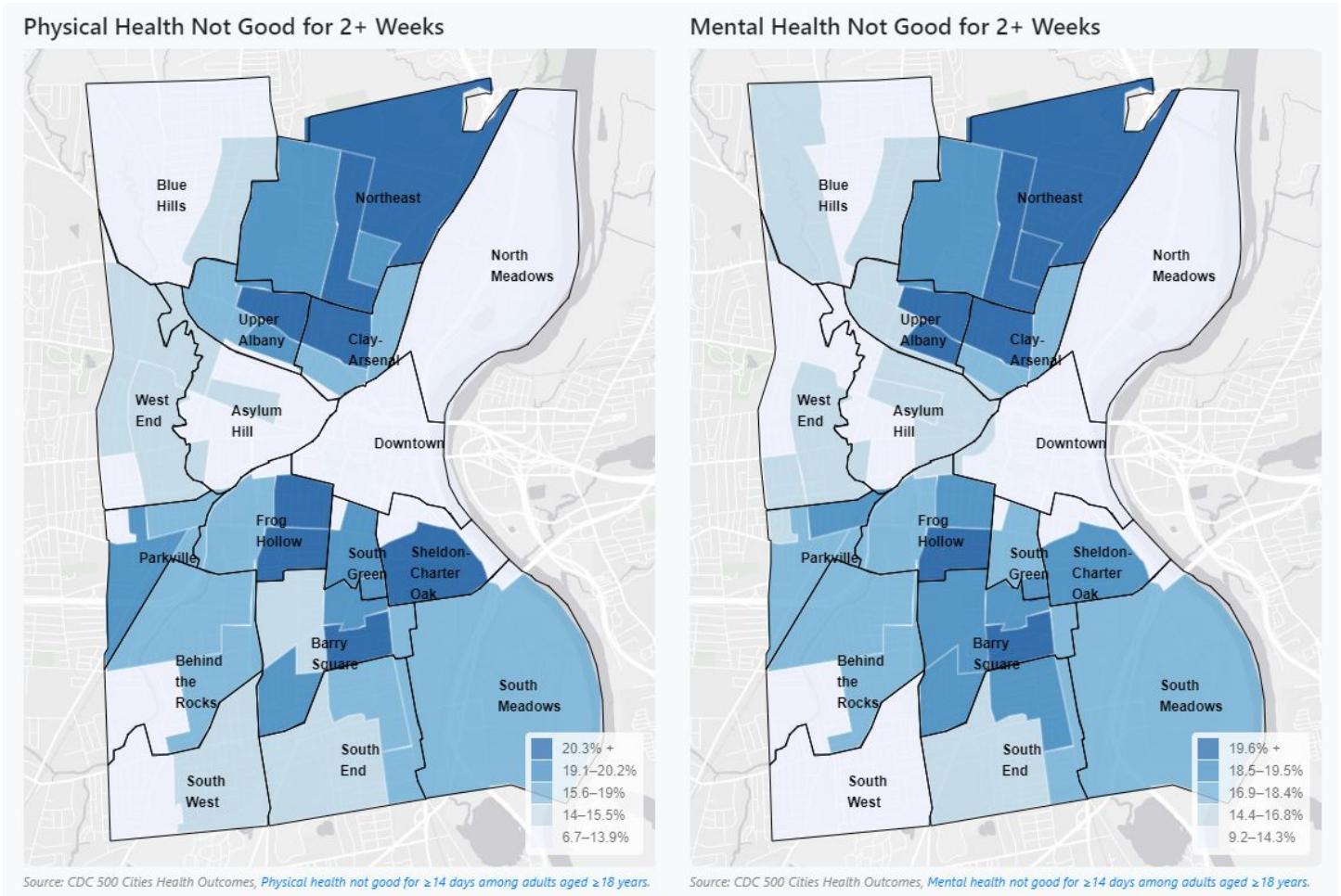
- More granular data are needed to understand the impact of rodents; currently the data are not collected with enough specificity.

The Health of our Residents

Eighteen health indicators were included in this analysis. These data were made available by the Centers for Disease Control at the census tract level for the 500 largest cities in the United States (https://www.cdc.gov/500cities/). Data are provided on health outcomes, unhealthy behaviors, and preventative health measures, andmany of the health measures exhibit similar patterns in Hartford.

In the neighborhoods of Clay Arsenal, the Northeast, and Upper Albany, as well as South in Frog Hollow, Sheldon Charter Oak, and Barry Square, more than 1 in 5 adults report poor physical health. The distribution of estimates for people reporting poor mental health transcend the north/south division.

The ribbons of high levels of poor mental health through the middle of the city shows a concentration of poor mental health reported in the Northeast neighborhood and a corresponding concentration in the South End neighborhoods of Frog Hollow and Barry Square, though the concentrations in the southern portion of the city are more geographically dispersed.



Construction of the Indices

Using publicly available data, we constructed two housing indices. One examines *Housing Stability*-- housing finances and tenure-- and the other examines *Housing Conditions* -- aspects of housing quality that focuses on the physical quality of the housing stock as part of the built environment.

Our housing conditions index tracks the aspects of housing quality that focuses on the physical quality of the housing stock as part of the built environment. Since Hartford currently lacks a comprehensive property assessment survey, we approximated housing conditions using other publicly available data sources from the Housing Code Enforcement Office.

The housing condition index is comprised of the following measures:

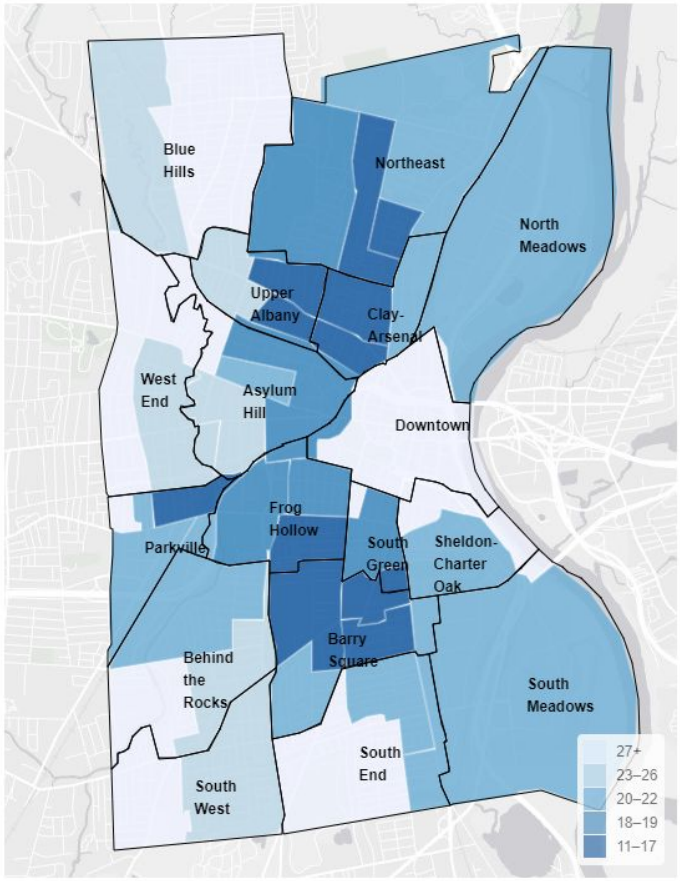
- Housing code violations, which were broken into sub categories to track the severity of the complaint.
- A verified measure of housing vacancy as reported by the United States Postal Service. We calculated a vacancy rate for each tract by creating a weighted average from 20 quarters of USPS vacancy data. Vacant properties have an outsized impact on the health of a neighborhood property market: they are frequently neglected and can become sites of rodent infestations, they easily fall into disrepair and affect surrounding property values, and they are the sites of a variety of criminal activity.
- Fire incidents, reported by the Hartford Fire Department, which are indicative of unsafe housing conditions that result in fire incidents.

In creating the housing stability index, we were primarily concerned with the financial and social experience of housing in Hartford. Financially, this index tracks the affordability of housing for both renters and owners, as well as the potential for a given house to be a quality investment. In addition, we include a series of measures meant to track the social/personal experience of housing. Here, we track whether residents own or rent their houses and how long they've remained in their current unit. We also track forced moves, including eviction and foreclosure. These measures offer insight into how rooted residents are in their communities and how vulnerable neighborhoods are to disruption. The index includes the following data:

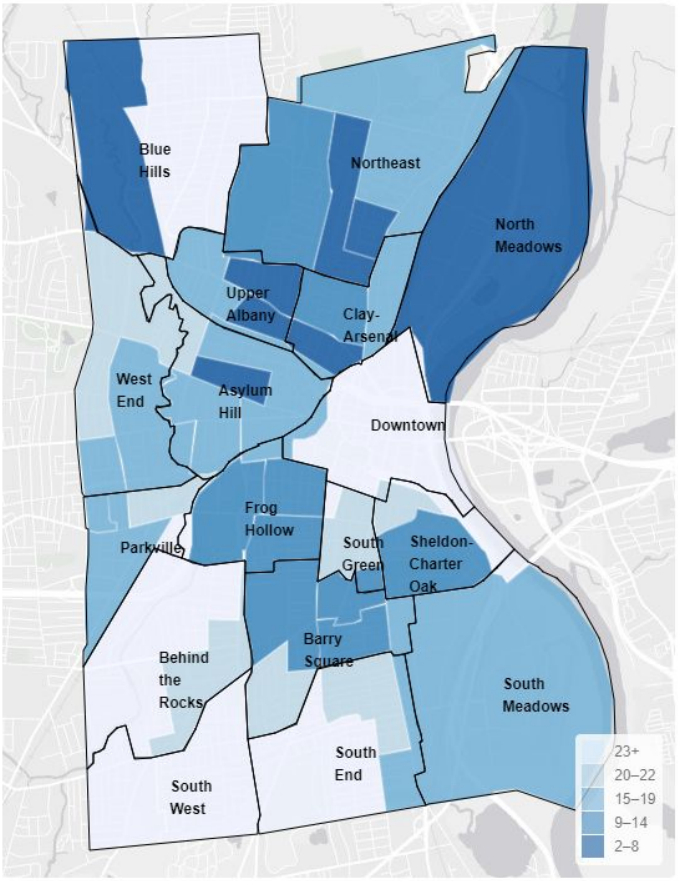
- occupancy,
- rent to income ratio,
- mortgage to income ratio,
- eviction rate,
- foreclosure rate,
- average length of tenure, and
- assessed price per square foot.

As seen in the map below, neighborhoods with poor Housing Conditions are also areas with poor health outcomes.

Housing Stability Index



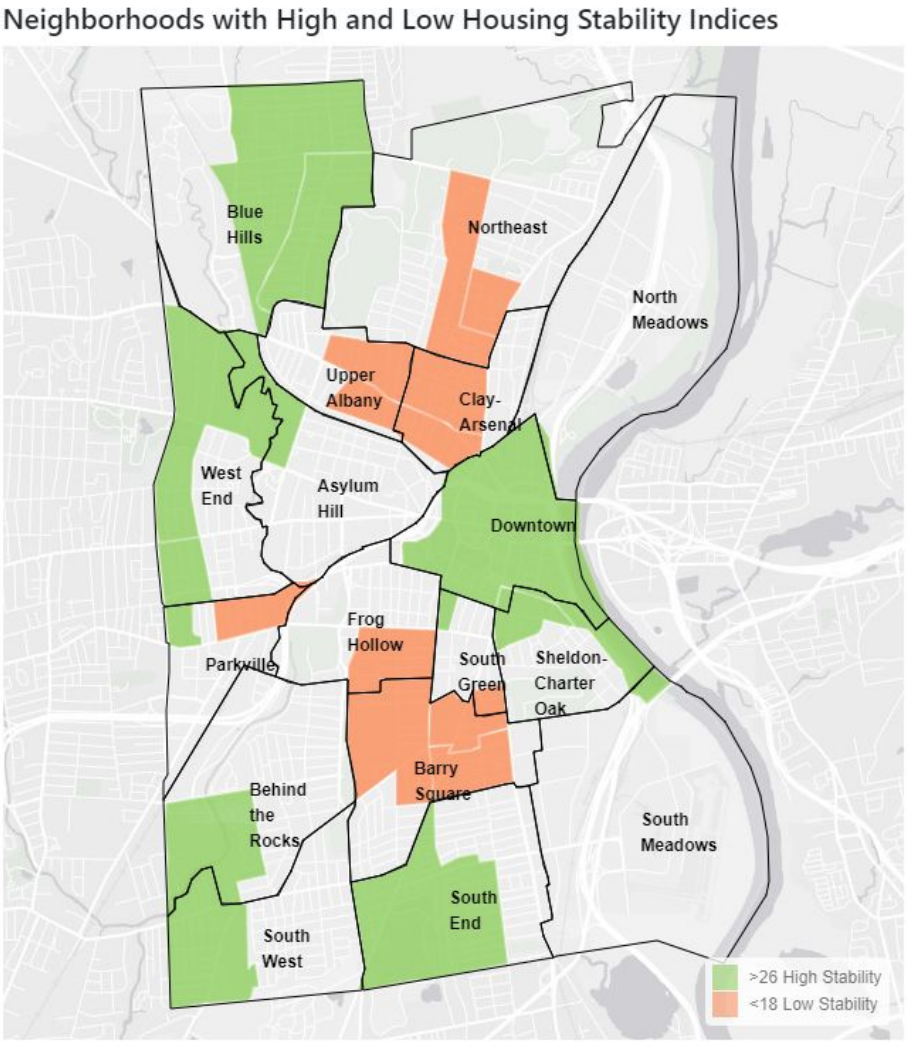
Housing Conditions Index



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

To help identify and get a sense of where there are neighborhoods with high housing stability and those with low housing stability, we took the census tracts in the highest and lowest quintiles mapped them and then compared it to the health data. The resulting findings emerge:

- Someone living in a highly unstable tract was 34 or 36% more likely to report being in poor mental or physical health than someone living in a tract with a high housing stability score. Smoking and COPD were both strongly related to the housing stability score, as were diabetes, obesity and lack of physical activity.
- Neighborhoods with highest housing instability: Barry Square, Clay Arsenal, Upper Albany, Northeast, and Frog Hollow.
- Neighborhoods with poor housing conditions exhibit poor health outcomes.



Someone living in a highly unstable tract was

- 36% more likely to have poor physical health,
- 34% more likely to be a current smoker,
- 34% more likely to have poor mental health, and
- 30% more likely to suffer from COPD.

(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

Using the available point data for housing code violations and foreclosures, we were able to highlight physical concentrations of instability and poor conditions at a more granular level than was possible at the census tract level. We identified areas of statistically significant concentrations of specific events, including housing code violations, essential services violations, and foreclosures. These allowed us to further drill down into individual neighborhood housing condition challenges to identify areas for targeted investment.

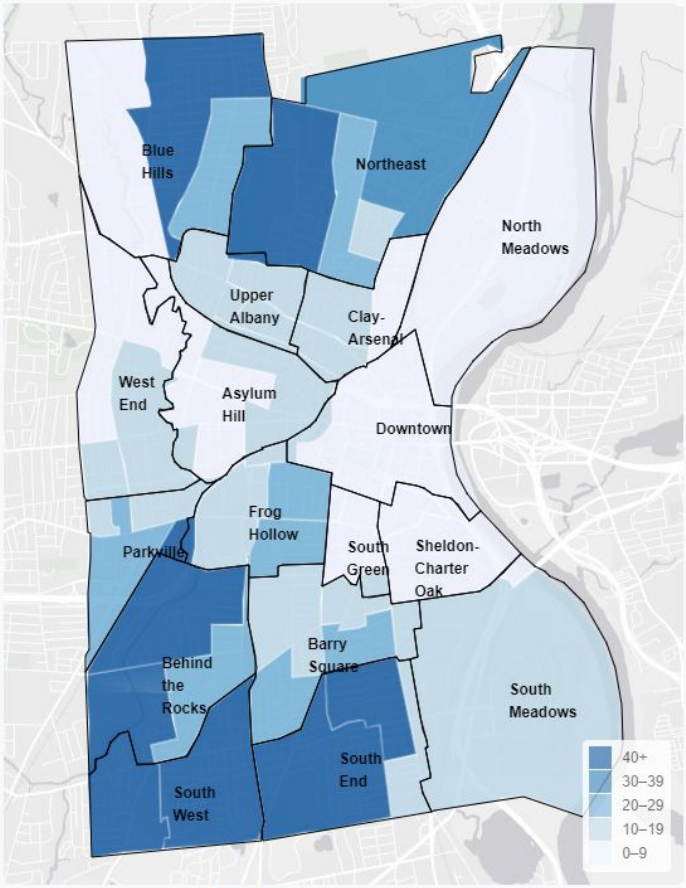
- Higher foreclosures rates are significantly correlated with poorer health outcomes and preventative measures in nearly all the health indicator estimates under review.

Foreclosures were unevenly distributed throughout Hartford neighborhoods, however. Census tracts 5012, 5041, 5028, 5017, and 5015 had foreclosure rates more than twice the city average. Three of these high foreclosure tracts were in the north end of the city, and the remaining two were centered on Park Street in the Frog Hollow and Parkville neighborhoods.

