

Residential Land Use Regulation and Chronic Disease Disparities by Income Level

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**Abstract**

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**Background:** Residential land use regulation refers to local government regulations that restrict how land is developed. They are the most important factor in the restriction of housing supply and is directly related to the unaffordability of housing in many cities.

**Methods:** The purpose of this ecologic study is to investigate the relationship between residential land use regulation and health disparities by income level. An index measuring the level of land use regulation in Metropolitan Statistical Areas (MSAs) was merged with survey data on prevalence of cardiovascular disease, diabetes, and asthma that were used to calculate a health disparities index. A linear regression model was fit to test for an association between baseline level of regulation in 2006 and change in chronic disease disparities by income in MSAs across the U.S. from 2006 to 2018. A first-differences model was fit to analyze the association between the change in level of land use regulation and change in chronic disease disparities by income in MSAs across the U.S. from 2006 to 2018.

**Results:** MSAs with more restrictive land use regulation in 2006 tend to be from west and northeast regions of the US and have a larger population compared to the MSAs with lower

levels of regulation. The results from the regression models suggest a weak positive relationship between the restrictiveness of land use regulation and health disparities by income. After adjusting for population size, median age, and region, each one-unit difference in WRLURI at baseline was associated with an increase in HDI from 2006 to 2018 of 0.17 (95% CI: -0.25, 0.59). The results from the Model 2 suggest that a one-unit change in the level of regulation from 2006 to 2018 is associated with a 0.08 (95% CI: -0.26, 0.42) increase in HDI on average. However, the results of both models were not statistically significant.

**Discussion:** In conclusion, there is a suggestive positive relationship between the level of residential land use regulation in US metropolitan areas and the relative difference in risk of chronic disease between those with higher incomes compared to those with lower incomes; however, the role of chance cannot be ruled out. Study power was a limitation given small number of MSAs. More research is needed to learn about the mechanisms in which residential land use regulation might impact health.

## Introduction

Residential land use regulation refers to local government regulations that restrict how land is developed or used.<sup>1,2</sup> The earliest forms of these regulations were zoning laws passed in the early 20<sup>th</sup> century designating whether land be used for commercial, industrial, or residential uses in order to reduce the negative externalities and health risks caused by certain industries.<sup>1</sup>

These regulations have expanded to include minimum lot sizes, density restrictions, height restrictions, minimum parking requirements, and building permit caps, among others. This body of regulation also includes the number of approvals needed to develop or renovate land and the length of approval processes.<sup>1</sup> The time taken to gain the approval of various local government entities increases the amount of time and uncertainty that developers and investors will recoup their investment. This time cost of regulation affects the supply of housing and is priced into the final price paid by homebuyers and renters.<sup>2</sup>

In general, residential land use regulations are the most important factor in the restriction of housing supply.<sup>1</sup> There is overwhelming evidence of a positive relationship between land use regulation and housing prices as well as a negative relationship between land use regulation and new housing construction.<sup>1</sup> Stricter land use regulations have also been shown to result in a lower density of living than if there were no such regulations.<sup>3</sup>

The restriction of housing supply and lack of affordability increases urban sprawl<sup>3</sup>, reducing access of people with low incomes to high opportunity areas with good jobs and low crime.<sup>1,4</sup> Residential land use regulation that discourages density has been shown to increase socioeconomic and racial segregation as cities with stricter land use regulation are more likely to be made up of more white non-Hispanic and of upper-income households.<sup>4-8</sup> Neighborhoods with a higher proportion of residents with higher incomes, more education, and low exposure to crime are also neighborhoods where residents are more likely to experience better health outcomes.<sup>9,10</sup>

Recent economic studies have modeled the negative effects that residential land use regulation has on local and national labor market allocation and economic growth.<sup>11</sup> Cross-sectional and longitudinal studies in public health literature have established the importance of neighborhood on health showing that neighborhood demographic characteristics have impacts on short- and long-term health outcomes, such as hypertension, cardiovascular disease, obesity, mental health issues, overall mortality.<sup>12-16</sup> However, no published study has measured the impact of residential land use regulation on health outcomes. I hypothesize that because stricter land use regulation forces lower-income people to live in less desirable neighborhoods with crime, noise, worse air quality, long commutes all increase stress which are associated with cardiovascular disease, asthma, and diabetes.<sup>17-23</sup>

### **Specific aims**

The purpose of this ecologic study is to investigate the relationship between residential land use regulation and health disparities by income level. This study addresses the following two aims:

1. Analyze the association between baseline level