Interestingly, these neighborhoods have very low homeownership rates compared with the city, suggesting that distressed landlords were more likely to experience foreclosure than owner-occupants. These high foreclosure

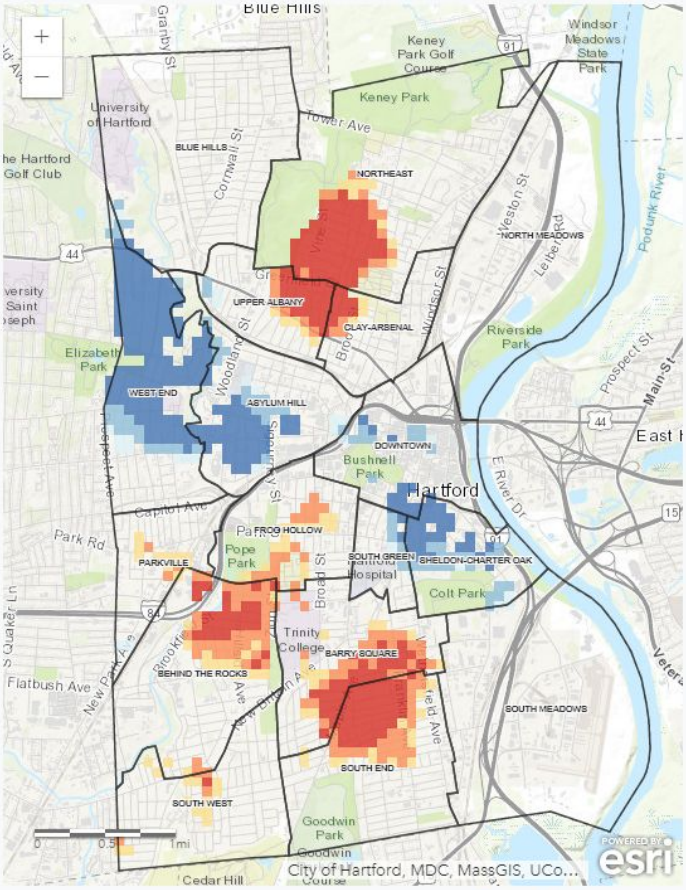
neighborhoods also have higher rates of all negative health indicators under study. Higher foreclosures rates are significantly correlated with poorer health outcomes and preventative measures in nearly all the health indicator estimates under review.

Foreclosures, 2011–2015



Source: City of Hartford, Foreclosure/Lis Pendens.

Foreclosures Hotspot Map



Source: City of Hartford, annual average number of foreclosures (2011–2015) Foreclosure/Lis Pendens normalized by Parcels.

Essential services calls are among the most serious housing code violations because they indicate that a property lacks heat or water service, making the property uninhabitable in the short term.

There is a large cluster in the North End that is spread throughout Upper Albany, parts of Clay Arsenal, and through the center of Asylum Hill. A smaller but significant cluster is concentrated in the center of Frog Hollow, and a third large cluster in Barry Square extends slightly north into the South Green neighborhood.

Introduction

Hartford is a small place, no more than 18 square miles and around 125,000 people. Despite this small footprint, Hartford is home to a diverse collection of neighborhoods, housing stock, and people. In this report, we drill down into Hartford's neighborhoods, investigating the relationship between housing conditions and health to identify where relationships in the data exist and provide insights for policymakers, advocates, and residents to remedy the disparities.

Most geographic analyses of Hartford focus on the disparities between the city and its surrounding suburbs. The disparities between the city and its metro area are immense, and can be found in nearly every measure available for study. For example, comparing the city of Hartford with the Hartford metropolitan statistical area, which encompasses 54 towns in Hartford, Tolland, and Middlesex Counties, shows that poverty in the city is four times higher, the unemployment rate is more than twice as high, and the homeownership rate is 1/3 of the surrounding area (see table below).

Table 1. Comparison between Hartford and the Hartford Metropolitan Statistical Area

	Hartford	Hartford MSA
Total Population	124,320	1,211,826
% Non-Hispanic White	15.5%	69.0%
Median Income ($2016)	$32,095	$71,379
Family Poverty Rate	29.0%	7.3%
% With College Degree	16.8%	37.6%
Owner-Occupied Housing	23.7%	66.6%
Median Property Value	$159,100	$244,000
Unemployment Rate	17.5%	7.6%

(Source: ACS 5-year Estimates, 2011-2015)

Because of these large disparities, most academic geographic analyses of Hartford focus on its relationship to the larger metropolitan area. In addition to these inter-municipal and regional disparities, however, there are substantial and persistent differences *within* the city of Hartford itself, which have received less attention, and which this project will investigate.

About the 500 Cities Data Challenge

The 500 Cities Data Challenge is a $1 million grant initiative that encourages communities to dig into the 500 Cities dataset and design innovative solutions that address social factors driving community health outcomes. The ideas generated through this grant competition are helping to build the foundation for better cross-sector

collaboration to foster a broad Culture of Health and guide other communities in how to use data more effectively.

Methodology and Data Limitations

This report relies on a series of city-specific datasets on housing conditions and a unique dataset of small area estimates for health outcomes, behaviors, and preventative measures that was produced by the Centers for Disease Control and funded by the Robert Wood Johnson Foundation. Using these data sources, we examined the following questions: are housing conditions – including measures of housing affordability, stability, and physical characteristics – related to health outcomes? Where in the city are housing conditions likely to be a factor contributing to health disparities? Which neighborhoods could benefit from targeted intervention?

First, this report explores the geographic differentiation of housing conditions within the city of Hartford. Using optimized hot spot analysis and geographic overlay, we identify concentrated areas of evictions, foreclosures, housing code violations, and vacancy rates within the city. Second, we use 500 Cities Data on small area estimates for a range of health outcomes, including asthma, obesity, stroke, stress, and poor mental health to investigate the geographic distribution of poor health in the city. Finally, by constructing two indices, one on housing conditions and one on housing stability, we are able to compare the differences in health outcomes amongst the most and least stable census tracts in the city and amongst the best and worst quality census tracts in the city.

Throughout this analysis, we have found a robust connection between both housing quality and housing stability measures and health outcomes. This connection remains strong across several different distinct indicators of housing, but the relationship should be interpreted with caution. First, the 500 Cities Data are estimates based on national survey data, rather than epidemiological data collected at the individual level. Because the 500 Cities estimates were created using demographic data on race, poverty, and age, these variables have an outsized explanatory force. The extent to which these demographic variables are related to housing measures may produce confounding results, and race and income have repeatedly been found to play an important explanatory role in the affordability and safety of housing. Secondly, the limited number of census tracts in the Hartford city limits - there are only 40 - resulted in limited statistical power with certain analyses. This suggests that increasing the scope of the analysis, for example expanding the analysis to include the other cities in Connecticut for which 500 Cities Data were made available, could improve the findings. Finally, the direction of the relationship we identify is indeterminate: that is, with the analytical tools available to us, it is not possible to say whether housing conditions affect health, or whether the converse is true, and the health of the population has an impact on housing stability or the quality of the housing stock.

The final piece of our analysis focuses on the differences in the relationship between housing and health in specific neighborhoods. We include a detailed description of the ways that housing and health correlate or fail to correlate within differently situated neighborhoods. Here, we are able to investigate ways that housing instability in high-priced neighborhoods with middling to good housing conditions contributes to health outcomes, compared with neighborhoods with poor housing conditions but high stability, for example. We include a discussion of this relationship in two sample neighborhoods - Barry Square and Northeast Hartford.

Data Sources

This project relies on two main types of data: small area estimates on health measures, produced by the Center for Disease Control (CDC) and the Robert Wood Johnson Foundation (RWJF), and local-level housing data compiled from multiple municipal and federal public sources.

500 Cities Data

The health data was produced by the CDC and the RWJF. The 500 Cities Data Challenge centered around using these new health measures in innovative ways. This dataset, referred to here as the 500 Cities Data Project, produced estimates at the census tract level for 27 different health measures, including 5 unhealthy behaviors, 13 health outcomes, and 9 prevention practices. Of these measures, our project focused on health outcomes and unhealthy behaviors.

Table 2. 500 Cities Data Measures

Health Outcomes	Arthritis among adults aged≥18 years
	Current asthma among adults aged≥18 years
	High blood pressure among adults aged≥18 years
	Cancer (excluding skin cancer) among adults aged≥18 years
	High cholesterol among adults aged≥18 years who have been screened in the past 5 years
	Chronic kidney disease among adults aged≥18 years
	Chronic obstructive pulmonary disease among adults aged≥18 years
	Coronary heart disease among adults aged≥18 years
	Diagnosed diabetes among adults aged≥18 years
	Mental health not good for≥14 days among adults aged≥18 years
	Physical health not good for≥14 days among adults aged≥18 years
	All teeth lost among adults aged≥65 years
	Stroke among adults aged≥18 years
Unhealthy Behavior Measures	Current smoking among adults aged≥18 years
	No leisure-time physical activity among adults aged≥18 years
	Obesity among adults aged≥18 years
	Sleeping less than 7 hours among adults aged ≥18 years
	Binge drinking among adults aged≥18 years

(*Source: CDC 500 Cities Measure Definitions, accessed online here*)

The CDC produced 500 Cities health measure estimates for the census tract level using an innovative multi-level regression and poststratification approach. This approach uses these estimation techniques to distribute results from the CDC's Behavioral Risk Factor Surveillance System (BRFSS) and the National Survey of Children's Health, two national-level surveys, to local areas. The estimates use detailed demographic data in their model, accounting for race, poverty, gender, and age to estimate the small area distribution of the various health measures under study. In addition, the model accounts for the associations between individual health outcomes, individual characteristics, and spatial contexts and factors at the state and county level. According to the CDC, several validation studies have confirmed that the small area estimates produced through the multi-level regression and poststratification models are consistent with the BRFSS survey estimates at larger geographies.[1]

Municipal and Federal Public Data on Housing Stability and Property Conditions

This project compiled a wide variety of data relating to housing in the city, ranging from data collected regularly by the Census to data collected in the course of regular administrative city activities such as housing code enforcement. To ensure that the data were comparable to the health measures under study, we standardized the time frame to encompass the years 2011-2015. When data existed as point data, it was aggregated to the census tract level when not being used in hotspot analysis.

Table 3. Data indicators and sources

	Description of Indicator	Data Source
Stability	Percentage of **owner-occupied units**	ACS 5-Year Estimates, 2011-2015
	Percentage of income going toward rent, or the **rent to income ratio**	ACS 5-Year Estimates, 2011-2015
	Percentage of income going toward mortgage expenses, or the **mortgage to income ratio**	ACS 5-Year Estimates, 2011-2015
	Average annual **eviction rate** from 2011-2015, measured by total legal evictions divided by the count of residential units	Eviction Lab, evictionlab.org
	Average length of time residents have lived in housing units, or average **length of tenure**	ACS 5-Year Estimates, 2011-2015
	Average annual **foreclosure rate** from 2011-2015, measured by the total number of foreclosure filings divided by the residential parcels	Foreclosure/Lis Pendens from City of Hartford, normalized using Parcels from City of Hartford.

[1] Zhang, X., Holt, J.B., Lu, H., Wheaton, A.G., Ford,E.S., Greenlund, K.J., and Croft, J.B., (2014). Multilevel Regression and Poststratification for Small-Area Estimation of Population Health Outcomes: A Case Study of Chronic Obstructive Pulmonary Disease Prevalence Using the Behavioral Risk Factor Surveillance System. *American Journal of Epidemiology*. 179 (8).

	Property value, as measured by the assessed value normalized by the developed square footage of a property	Hartford's Grand List, from City of Hartford
Conditions	Total number of **housing code violations per unit**, 2011-2015, measured by **all** violations reported to the Housing Code Enforcement office or Public Health office, divided by total residential units	Housing Code Cases from City of Hartford, downloaded June 2018.
	Total number of **bedbugs violation complaints per residential unit,** 2011-2015.	Housing Code Cases from City of Hartford, downloaded June 2018.
	Total number of **essential services code violation complaints per residential unit**, 2011-2015, which includes complaints regarding lack of running water or heat, among other issues	Housing Code Cases from City of Hartford, downloaded June 2018.
	Total number of **rodent violation complaints per residential unit,** 2011-2015.	Housing Code Cases from City of Hartford, downloaded June 2018.
	Total number of **vacate now violation complaints per residential unit,** 2011-2015. These complaints were serious enough to result in immediate evacuation of housing units.	Housing Code Cases from City of Hartford, downloaded June 2018.
	Average annual **vacancy rate**, 2011-2015	USPS Vacancy Data, produced by the Department of Housing and Urban Development
	Average annual **fire incidents**, per parcel, 2011-2015.	Fire Incidents datasets, 2011, 2012, 2013, 2014, and 2015, from City of Hartford, downloaded July, 2018.

Analysis of Spatial Distribution of Health Measures

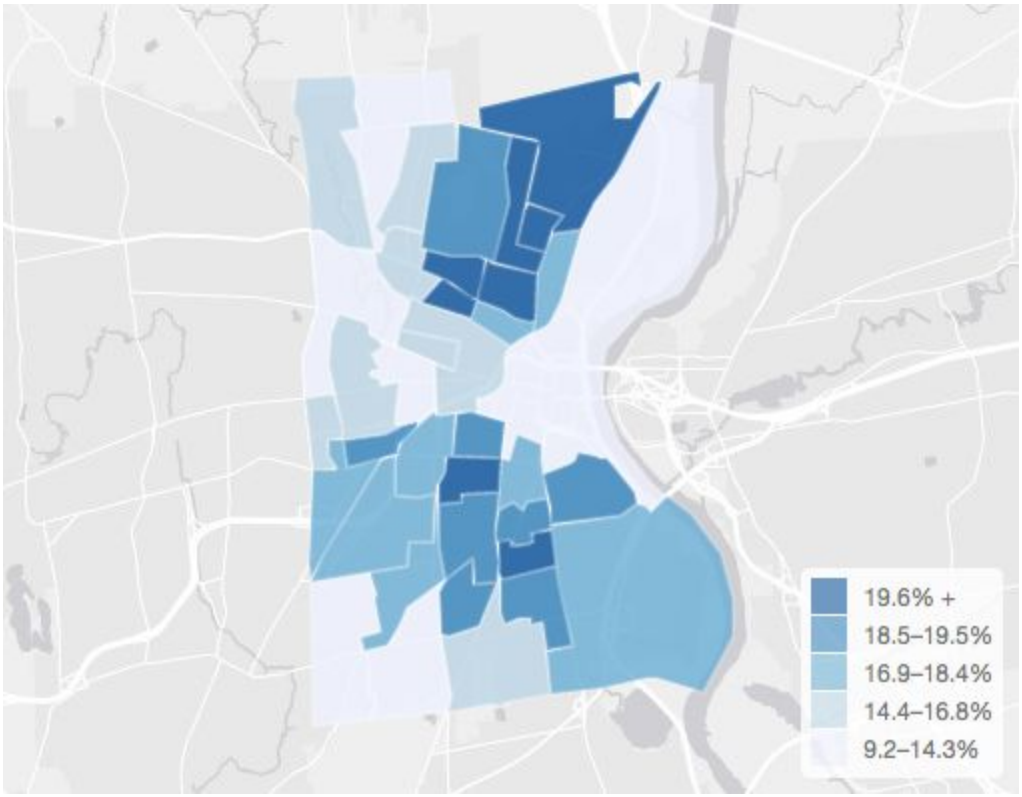
Using the 500 Cities dataset, we mapped a series of health measures using quantile breaks to identify spatial patterns associated with negative health measures within the city. You may explore the spatial distribution of every health measure on our public ArcGIS Online map here.

Hartford is a racially segregated city (see maps on Data Platform). The internal geography of Hartford is split in two: the North End of Hartford, where a majority of African Americans and Caribbean immigrants live, and the

South End of Hartford, historically home to immigrant groups recently arrived in the city (Italians in the 1950s and 1960s, and Hispanic/Latinx immigrants recently). The northwestern, southwestern, and western sides of the city, as well as the more recently gentrifying downtown core, tend to house a racially diverse mix of working and middle class family households.

Persistent and familiar geographic patterns emerged, which are best captured by the two holistic health measures defined in the project: whether individuals reported that their mental health and/or physical health was not good for more than two weeks.

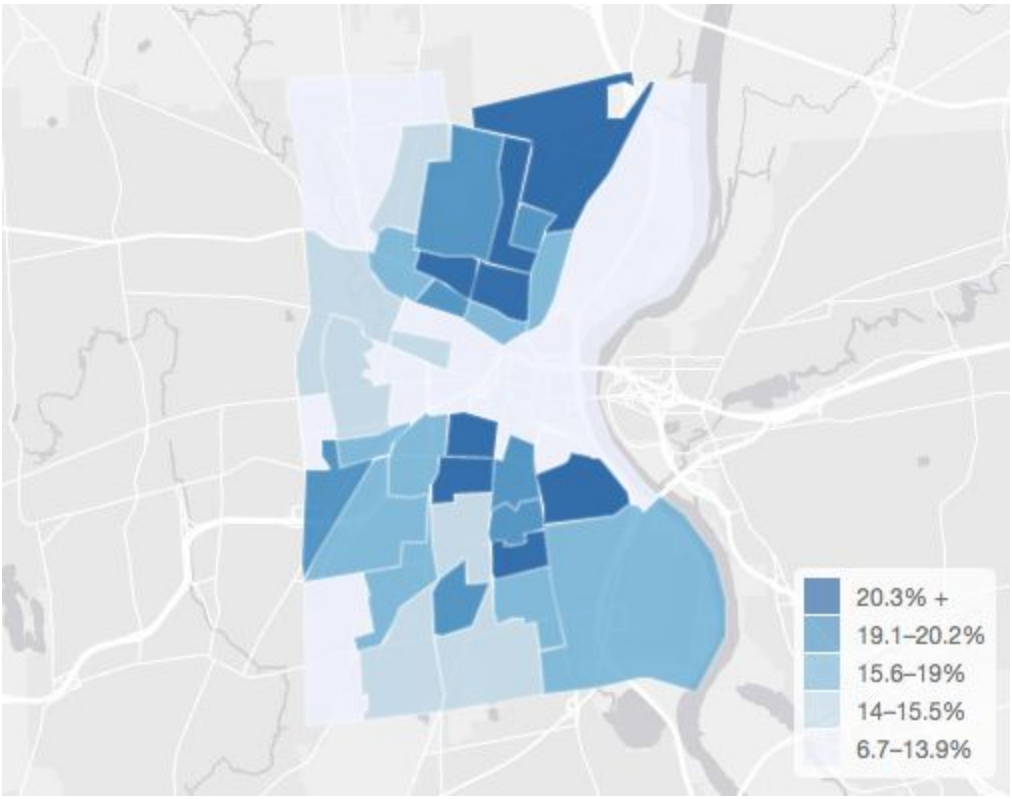
Figure 1. Map 1: Individuals Reporting Mental Health Not Good for 2+ Two Weeks



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

Here, the distribution of estimates for people reporting poor mental health transcend the North/South division. The ribbon of high levels of poor mental health through the middle of the city shows a concentration of poor mental health reported in the Northeast neighborhood and a corresponding concentration in the South End neighborhoods of Frog Hollow and Barry Square, though the concentrations in the southern portion of the city are more geographically dispersed.

Figure 2. Map 2: Individuals Reporting Physical Health Not Good for 2+ Weeks



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

The spatial distribution of poor physical health demonstrate a similar spatial pattern, one that is perhaps slightly more explicit. Here, a ribbon of relatively stronger physical health cuts through the central area of the city, encompassing the Downtown neighborhood, Asylum Hill neighborhood, and portions of the West End. Pockets of extreme values - neighborhoods in which more than 1 out of every 5 residents are estimated to experience poor physical health - are found North in Clay Arsenal, the Northeast, and Upper Albany, as well as South in Frog Hollow, Sheldon Charter Oak, and Barry Square neighborhoods.

Most of the health measures under study exhibited similar spatial patterns, with the exception of certain measures that appear strongly related to age. These measures, including binge drinking, cancer, and arthritis, exhibited spatial distributions that flouted the overall trend. Notably, by visualizing these spatial trends at the level of the census tract, it became clear that important spatial patterns emerged that were not dictated by the persistent divisions between the North and the South ends of the city. Moreover, these divisions were not neatly distributed throughout neighborhood boundaries: pockets of relatively high values were distributed among several neighborhoods, even when a neighboring census tract in a neighborhood was better situated.

Following the initial analysis of the distribution of all health measures provided by the 500 Cities Dataset, we examined the relation between the health measures and housing conditions. In particular, we were interested in answering the following questions:

1. Were similar spatial distributions visible with housing stability and conditions measures?

2. Were neighborhoods with high levels of negative health outcomes or behaviors more likely to also experience high housing instability or poor property conditions?
3. Where were overlaps, and where were disconnections between these two categories?

To answer these questions, we began by analyzing the distribution of several measures of housing stability and quality throughout the city by using publicly available data.

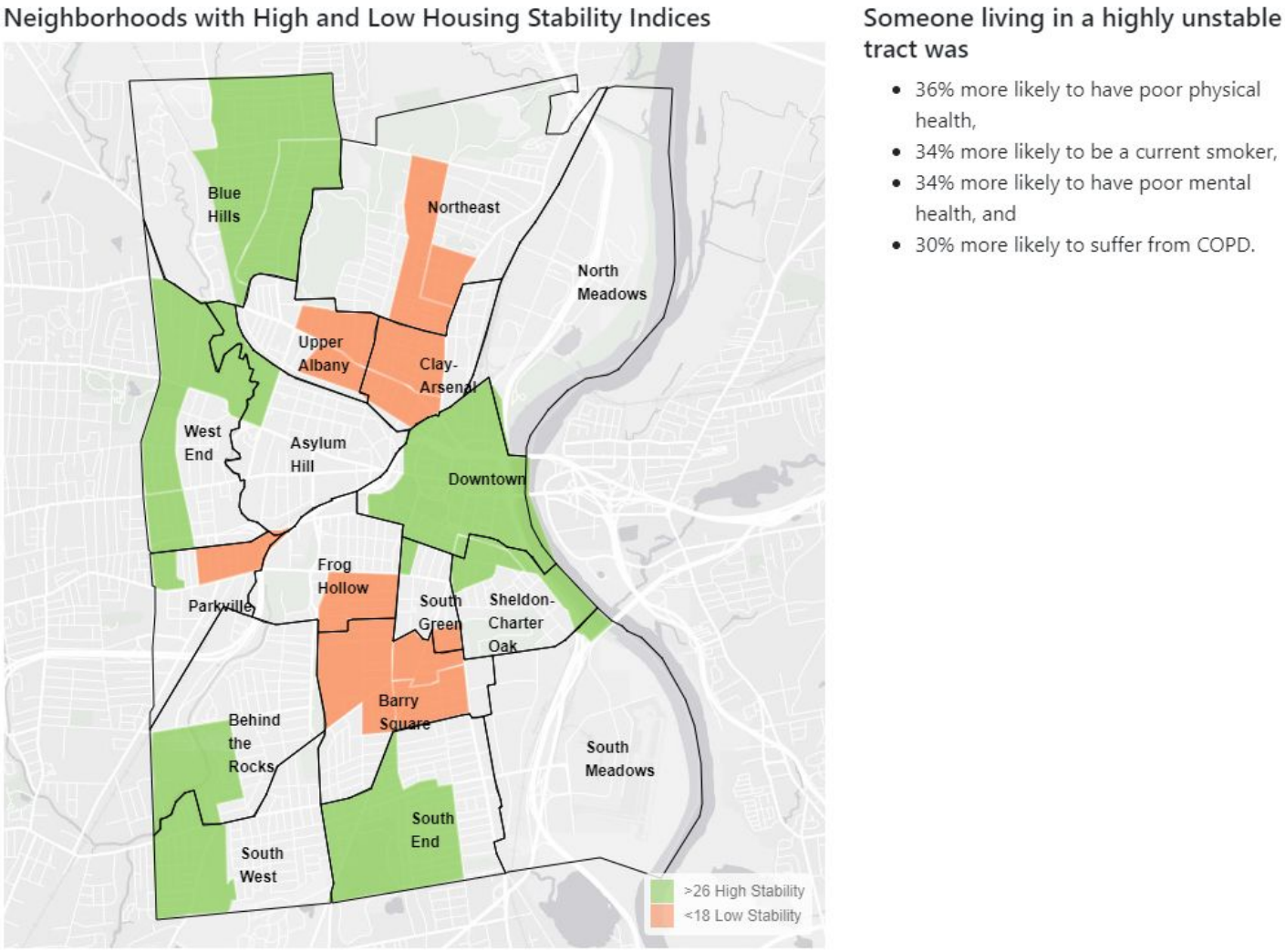
Analysis of Spatial Distribution of Housing Measures

We first mapped each of the housing measures using the same analysis strategy as we did to map the health measures: we aggregated point data to the level of the census tract when necessary and created choropleth maps using quantiles to analyze the relative prevalence of measures in census tracts and neighborhoods. You may explore the spatial distribution of the housing stability measure on our public ArcGIS Online Storymap here and the housing condition measures here.

The geography of individual measures varied substantially, but when smoothed by the creation of two index measures, they settled into a pattern that mimicked the pattern displayed by the health measures. The details of the geography of the two indices - one measuring housing stability and one measuring property conditions - is explained in the section below.

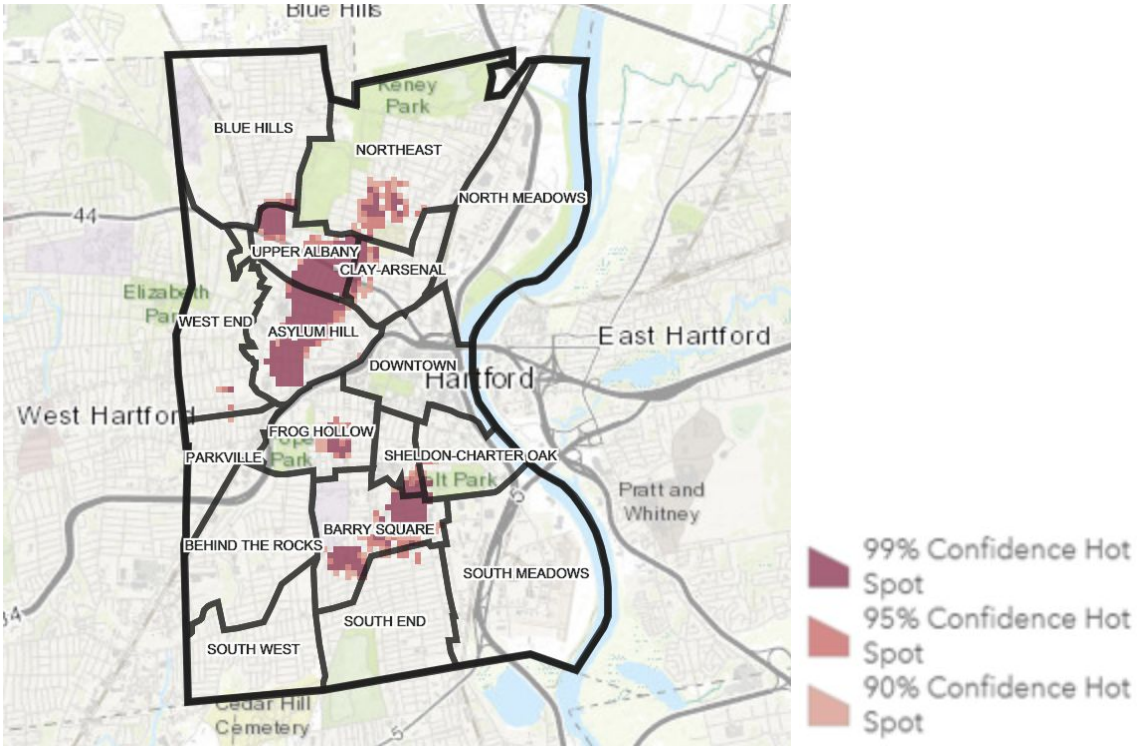
One advantage of working with housing data is that data often exist at the address level. Access to this point data allows for the use of hot spot analysis techniques that would not be possible at the census tract level in a city like Hartford, which has only 40 census tracts. Using the available point data for housing code violations and foreclosures, we were able to highlight physical concentrations of instability and poor conditions at a more granular level than was possible at the census tract level. Using the optimized hot spot analysis tool in ArcGIS version 10.2, we identified areas of statistically significant concentrations of specific events, including housing code violations, essential services violations, and foreclosures. These allowed us to further drill down into individual neighborhood housing condition challenges to identify areas for targeted investment.

Figure 3. Map 3. Neighborhoods with High and Low Housing Stability Indices Health Outcomes Highlights



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

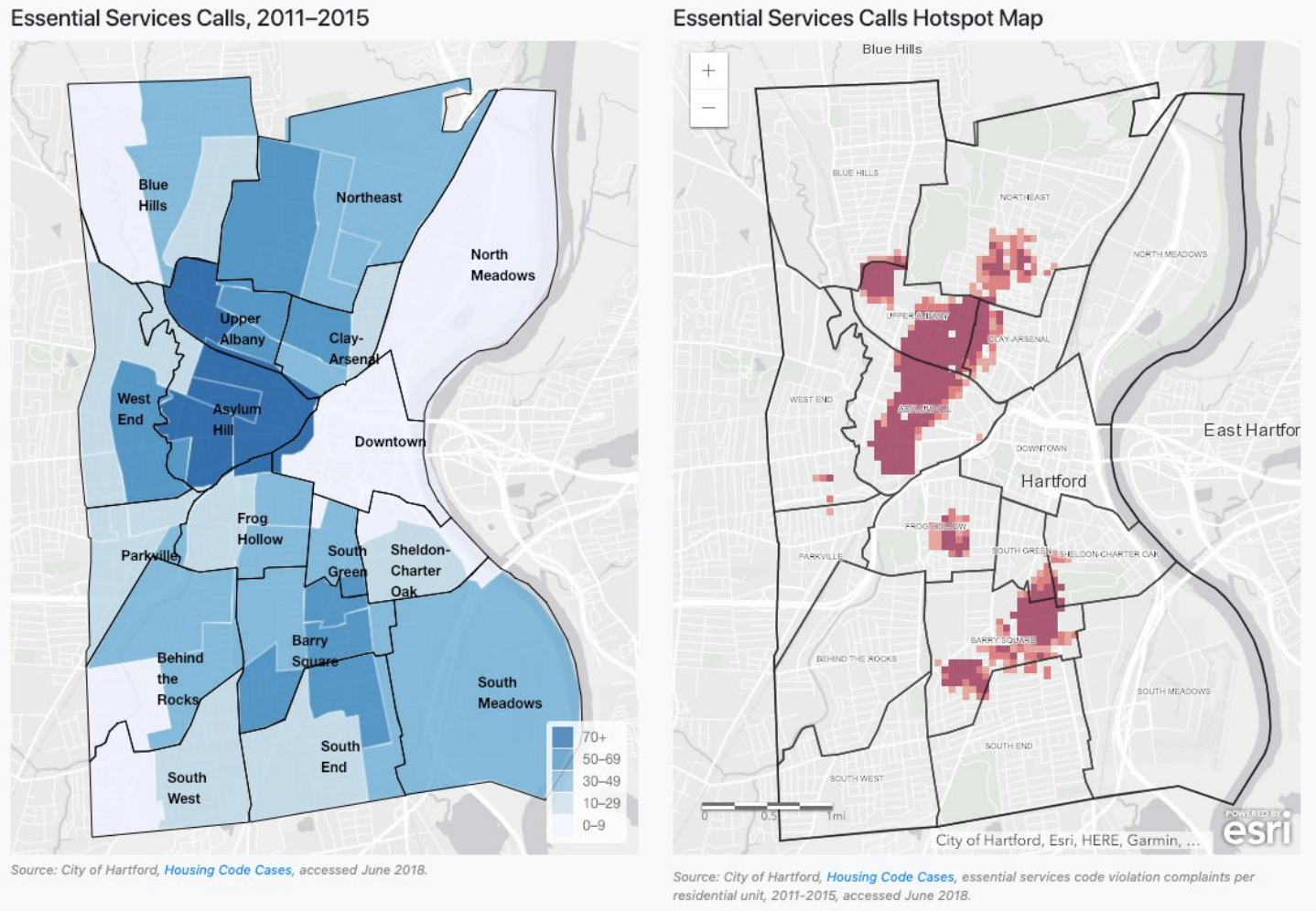
Figure 4. Map 4: Optimized Hot Spot Analysis of Essential Services Violations



(Source: City of Hartford, accessed June 2018.)

Essential services calls are among the most serious housing code violations, because they indicate that a property lacks heat or water service, making the property uninhabitable in the short term. We found clusters of essential services violations in three main areas of Hartford: a large cluster in the North End that spread throughout Upper Albany, parts of Clay Arsenal, and through the center of Asylum Hill. Additionally, we found a small but significant cluster in the center of Frog Hollow, and a third large cluster in Barry Square that extended slightly north into the South Green neighborhood. These locations mirror many of the spatial patterns identified in the health measures, producing a similar ribbon of poor housing conditions through the North/South spine of the city.

Figure 5. Map 5: Essential Service Calls, 2011-2015 compared to Essential Services Calls Hotspot Map



Following this analysis, the questions remain: to what extent are housing conditions and housing stability measures related to health outcomes? What is the strength of the apparent relationship? In which measures is the relationship most prevalent, and which might suggest the need for more in depth study?

Housing Stability & Property Conditions Indices

The individual housing measures, as mentioned above, exhibited a fair amount of statistical noise. In order to investigate the relationship between housing quality and health, we constructed two indices to track different aspects of the two: housing stability and housing conditions.

We distinguish between housing conditions and housing stability for two central reasons: 1) many housing conditions measures are collected at the property level but are not collected citywide, which may result in geographic distortions, while most stability measures are collected through Census estimates; and 2) physical

housing conditions have been associated with several specific health conditions, such as asthma[2] and lead poisoning[3].

Housing Stability Index

In creating the housing stability index, we were primarily concerned with the financial and social experience of housing in Hartford. Financially, this index tracks the affordability of housing for both renters and owners, as well as the potential for a given house to be a quality investment. In addition, we include a series of measures meant to track the social/personal experience of housing. Here, we track whether residents own or rent their houses and how long they've remained in their current unit. We also track forced moves, including eviction and foreclosure. These measures offer insight into how rooted residents are in their communities and how vulnerable neighborhoods are to disruption. The index includes the following data:

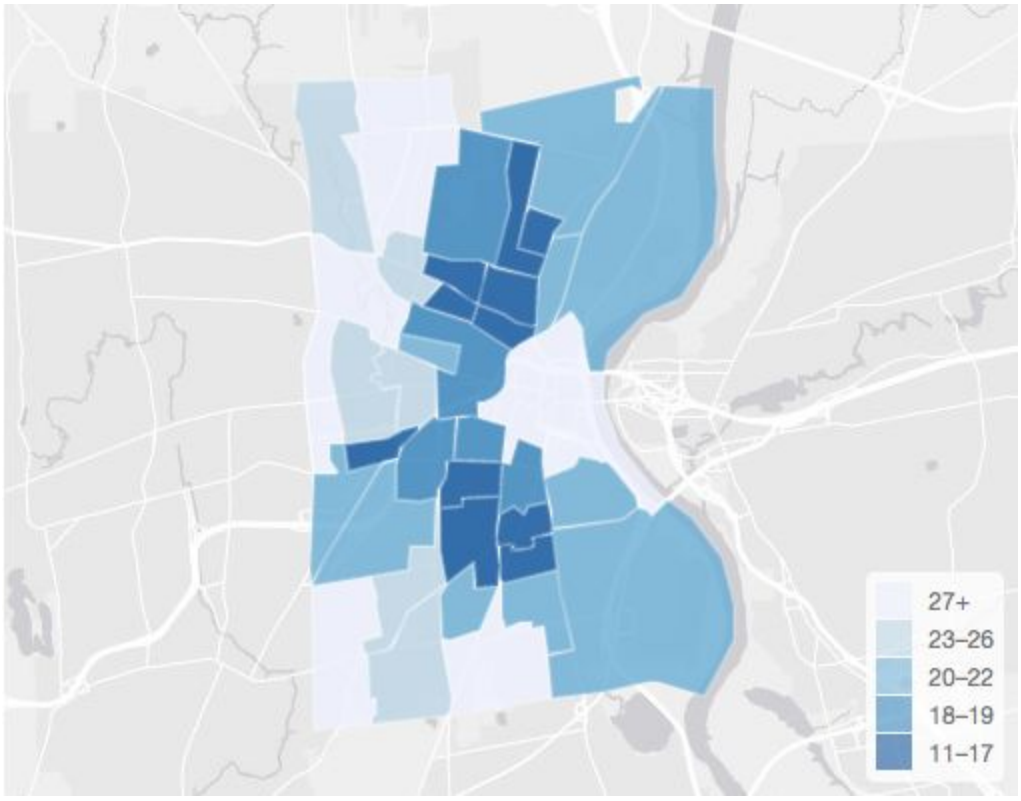
- occupancy,
- rent to income ratio,
- mortgage to income ratio,
- eviction rate,
- foreclosure rate,
- average length of tenure, and
- assessed price per square foot.

After compiling the indicators, we ranked each census tract based on its position relative to other tracts and assigned each tract a score. A score of five meant that the tract scored the best on a given indicator, while a score of one meant that that tract scored the worst on that indicator. So, if a census tract had the highest eviction rate in the city, it would receive a one for that measure; if it boasted the highest price per square foot in the city, it would receive a five. These scores were added up for each tract to determine the index score. Actual scores for the Hartford tracts ranged from 11 (the most unstable tract) to 31 (the most stable tract). There was the potential for scores to range from 7 to 35.

[2] Belanger, K., Beckett, W., Triche, E., Bracken, M.B., Holford, T., Ren,P.,...Leaderer,B.P.(2003). Symptoms of Wheeze and Persistent Cough in the First Year of Life: Associations with Indoor Allergens,Air Contaminants,and Maternal History of Asthma. *American Journal of Epidemiology*, 158(3),195-202. doi:10.1093/aje/kwg148

[3] Sullivan, Louis W., Secretary of Health and Human Services. October 7, 1991. Conference sponsored by the Alliance to End Childhood Lead Poisoning.

Figure 6. Map 6: Housing Stability Index



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

The results, when mapped in quintiles, display a pattern very similar to the distribution of poor health outcome measures through the city. The central band of instability, which snakes from the Northeast neighborhood through Clay Arsenal and Upper Albany before skirting to the west of Downtown and reappearing in Frog Hollow, South Green, and Barry Square is by now a familiar pattern.

Housing Conditions Index

Our housing conditions index tracks the aspects of housing quality that focuses on the physical quality of the housing stock as part of the built environment. Since Hartford currently lacks a comprehensive property assessment survey, we approximated housing conditions using other publicly available data sources from the Housing Code Enforcement Office. Although there is data available to evaluate the city in terms of housing conditions, these data must be interpreted with caution because they are based on reports and are not guaranteed to reflect the relative conditions throughout the city.

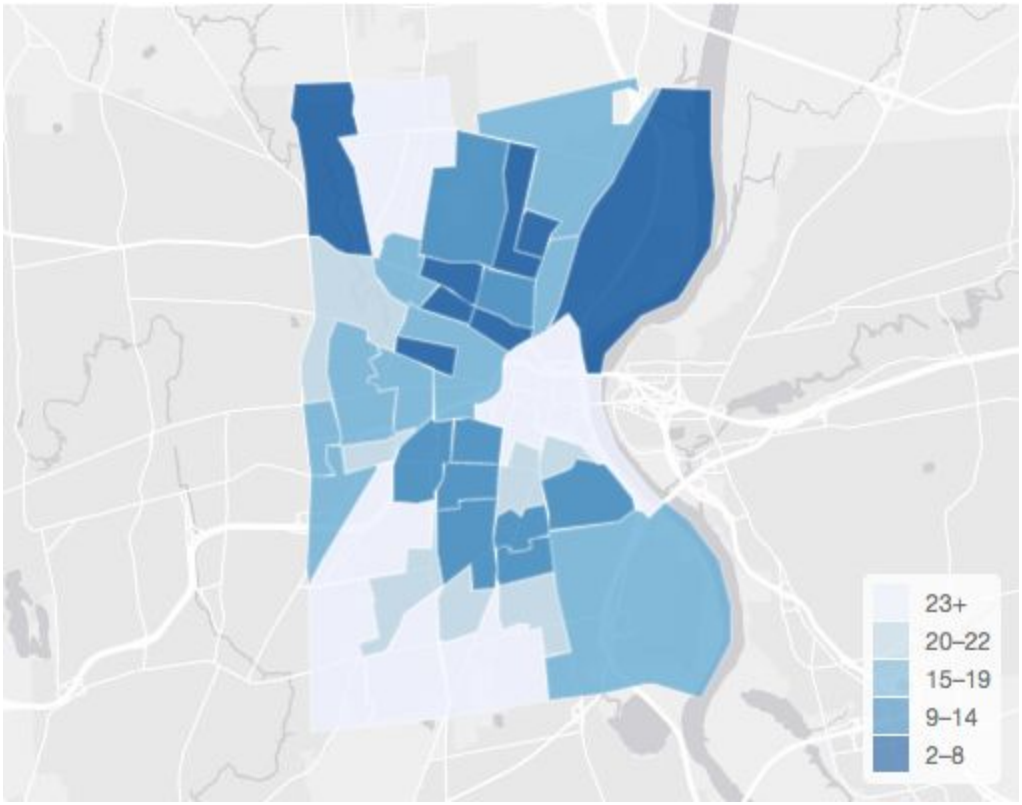
This index is comprised of the following measures:

- Housing code violations, which were broken into sub categories to track the severity of the complaint.
- A verified measure of housing vacancy as reported by the United States Postal Service. We calculated a vacancy rate for each tract by creating a weighted average from 20 quarters of USPS vacancy data. Vacant properties have an outsized impact on the health of a neighborhood property market: they are

frequently neglected and can become sites of rodent infestations, they easily fall into disrepair and affect surrounding property values, and they are the sites of a variety of criminal activity.

- Fire incidents, reported by the Hartford Fire Department, which are indicative of unsafe housing conditions that result in fire incidents.

Figure 7. Map 7: Housing Conditions Index



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

Using these measures, we created a composite index similar to the one generated for housing stability. Again, we aggregated measures up to the tract level and ranked the tracts from best to worst. For each indicator, the tract received a score of 1-10. Since we were limited to only two indicators appropriate to estimate housing conditions, we used deciles as opposed to quantiles to distribute index scores. Therefore, each tract could receive a potential score of 2-30. For this index, the highest census tract scored 29 while the lowest scored two.

The distribution pattern is familiar: Downtown, the Southwest, and the Blue Hills neighborhood received the highest rankings in our property conditions index, while large swaths of the Northeast neighborhood, Clay Arsenal, Upper Albany, and Asylum Hill received low marks on the conditions index. As discussed above, the high levels of calls for housing code violations throughout the areas of the West End that are largely comprised of rental units result in that area receiving lower scores in the property condition index than they did in the stability index.

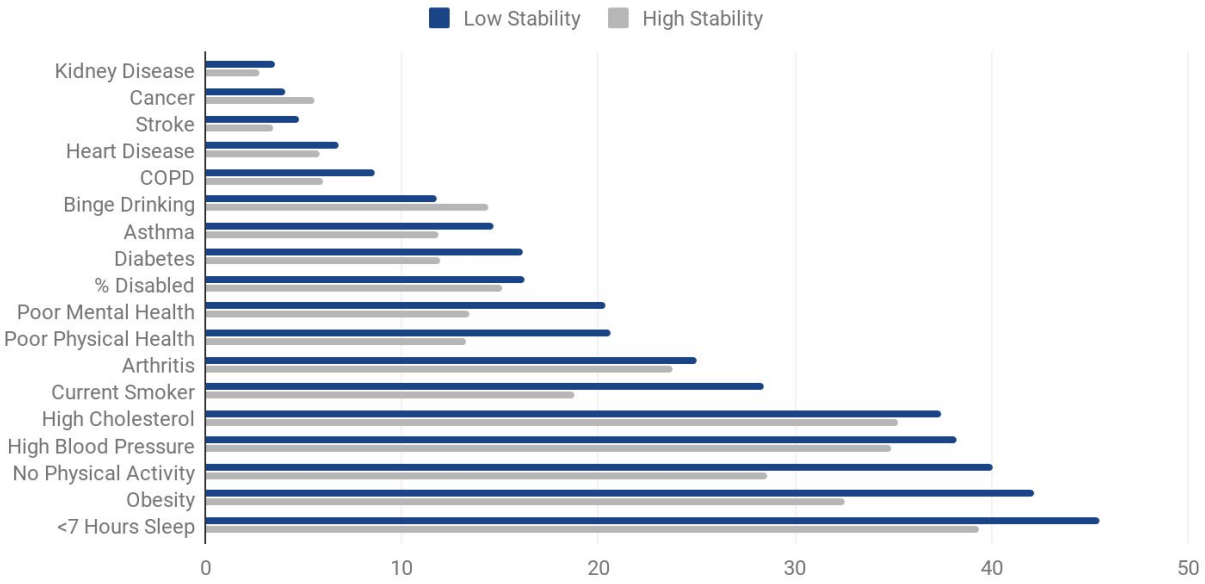
Bringing it Together: Housing Quality & Health Measures

This analysis is exploratory, drawing on a wide variety of data sources to tell a complex story about the relationship between housing quality - including social, financial, and physical characteristics - and health - including negative behaviors, mental health, and a variety of physical conditions. The central advantage of this project is its ability to investigate multiple health measures at once, which offers a unique perspective on the geographic distribution of multiple health measures throughout the city, providing an important ecological perspective. In addition, we have compiled a wide variety of data on multiple aspects of housing, allowing us to tease out the relative importance of physical property conditions when compared to the social and financial aspects of housing.

To analyze the relationships between housing and health, we used our property conditions index and stability index to identify the "best conditions/ worst conditions" and "most stable/ least stable" census tracts in the city. Then, we compared average health measures across each of the measures available in the 500 Cities Dataset. In doing so, we developed these major findings:

(1) The most stable tracts had better health measures than the least stable tracts on almost every health measure under study, a surprisingly robust pattern given the diversity of health measures that we included here.

Figure 8: Health Measures: Low Stability Tracts vs. High Stability Tracts



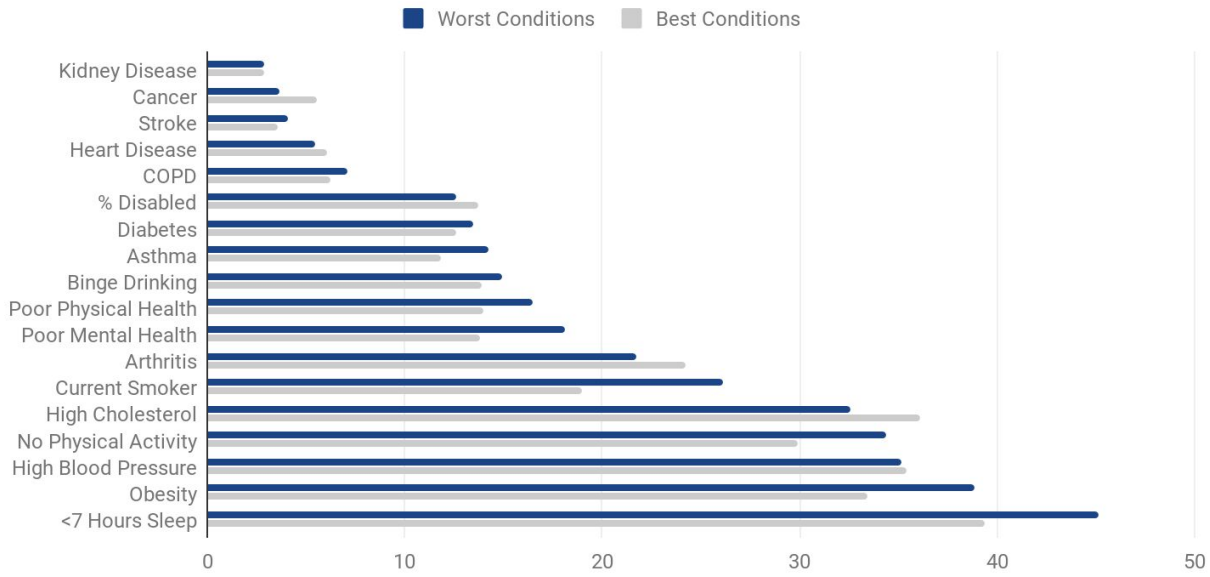
(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

In this analysis, a few health measures appear to be more affected by stability than others. The most general health measures - self-reported poor physical health and poor mental health - were more strongly associated with stability: someone living in a highly unstable tract was 34% more likely to report being in poor mental and 36% more likely to report being in poor physical health than someone living in a stable tract. Of the specific

measures, smoking and COPD were both strongly related to a tract's stability, as were diabetes, obesity and lack of physical activity.

(2) The tracts with the best property conditions also exhibited better health measures than the worst property conditions, although with slightly less regularity. As with the stability measure, the general health measures were the most closely related to property conditions.

Figure 9. Health Measures: Worst Conditions vs. Best Conditions



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

(3) The relationship between both stability and conditions and health was clearest in the most general health measurements available. Housing conditions and stability also seemed related to whether someone was a current smoker. These general health measures - whether an individual reported being in poor physical or mental health for more than two weeks - provide a useful snapshot into health that other more specific measures may not, especially when investigating the broad and amorphous effects of a social category as large as housing.

(4) The health measures that bucked the trend included arthritis, binge drinking, and cancer (excluding skin). These measures are those that tend to be highly related to age, which may explain the contrary findings.

Key Drivers of Health in the Neighborhoods

In all, this project investigated 15 measures related to the quality of housing in Hartford neighborhoods and 18 health measures. By combining them into our stability index and conditions index, we were able to assess the general impact of housing along these two axes on various health indicators.

Of the indicators we examined, however, three stood out as key drivers of health disparities between the neighborhoods. In this section, we describe in detail the impact of neighborhood foreclosure rates, the prices per square foot, and the concentration of calls to Housing Code Enforcement for essential services on various health measures.

Table 4. Correlation Coefficients for Housing Measures

	Foreclosure	Price per Square Foot	Calls for Essential Services
Obesity	.62**	-0.69**	.63**
Asthma	.47**	-0.51**	.61**
Stroke	.49**	-0.34**	.45**
<7 Hours Sleep	.53**	-0.67**	.67**
Poor Mental Health	.60**	-0.66**	.56**
Poor Physical Health	.64**	-0.57**	.50**
Heart Disease	.46**	-0.17**	.28
COPD	.54**	-0.42**	.45**
No Physical Activity	.67**	-0.64	.52**
Disabled	.16	-0.19**	.20
Arthritis	.42**	-0.42**	.32*
Binge Drinking	-0.51**	0.57**	-0.45**
High Blood Pressure	.44**	-0.52**	.43**
Cancer	.04	0.15	.11
Current Smoker	.59**	-0.87**	.64**
Diabetes	.57**	-0.66**	.47**
High Cholesterol	.47**	-0.41**	.26
Kidney Disease	.53**	-0.59**	.39*

*Denotes statistical significance at the .05 level
**Denotes statistical significance at the .01 level

Foreclosure

The foreclosure rate in Connecticut has decreased steadily since 2005, but it is still among the highest in the country. In 2017, 0.78% of units in Connecticut were in foreclosure, compared with 0.51% nationally. The foreclosure rate in Hartford slightly exceeded the state average, but not by much: between 2011-2015, there were 806 foreclosure filings in Hartford, an annualized rate of approximately 0.80%.

Foreclosures were unevenly distributed throughout Hartford neighborhoods, however. Census tracts 5012, 5041, 5028, 5017, and 5015 had foreclosure rates more than twice the city average. Three of these high foreclosure tracts were in the north end of the city, and the remaining two were centered on Park Street in the Frog Hollow and Parkville neighborhoods. These neighborhoods have very low homeownership rates compared with the city, suggesting that distressed landlords were more likely to experience foreclosure than owner-occupants. These high foreclosure neighborhoods also have higher rates of all negative health indicators under study, save two (binge drinking and cancer rates). Higher foreclosures rates are significantly correlated with poorer health outcomes and preventative measures in nearly all the health indicator estimates under review.

Figure 10. Map 8. Foreclosures, 2011-2015 and Foreclosures Hotspot Map

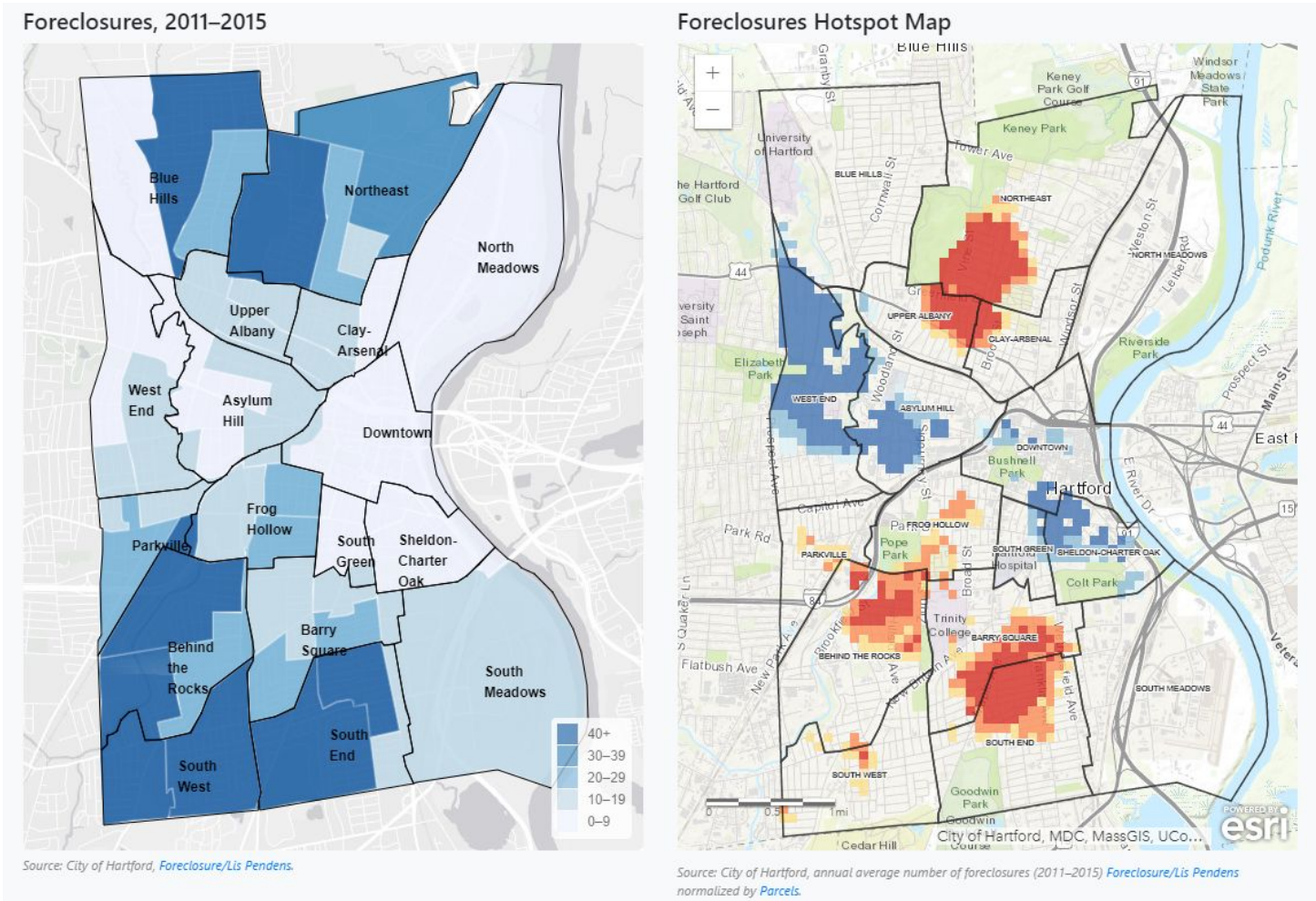
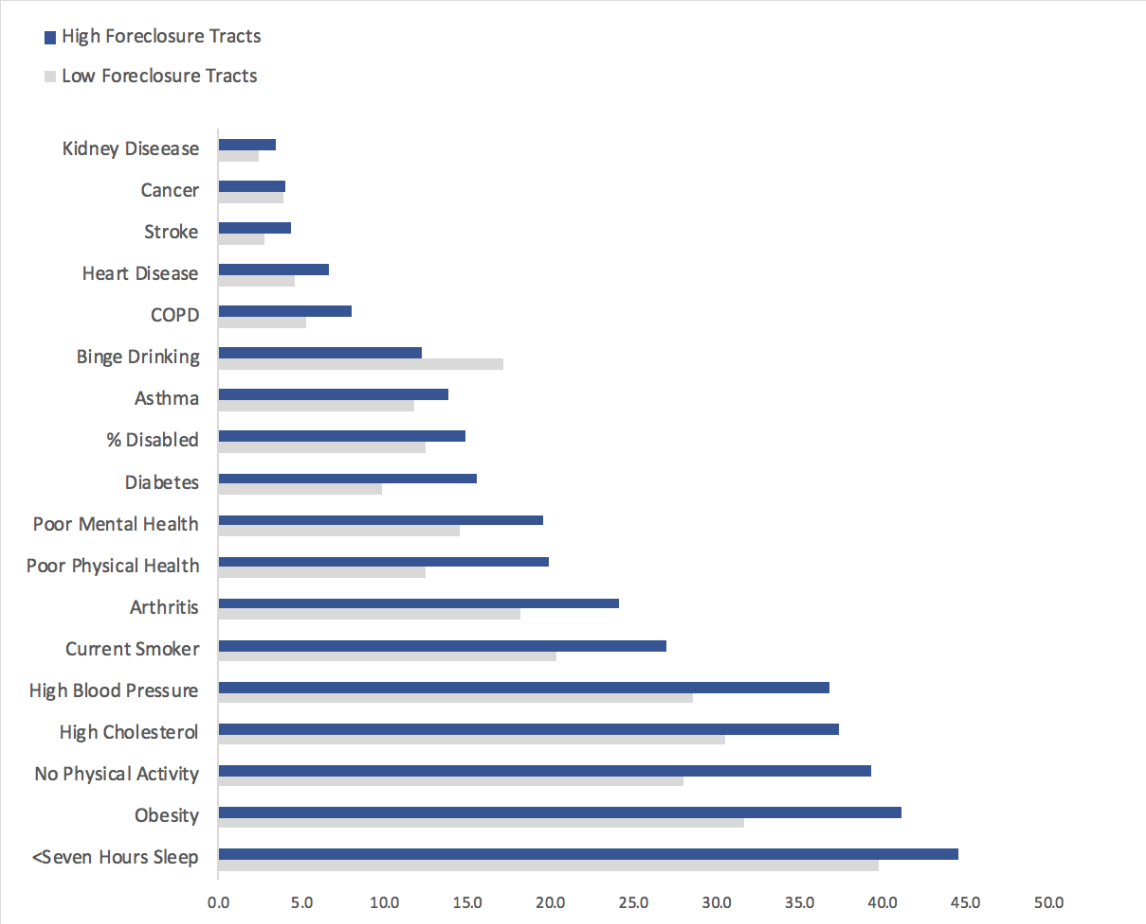


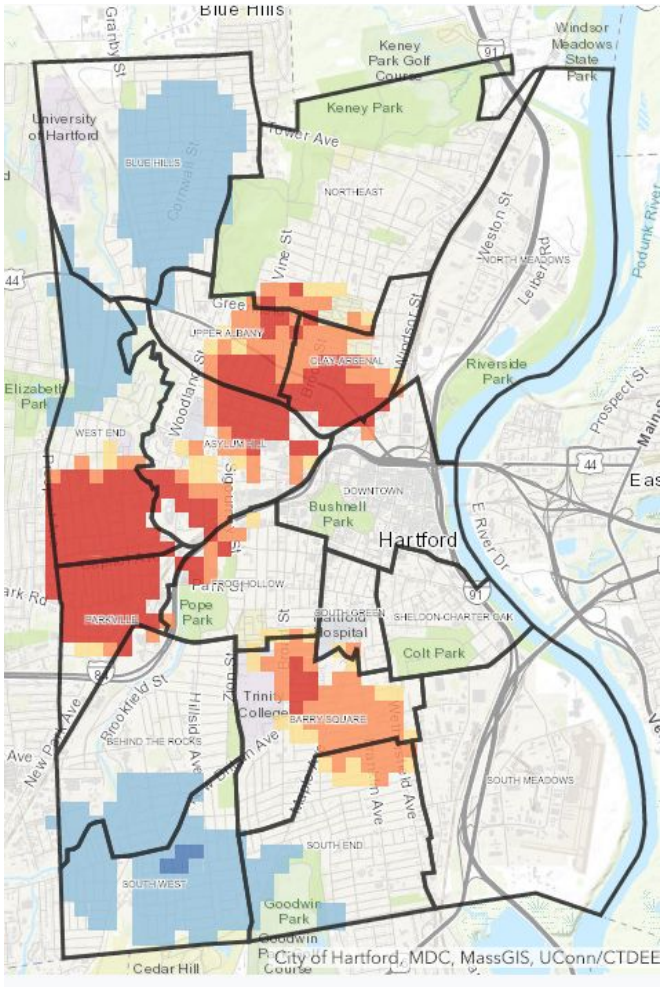
Figure 11. Health Measures Compared to High Foreclosure Tracts vs. Low Foreclosure Tracts



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

Interestingly, the foreclosure rate was a better predictor of negative health outcomes than the eviction rate, although both variables measure forced residential instability. The eviction rate had lower correlations with all health indicators under review than the foreclosure rate, although several correlations were still statistically significant. When evaluating the relative impact of each measure, it is important to note that the formal eviction rate does not track the prevalence of more common informal or "DIY" evictions, but rather only measures evictions that had entered the legal process. Certain vulnerable populations, especially undocumented renters, may be more likely to vacate an apartment prior to a formal eviction filing. A visual inspection of the distribution of high eviction rates suggests that some areas of high instability according to other measures - specifically tracts in Frog Hollow, Parkville, and Barry Square - had lower eviction rates than neighborhoods such as Asylum Hill and North Meadows (a largely industrial neighborhood). This may indicate racialized eviction patterns in the city, since both Asylum Hill and the north end more generally are predominately African American, while south end neighborhoods have high concentrations of Latinx residents. Alternatively, it may suggest a different spatial pattern between DIY and formal evictions, with formal evictions concentrated in African American communities and DIY evictions common among immigrant and migrant communities. Further research into the prevalence of informal, DIY evictions would be necessary to determine the explanation for this difference.

Figure 12. Map 9. Evictions Hot Spot Map



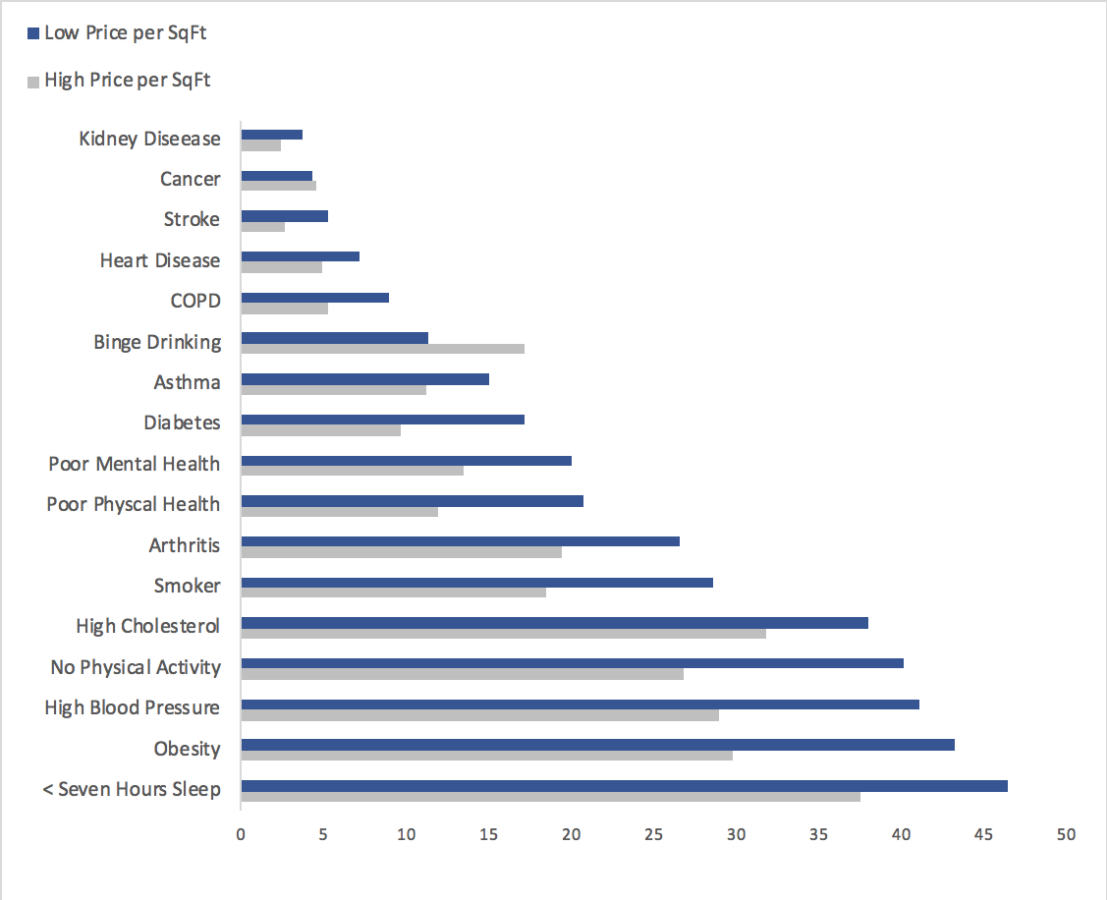
(Average annual eviction rate from 2011-2015, measured by total legal evictions divided by the count of residential units. Source: Eviction Lab.)

That said, the foreclosure rate is a robust predictor of poor health outcome estimates in our study. One potential reason it is a robust predictor is because it tracks financial precarity and instability among both renters and owners. Owner occupants are clearly negatively affected by foreclosure, losing both any equity they have accumulated in their property and the use of their living space. The foreclosure of a rental property, however, affects renters, property owners, and neighborhood housing market dynamics. If renters have difficulty paying, or if rents lag behind the cost to maintain housing, landlords may fall behind in mortgage payments and become vulnerable to foreclosure. Renters are subsequently negatively impacted by foreclosures, incurring additional moving costs and experiencing instability following the foreclosure of their rental unit. Moreover, the concentration of foreclosures in specific neighborhoods indicates flawed housing market mechanisms in which the costs to maintain properties and service the debt on a property are no longer exceeded by market rent. This is a particularly dangerous set of market conditions for a renter-heavy city such as Hartford, and therefore suggests that a high foreclosure rate highlights some of the most distressed neighborhoods in the city.

Price per Square Foot

The second measure of housing quality that was robustly related to health conditions was the price per square foot measure. Hartford house prices lag behind other communities in the state of Connecticut. Using other measures of housing value, such as Zillow's price estimate and the Census ACS estimate of housing values, the CT Data Collaborative found that the city of Hartford's property values were the second lowest in the state, just above Waterbury (http://housing.ctdata.org/). The estimate of median home value in Hartford ranges from $106,000 (Zillow) to $159,000 (Census). In our study, the assessed value per square foot of living space was strongly correlated with various health measures. Across all health estimates, save those for binge drinking and cancer, the price per square foot was among the most strongly correlated of housing-related variables: as house value increases, negative health outcomes decreases.

Figure 13. Health Measures Compared to Low Price per Square Foot vs. High Price per Square Foot



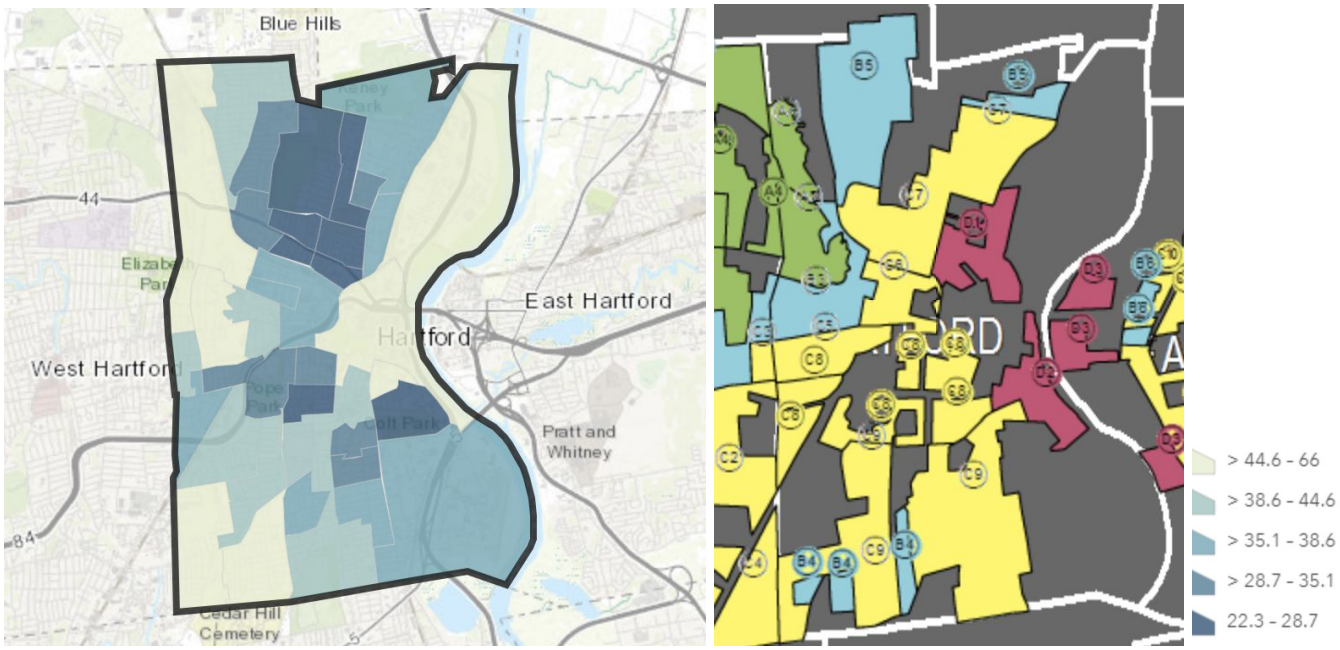
(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

This relationship, despite its apparent strength and consistency, should be interpreted carefully. Price per square foot is strongly and significantly correlated with both the percentage of people living in poverty (-0.63) and the percentage of non-Hispanic White residents (0.76). Both poverty and race measures were used in the model that created the 500 Cities small area estimates for the health measures, meaning that measures that are strongly correlated with those demographic variables should be interpreted with caution as we seek to tease out

the independent effects of housing on health. The foreclosure rate, in contrast to the price per square foot measure, is only loosely correlated with the percentage of people living in poverty (0.41), although it is more strongly correlated with the percentage of non-Hispanic White residents (-0.62).

Despite these limitations, the price per square foot measure does provide a certain estimate of property value, which has implications for the ability of property owners to borrow against the property for capital improvements and needed repairs. This measure comes from the city's assessor office, which determines price assessments for the purposes of taxation. Because of this provenance, the measure does not measure traditional economic view of housing value, but rather the city's determination of value. It represents legacies of patterns of investment throughout the city, and a visual inspection of the distribution of low assessed price per square foot shows a concentration of low values in the north end of the city, which has been a predominately African American neighborhood since the middle of the 20th century. It is particularly striking to overlay the mapped results of price per square foot with the "redlined" neighborhoods from 1937 HOLC report: the neighborhoods of Clay Arsenal, just north of downtown, and Sheldon Charter Oak, just south of downtown, both fall in the lowest 20th percentile of price per square foot in 2018, and they were both the only neighborhoods in Hartford that were graded "D" level or "hazardous" for investment purposes by federal workers in 1937.

Figure 14. Map 10: Price per Square Foot and Historic Redlining



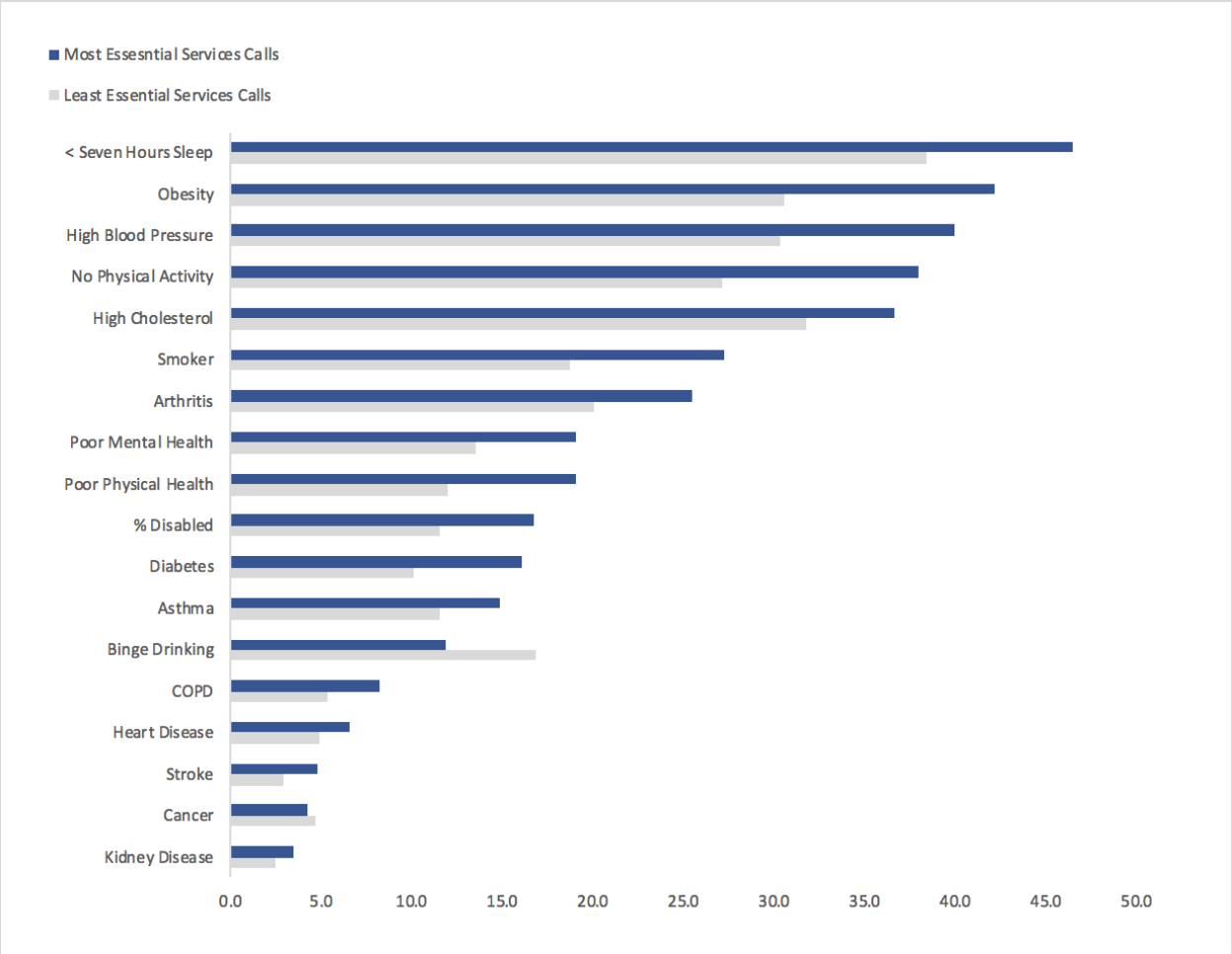
(Source: Federal HOLC "Redlining" Map, Hartford area, 1937, accessed online via UCONN's MAGIC, http://magic.lib.uconn.edu/otl/doclink_holc.html.)

Calls for Essential Services

The final measure of housing quality that was robustly correlated with a variety of health measure estimates was complaints regarding essential services, as reported by the housing code enforcement office. Essential services calls are among the most serious that the housing code enforcement office receives, involving tenants who have no heat or no water or who are experiencing significant active leaks. In our analysis, we compared

tracts based on the rate of essential services calls per residential unit. Every health estimate under study was significantly correlated in the correct direction with the essential services call rate, save binge drinking, cancer, high cholesterol, heart disease, and percent disabled.

Figure 15. Health Measures Compared to Most Essential Service Calls vs. Least Essential Service Calls



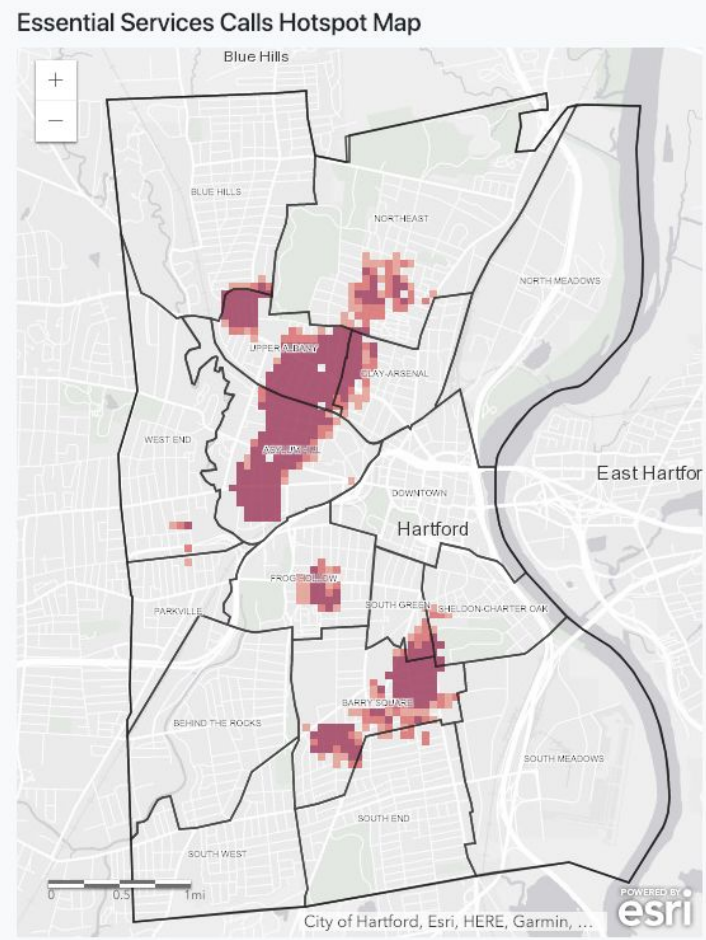
(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

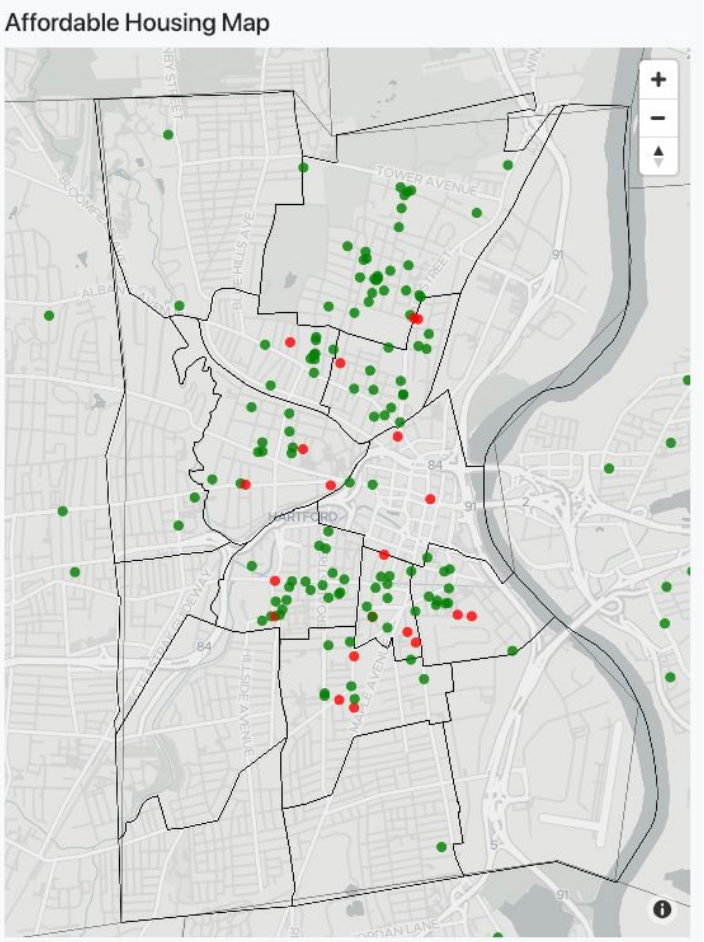
There are limitations to using this measure as an indication of housing quality. The first and most significant is that renters are the primary consumers of the housing code enforcement office. To put it simply: property owners will not call the city to report their own property maintenance problems. Owner-occupied units may also find their way onto the enforcement roll, but these complaints typically originate with neighbors and are typically for exterior problems relating to overgrown vegetation or other issues that may encourage rodent habitat, for example. Because of this, essential services calls are almost exclusively made to renter-occupied units.

This limitation aside, the calls for essential services are a better measure of housing quality - and are more strongly correlated with a variety of health measures - than is the alternative measure: the catch-all category of housing code violations. General housing code violations include issues such as mold, loose hand railings, and trash, among other issues. The currently available dataset also includes every complaint made, regardless of its

validity. We are currently unable to filter these housing code violations to determine which are legitimate and which are unfounded complaints. Examining the distribution of housing code violation complaints, some neighborhoods, specifically in the West End of the city, that have exhibited relatively high stability and otherwise good housing conditions on other measures, show clusters of housing code complaints. Rents in this neighborhood in particular are high relative to the rest of the city, so while the concentration of complaints may indicate poorer property conditions than other sections of the city, it may also indicate that renters have higher expectations for unit quality and are more likely to complain to the city when their expectations are not met.

Figure 16. Map 11. Essential Services Calls Hotspot Map next to Affordable Housing Map





Source: City of Hartford, Housing Code Cases, essential services code violation complaints per residential unit, 2011-2015, accessed June 2018.

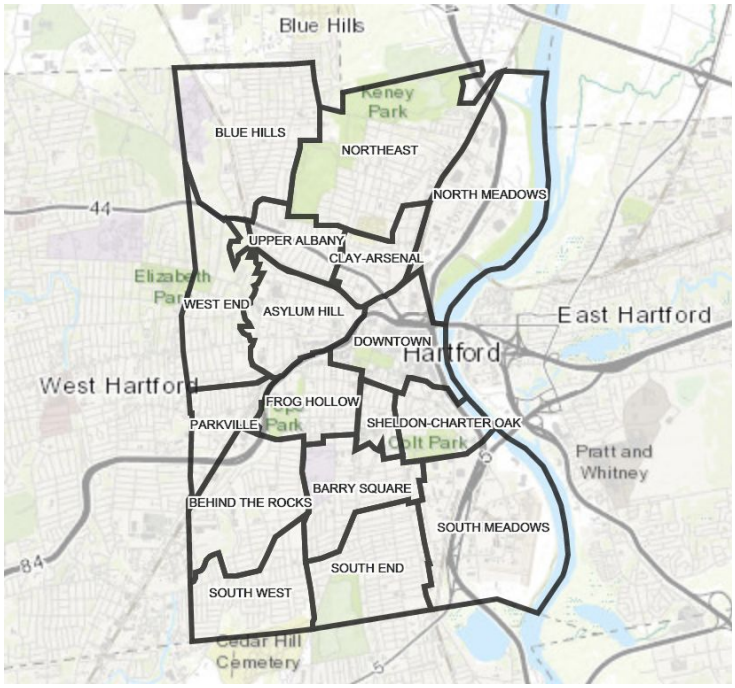
Source: National Housing Preservation Database, Publically Supported Housing Inventory, accessed November 16, 2018.

Neighborhood Level Analysis

Until now, this study has primarily analyzed data at the geographic level of the city, considering all of Hartford's 40 Census tracts. Now, we drill down to analyze the data at the neighborhood level, focusing on two of Hartford's 17 neighborhoods. While a tract level analysis is useful for analyzing variation at the scale of the city, thereby making it more useful to uncovering larger-scale relationships, neighborhood level analysis is more useful for conveying general trends and a grounded understanding of how two important issues - housing

and health - influence one another within social boundaries. This section provides a neighborhood analysis of housing and health in two of Hartford's neighborhoods, Barry Square and the Northeast neighborhood.

Figure 17. Map 12: Hartford's Neighborhoods



(Source: City of Hartford)

We defined neighborhood boundaries by using city-drawn neighborhood boundaries, which were based on a strong tradition of neighborhood-oriented community organizing in Hartford and represent real and ongoing boundaries of communal work. These boundaries are socially and politically meaningful to residents in Hartford and are about 3-4 times larger than a census tract. In contrast to census tracts, which are based on population, neighborhoods are places that residents and non-experts can envision and identify.

A few caveats related to definitions and methods: first, the city's census tract boundaries do not perfectly align with the city's neighborhood boundaries. They align closely, but we slightly altered three neighborhood boundaries (Asylum Hill, Barry Square and the South End) in ArcGIS in order to contain groups of census tracts. The majority of neighborhood boundaries did not have to be altered. Second, in order to analyze data at the neighborhood level, we aggregated the data for the Census tracts together by compiling the data from the census tracts that comprised a neighborhood and calculated the weighted averages.

Selecting Neighborhoods for Analysis

We are including analyses of Barry Square and Northeast here because they differed in our housing indices. The Northeast neighborhood exhibited below average stability and below average property conditions in our two indices. Barry Square, on the other hand, ranked close to the city average in property conditions, but was near the bottom on stability.

In this analysis, we asked whether there were observable differences in health measures among differently situated neighborhoods with respect to housing quality. As a result, we found that the general trend observed

throughout this report - namely that poor health outcomes are present in areas of poor housing quality - continues at the neighborhood level.

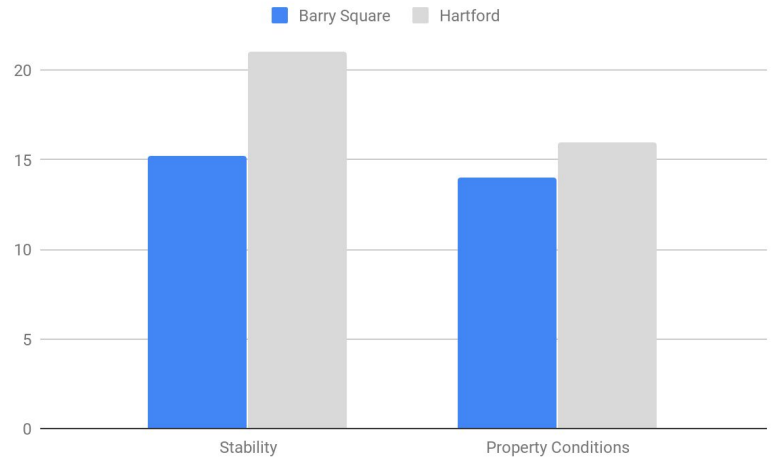
This observation holds true for areas of high housing instability and poor housing conditions, but it is more extreme for areas that contain both high instability and poor housing conditions. In general, we notice a pattern in these two neighborhoods. In Barry Square, a neighborhood with low stability and relatively average property conditions, health outcomes across indicators are somewhat worse than city averages. In the Northeast neighborhood, which experienced both low stability and poor property conditions, health outcomes are significantly worse than city averages.

Barry Square

Barry Square is a neighborhood surrounded by prominent Hartford institutions: Hartford Hospital bounds the neighborhood to the north, Trinity College occupies its western edge, and the Institute for the Living occupies the center. It is a historically working-class neighborhood, home to successions of recently arrived immigrant groups, from the Irish in the early 20th century to an increasingly diverse group of immigrants from various Latin American countries today. The housing stock is primarily 2- and 3- family structures, interspersed with single family homes.

In Barry Square, we identified an overall pattern of below average housing stability and close to average property conditions, relative to the city. The average stability index score in Hartford, according to our analysis, is 21 out of a possible 35; the Barry Square stability index score was 15. A lower stability index score indicates areas where foreclosure and eviction rates are higher, housing is less affordable, and housing values are less robust. The average property conditions index score in Hartford was 16 out of a possible 30; Barry Square was slightly below this average, scoring 15. A higher property conditions score indicates areas with fewer housing code violation complaints and lower vacancy rates.

Figure 18. Property Conditions and Stability Index: Barry Square vs. Hartford



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

Affordability is a substantial challenge in this neighborhood, with the average resident spending 46% of their household income on rent. For conext, the average Hartford renter spends approximately 35% of their income

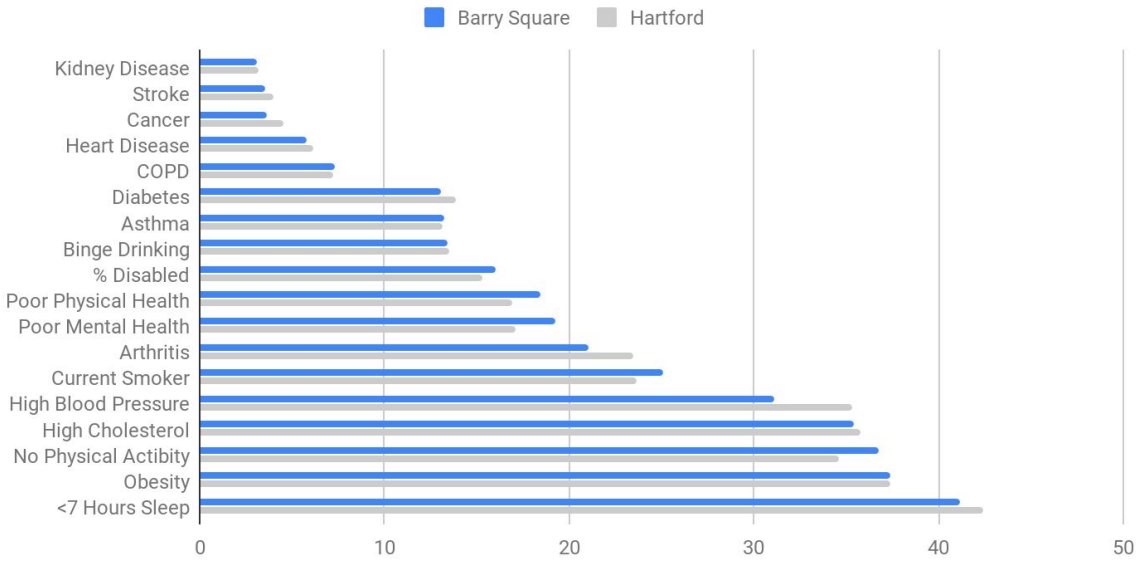
on rent. Barry Square also has a high eviction rate of 6.5% which is among the highest in the city. One census tract in particular, directly south of Hartford Hospital and bounded to the west by Washington Ave. and to the east by Wethersfield Ave., reported the second highest eviction rate in the city: nearly 10% of residents received a formal legal eviction in any given year between 2011-2015. Property owners struggle as well: two of Barry Square's census tracts are in the top 20% of foreclosure rates in the city.

In our index that measures property conditions, Barry Square is closer to the city average, mostly due to a relatively low vacancy rate. Despite affordability challenges and forced relocations, the neighborhood features a low vacancy rate relative to the rest of the city. The neighborhood vacancy rate stands at 6.6% which is lower than the citywide rate of 7.4%. It is possible that the neighborhood vacancy rate is slightly inflated due to the presence of Trinity College in Barry Square: empty student dorms are counted as vacant during each summer quarter in the USPS dataset. When the Trinity College tract is not included in the analysis, the neighborhood vacancy rate drops to 5.8%. However, Barry Square scores worse relative to the rest of the city on other indicators of property conditions, including housing code violations and fire incidents. Of the four Barry Square tracts, three are in the 50th percentile for number of fire events, and two out of four were below average in housing code violation complaints. The result is that housing conditions in the neighborhood remain just below average for the city.

Importantly, the poor housing measures are not evenly distributed throughout Barry Square. One particular census tract in Barry Square is among the most challenged in the city along several measures. This tract is directly south of the Hartford Hospital, bordering the South Green neighborhood. It was in the bottom 20 percent in rent to income, eviction, length of tenure, foreclosure, and in the bottom 10 percent in housing code violations, calls for essential services, and vacate now notices. In contrast, the census tract directly to the west was above average on most measures. This particular pattern emerged consistently in our neighborhood-level analyses: pockets of concentrations of poor housing conditions would be bordered or at times surrounded by areas with much better conditions. Because of this, it is crucial to avoid characterizing whole neighborhoods based on the conditions of individual tracts.

This lesson becomes more clear as we shift to analyzing the overall health conditions in Barry Square. When viewed as a neighborhood, it appears that there are only minimal differences in health outcomes in the neighborhood when compared to the city averages. Indeed, on a number of health outcomes, Barry Square charts better on a number of health outcomes including stroke, heart disease, and high blood pressure. The remaining measures are so similar to the city rate that overall picture shows Barry Square to be about the average of the city on most health measures.

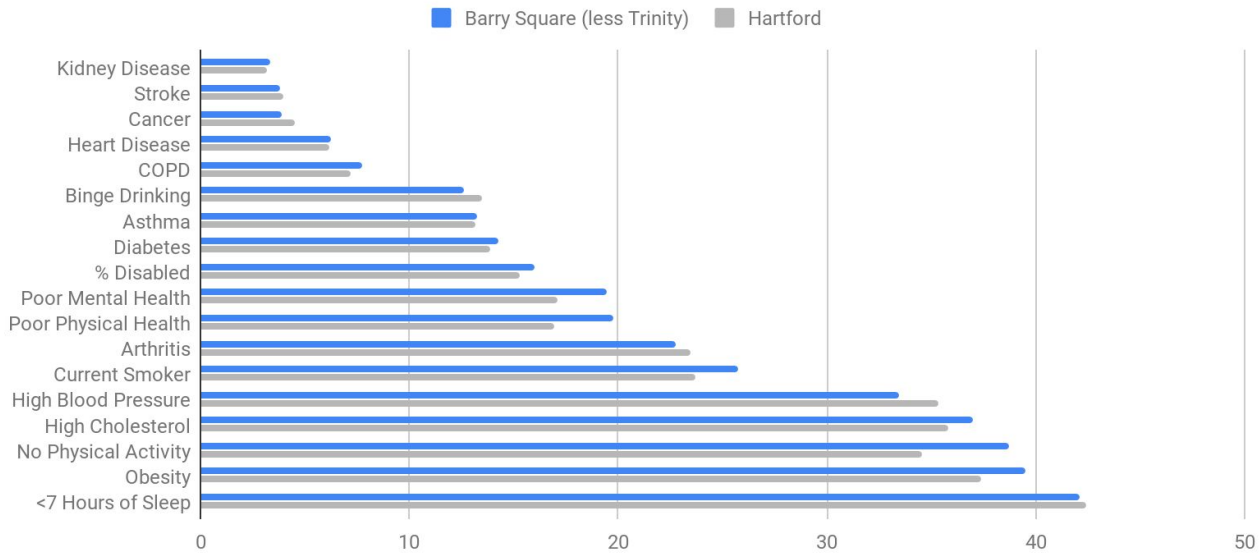
Figure 19. Health Measures: Comparison of Barry Square and Hartford



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

However, we also know that Barry Square includes approximately 2,000 Trinity College students that are figured into the 500 Cities estimates. Students from Trinity College tend to be significantly wealthier, whiter, and younger than the typical Hartford resident (in addition to most not being full-time Hartford residents). Consequently, the tract that contains Trinity College has higher number of positive health measures when compared to the city average. For example, the tract with Trinity College has an average obesity rate of 31.1%, lower than the city average of 37.4%. When controlling for the presence of Trinity College students by removing that tract from the neighborhood's data, we then see a notable worsening of health outcomes. Barry Square then has worse health measures than the city on 11 of 17 health outcomes. Additionally, three of the six health outcomes in which Barry Square fared better than the rest of the city were arthritis, binge drinking, and cancer (excluding skin). We previously found those three health outcomes to be more correlated to age with cancer and arthritis being more prevalent in older populations and binge drinking being prevalent in younger populations.

Figure 20. Health Measures: Barry Square (removing Trinity College) and Hartford



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

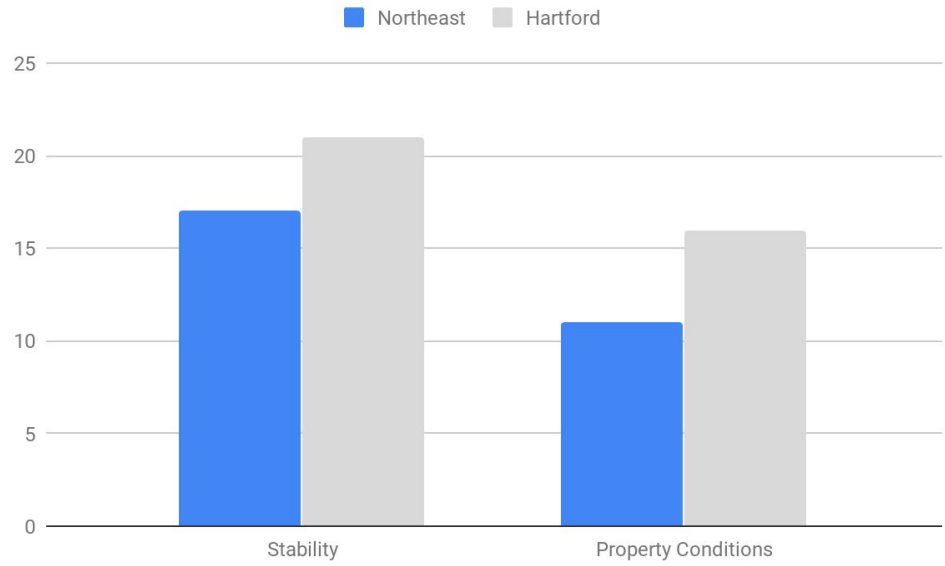
That said, the differences are not as substantial as the differences between the tracts that scored in the extremes of housing conditions and stability measures. On the whole, Barry Square fares poorly in the housing stability index, remains approximately average in overall housing conditions, and, in the end, fares slightly worse but not substantially so than the city on a host of health measures. The influences of low vacancy throughout the neighborhood, which increases the property conditions score for the neighborhood, may mitigate negative health impacts, for example, and would require more investigation. Ultimately, when searching for patterns in the relationship between housing and health at the neighborhood level, the importance of carefully analyzing the relative importance of each individual area and each individual measure is paramount.

Northeast Neighborhood

The Northeast neighborhood, which is sometimes simply referred to as the North End occupies the area east of Keeney Park and west of the river. Keeney Park is the largest municipal park in Hartford, stretching across the border into Bloomfield and Windsor. The neighborhood is predominately African American, and has been so since the middle of the 20th Century, and the neighborhood also includes newly arrived immigrants from the Caribbean and Latin America. The housing stock is primarily 2- and 3- family structures, interspersed with single family homes.

As a neighborhood, Northeast fared poorly in both the housing stability and housing conditions indices we created to measure housing quality. It ranks below average on both indices when compared to the city, scoring 17 on our housing stability index and 11 on our property conditions index, compared to city averages of 21 and 16, respectively. Northeast scores slightly higher than Barry Square on housing stability, though it is still well below the city average, and is among the worst in the city on the property conditions index.

Figure 21. Property Conditions and Stability Index: Northeast vs. Hartford



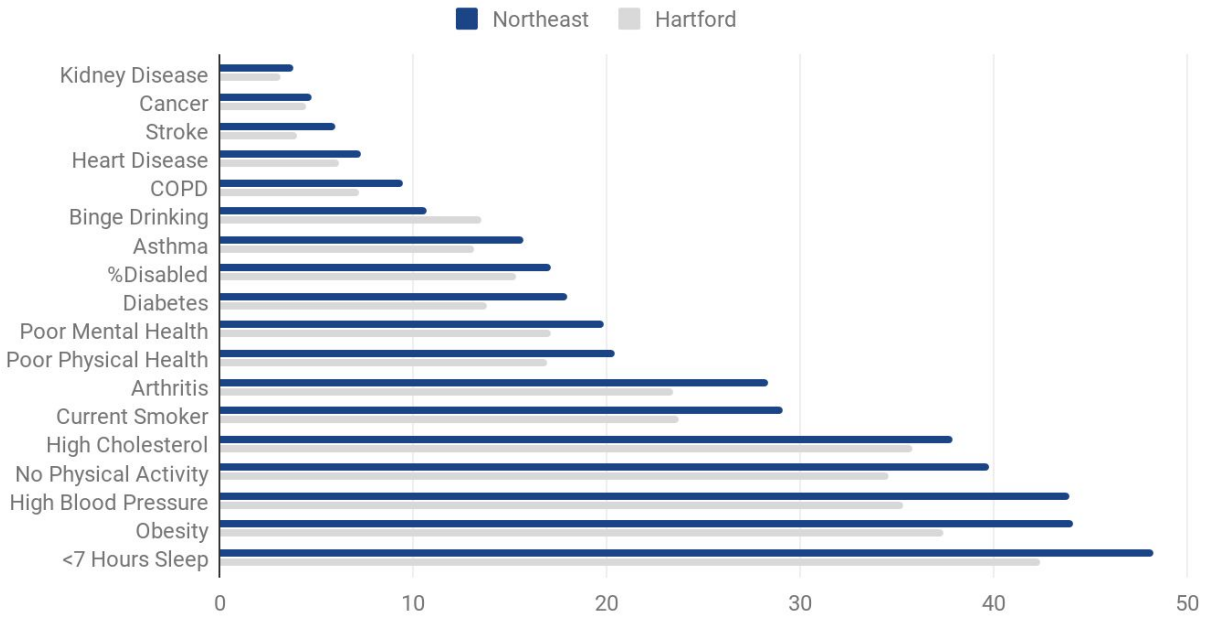
(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

In contrast to Barry Square, where affordability concerns and forced relocation negatively impacted the stability index, stability in the Northeast neighborhood was more affected by low property values and foreclosure. The average Northeast household spends just over 37% of their income on rent, for example, which is on par with the city average of 35%. In fact, residents in the Northeast stay in their homes approximately 1 year longer than the typical city resident, staying an average stay of 8.5 years in the Northeast compared to 7.6 years in the city as a whole. However, housing stability is below average in the neighborhood because of evictions, foreclosures, and low property values. Property values in the neighborhood are among the lowest in the city: the average assessed price per square foot of residential property in the neighborhood is $28.85 per square foot which is about 75% of the city average of $38.39 per square foot. Foreclosure rates are particularly high in the neighborhood, and two of the four tracts experienced among the worst foreclosure rates in the city. Forced relocation pressures negatively impact the neighborhood, and the property owners remain trapped by relatively low prices which may hurt their ability to borrow money to invest in the capital expenditures.

Further, the Northeast neighborhood also suffers from poor property conditions. Of particular note is the neighborhood vacancy rate in Northeast. Between 2011-2015, the average neighborhood vacancy rates was 10.9%, compared with an average annual vacancy rate of 7.4% in the city as a whole. One tract in the neighborhood - the tract immediately adjacent to Keeney Park - experienced a 16.3% vacancy rate in that same time period, which was the highest vacancy rate in a predominately residential census tract in the city. The high vacancy rate may contribute to overall neglect of property in the neighborhood: the Northeast outpaces the rest of the city in housing code violations (0.50 code violations per unit in Northeast versus 0.41 code violations per unit for the city).

In Northeast, where there is both low stability and poor property conditions, health outcomes are significantly worse than city averages.

Figure 22. Health Measures: Northeast vs. Hartford



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

As the chart above shows, Northeast features worse health outcomes than the city average on all health outcomes except for binge drinking. Specific outcomes for each health indicator can be seen in chart 1, but a few particularly stand out. In this analysis, 9 of 17 health outcomes are at least 20% higher in Northeast than in the rest of city. A Northeast resident is 50% more likely to experience a stroke than your typical Hartford resident. Therefore, the result is that in neighborhoods like Northeast where there are both low housing stability and poor conditions, we see the presence of worse health outcomes.

Next Steps and Recommendations

- Data collection improvements
    - Work with the city to improve the collection and reporting of bed bug and rodent incidents. The data are collected on reports of these conditions, but we were unable to use the data since there was no way to determine if an incident was substantiated or not.
    - Work with the City of Hartford Blight Department to implement a data collection and public data reporting mechanism for blighted residential properties.
- Policy
    - Engage housing advocates in a discussion with these data to develop policies and programs that could help mitigate foreclosures.

    - Present the findings to the City Health Department and help generate intervention services that would reduce the number of calls for essential services.

- Public Education
    - Build a public education curricula on how to use these data to improve the culture of health in their community.

Appendix A: Opportunities in Using Cross Sector Data

Throughout our work on this project, we engaged audiences across the city at various stages of our analysis and also by communicating through various mediums. At the end of our work, we held an event that crossed sectors and drew an audience of forty people. Below is a summary of the event and the reactions/discussions during the Data Walk and the feedback from our survey at the end of the discussion.

Participants from across Hartford were invited to join us in an interactive discussion about our Health in Hartford's Neighborhoods project. During the event, we facilitated a participatory planning session utilizing the findings from the project to examine the use of data in understanding policy issues. We deconstructed public data sources and developed a foundational understanding of the data that do and do not exist. Learned about other health and housing related projects and initiatives happening in the city. Held a data walk where the group was split into three groups and spend ten minutes examining different visualizations and discussing the data presented in the maps.

Remarks from the Data Walk:

Question: What do you notice?

- Hotspot map provides much more accurate data to inform targeted response
- Redlined in 1937 - conditions never improved
- Areas with unstable housing and negative health outcomes lacks access to larger grocery stores
- Green areas are highest ownership areas

Question: What do you wonder?

- Will 500 cities data be updated by the CDC?
- What types of homes are being foreclosed on (single v. multiple family homes)?
- How did this happen?
- Would be interesting to make a map of preventable foreclosure data (if exists)
- How much housing is income restricted? What would it look like w/out Hartford Housing Authority?
- I'm curious to know how other cross-sectoral measures would look e.g. educational disparity

How will you use these data/findings?

- What would map look like if mapped by street, knowing there is a mix of gov't housing, income or age-restricted housing?
- Start community conversations but check the results w/ those who live it.
- Find opportunity for effective intervention (possibly target eviction rate or foreclosure rate)

    - Compare back w/ health care utilization for chronic conditions or preventable admissions

Feedback on the usefulness of the event:

- Learning about the other groups with a Hartford and statewide focus who work on housing and health.
- The group interaction and thinking out loud as a group
- The discussion @ the maps was very useful, because it brought together the perspectives and contextual factors. That cross pollination was valuable.
- The opportunity to be inspired by the thinking of others--something that is only this effective in a live discussion.
- Great to discuss these topics with other stakeholders and ponder the possibilities for the use of the data, how it could be enhanced and what is missing.
- Looking around the room and seeing all the data uses in Hartford and imagining how data can be used to create collaborations
- Causing people to think and talk together, which in turn increases likelihood of taking action together

What is one thing you learned and/or will use after the event:

- I will go back to review data & hope to see/correlate other health data within to be able to how potential funders to allow us to provide specific legal advocacy & representation for our population served.
- I will use this data and similar data to compare with other factors (such as chronic absenteeism)
- Will use some data points shared for upcoming community conversations and needs assessments for grant applications.
- Good to know about alternative data measures - eg. foreclosure "hotspot" data
- Sharing the data w/colleagues in the field.

Appendix B: Hotspot Analysis Technical Details

Understanding the Housing Code Violation Data through Optimized Hotspot Analysis

The Housing Code Violation data set made public by the city on the open data portal offers a good entry point into understanding complaints made about housing by Hartford residents. However, it tracks complaints only not substantiated complaints. This is important, because oftentimes complaints data - such as reported crimes for example - is better at tracking the location of people who feel empowered and secure enough to make reports to an authority. In the case of housing complaints, it's easy to imagine that a more empowered class of renters may have higher standards for property maintenance and feel more compelled to make those complaints.

We analyzed the geographic distribution of housing code violation complaints lodged between 2011-2015, and were able to break out the type of complaint into the 7 categories listed below.

Table 5. Housing Code Violation Complaints

Complaint Type	**Number**	**(% of Total)**
Housing Code Enforcement	9,279	(56%)
Certificate of Apartment Occupancy	3,718	(22%)
Essential Services	1,561	(9%)
Bed Bugs (HCE)	980	(6%)
Rodent (HCE)	703	(4%)
Rooming House / Hotel	256	(2%)
Fair Rent	60	(<1%)
Total	**16,557**	**(100%)**

(*Source: City of Hartford, accessed June 2018)*

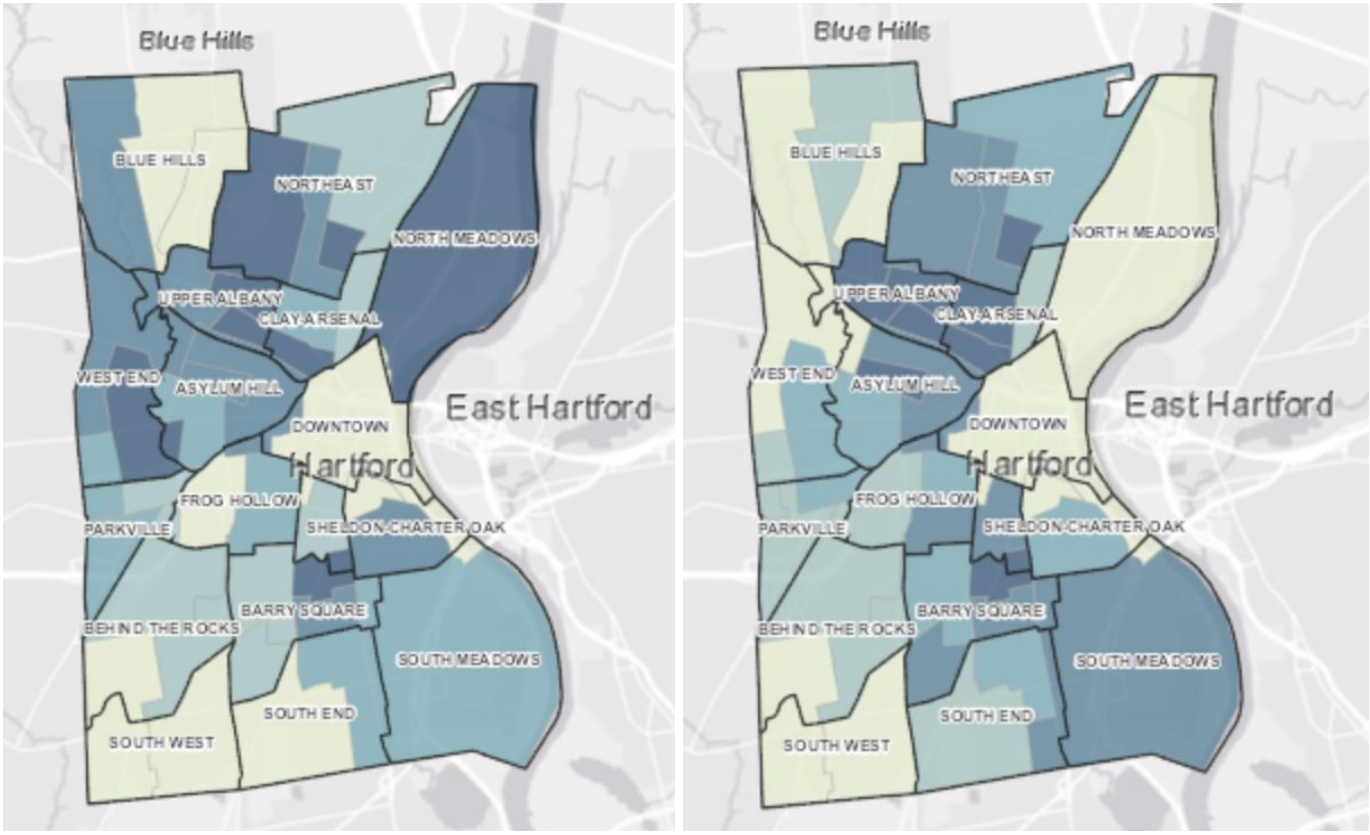
By far the largest complaint is the catch-all category of "housing code enforcement." According to our interview with the Housing Code Enforcement Office, this could capture anything from an actively leaking ceiling to a missing screen on an upper level window. In fact, since this is the 'catch-all' category, we observed that the geographic distribution of the complaints suggested that they might not be the best measure of underlying housing quality. Even though this is the largest category, it is impossible to filter these complaints by severity or by whether these complaints were found to be legitimate.

The category that provided the most insight and is one that we ultimately found had a strong correlation with a

variety of health measures in our study are Essential Services violations. This category tracks complaints in which a someone lacks heat or hot water. It makes up almost 10% of the total volume of complaints.

The distribution of complaints per unit, when mapped at the city level, validated a few assumptions. In the map on the left, housing code violation complaints per unit broken down by quintile - the darkest color is the top 20th percentile of complaints. In the map on the right, essential services complaints per unit are also broken down by quintile: the darkest color is the top 20th percentile.

Figure 23. Map 13: Housing Code Violation Complaints & Essential Services Complaints - per unit



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

As evidenced by the distribution displayed on the map, the West End neighborhood in Hartford, is one of the top 5 census tracts in complaints per unit. It may be that the West End, especially the southern portion of the neighborhood where there's a concentration of rental units, has among the worst property conditions in the city, but it may also be that residents of that neighborhood, who are slightly more affluent, younger, and paying higher rent than other parts of the city feel more empowered and secure enough to make complaints and have higher standards for property maintenance.

The break down of essential services complaints, on the other hand, draw your attention to neighborhoods like Upper Albany and Clay Arsenal, as well as Frog Hollow, South Green, and Barry Square. These are neighborhoods that have lower socioeconomic characteristics and observably worse housing conditions.

Optimized Hotspot Analysis:

We were interested in whether there were statistically significant concentrations of housing code violations complaints, which might hint at a geographic strategy to rehabilitate housing stock. In order to understand the spatial distribution of these two variables a bit more, we conducted an optimized hot spot analysis to identify significant clusters of complaints.

The first step was to identify the geographic areas in the city in which incidents were possible. Large swaths of land in Hartford are institutional, commercial, industrial, or park land, which, if left in the analysis, would skew the results. Therefore, we took the following steps to identify areas of residential property and limit the geographic :

- First, we used the GIS Parcel data as the base layer, which is a shapefile that contains the outlines of all land parcels in the city.
- We joined this layer with the CAMGIS dataset, which tracks ownership and zoning on all properties in Hartford.
- We selected and exported a vector shapefile that included only residential property types.
- The resulting polygons no longer included parks, city or state-owned nonresidential property, commercial property with no residential units, or roadways.

The results are displayed in the two maps below. The map on the right shows where residential properties are located in the city.

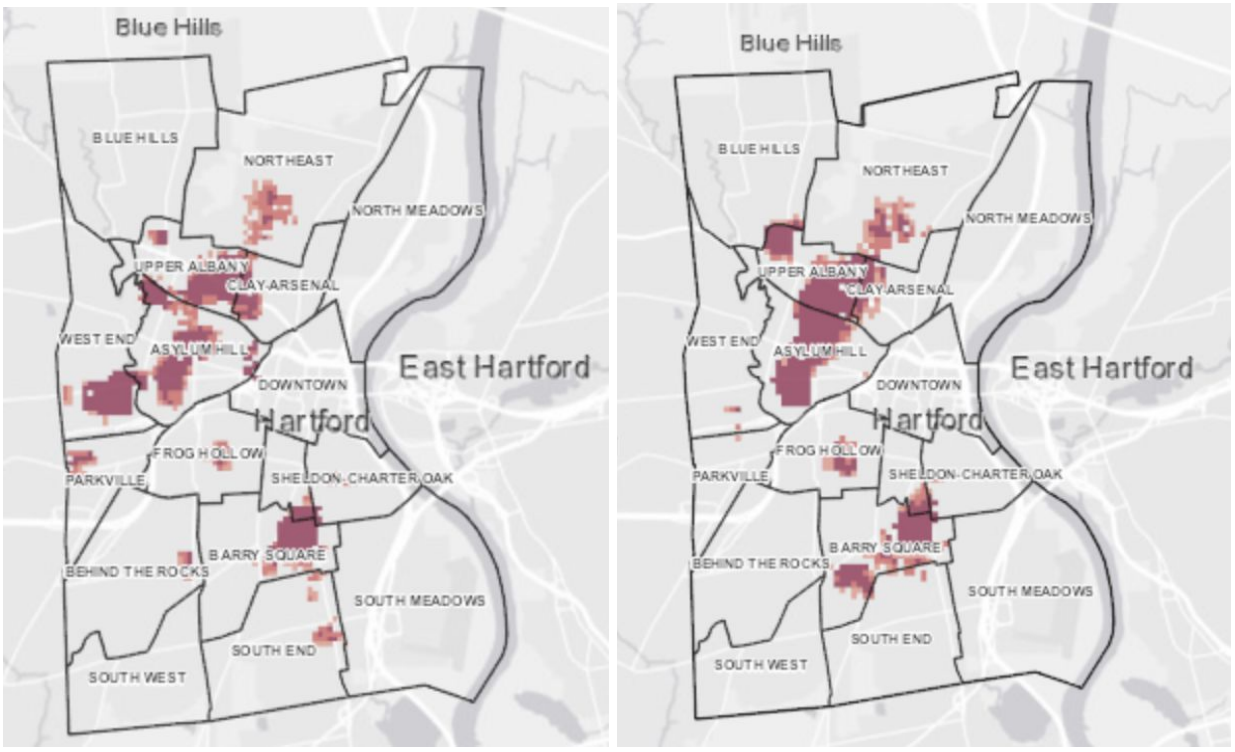
Figure 24. Map 14. Hotspot and Optimized Maps

(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

Final Results:

The following maps show the final hotspot analysis for Housing Code Enforcement complaint data and Essential Service Call data.

Figure 25. Map 15. Final Hotspot Analysis: Housing Code Enforcement & Essential Service Calls



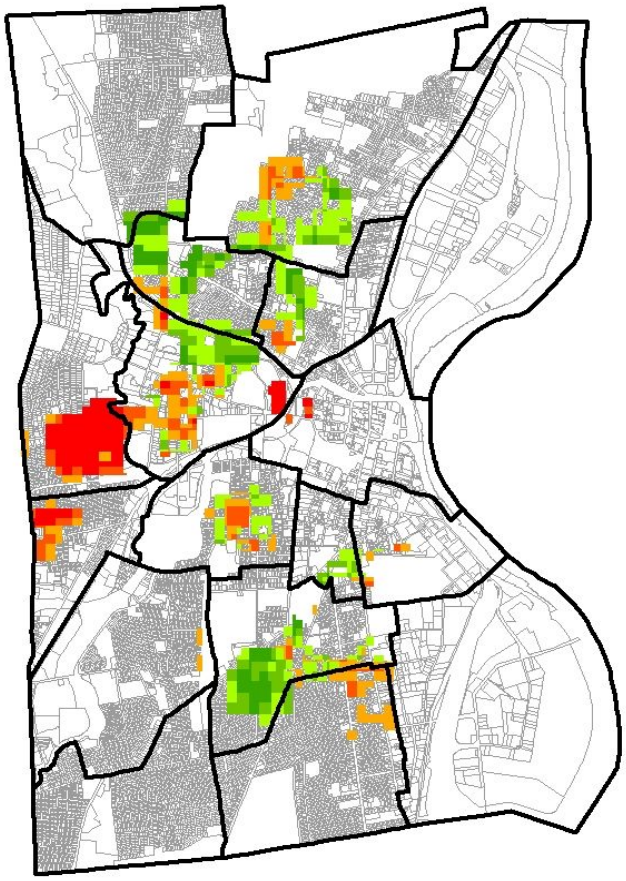
(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

In order to determine the actual difference between the areas of concern that these two analysis display, we converted the polygons from the two optimized hot spot analyses into rasters and subtracted the essential services hotspot map from the housing code enforcement map.

The red displays locations where there were concentrations of housing code enforcement complaints but not essential services complaints, and the dark green displays areas where there were concentrations of essential services complaints but not housing code enforcement.

The two most important areas to look at here are the west end and the much-expanded hotspot area through the southwest corner of Barry Square. Looking at these analyses, it became evident that using essential services data would help better estimate the underlying property conditions and help understand more fully the relationship of housing conditions to health.

Figure 26. Map 16. Difference Between Hotspot Analysis



(Developed by Trinity College Liberal Arts Action Lab and Connecticut Data Collaborative.)

The correlation between essential services calls per unit and the health measures listed below was statistically significant and relatively robust given the number of different types of health outcomes and practices we investigated. The 500 Cities dataset tracks 18 different health outcomes measures, and the ones listed in the table below were the ones that were significantly correlated with essential services calls.

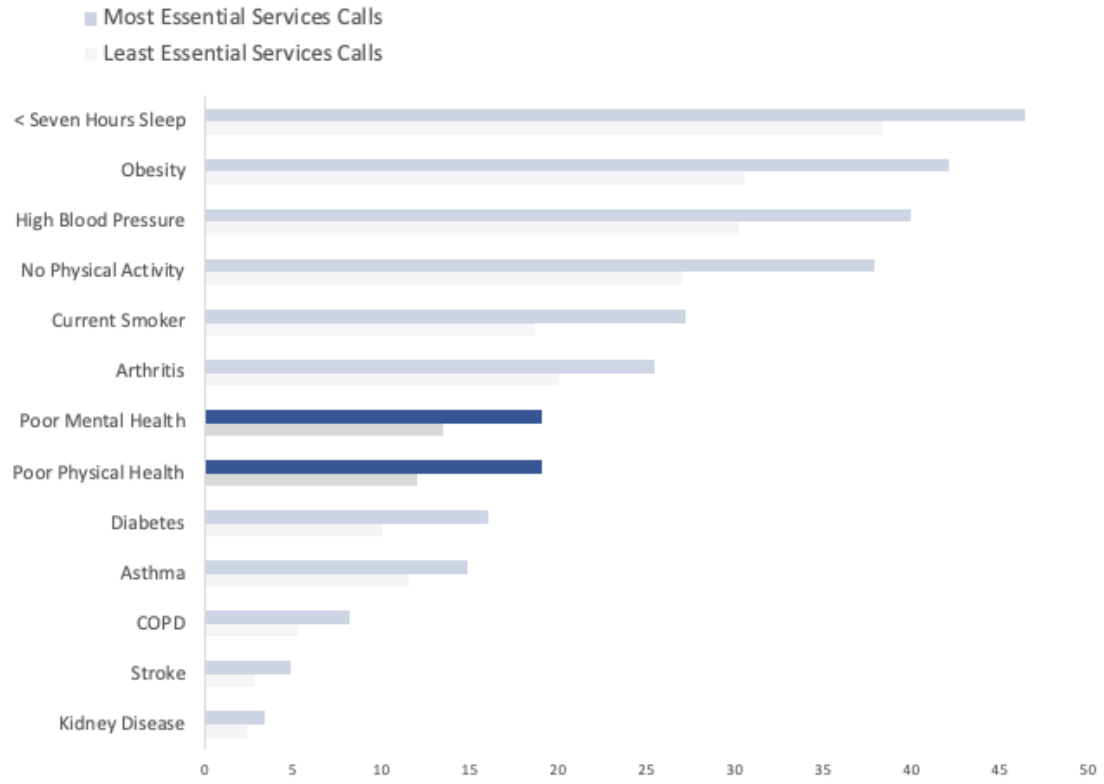
Table 6. Correlation Coefficients for Essential Service Calls and Health Measures

Health Measure	**Correlation with essential services calls per unit**
<7 Hours Sleep	.67**
Current Smoker	.64**
Obesity	.63**
Asthma	.61**
Poor Mental Health	.56**
No Physical Activity	.52**
Poor Physical Health	.50**
Diabetes	.47**
Stroke	.45**
COPD	.45**
High Blood Pressure	.43**
Kidney Disease	.39*
Arthritis	.32*

*Denotes statistical significance at the .05 level
**Denotes statistical significance at the .01 level

If we focus in on two of the more general measures of health- whether people reported being in poor mental health or poor physical health for the past 2 weeks, we can see more clearly what is happening. Just about 1 in 5 people living in census tracts with the highest number of essential services calls per unit reported being in poor mental or physical health for the past two weeks. In neighborhoods with the least number of essential services calls per unit, that number dropped to about 12-13%. Put another way, someone in a census tract with high numbers of essential services calls was 30% more likely to report being in poor mental health and 37% more likely to report being in poor physical health.

Figure 27. High and Low tracts with Essential Service Calls



(Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. 500 Cities Project Data [online]. 2018 [accessed June, 2018]. URL: https://www.cdc.gov/500cities.)

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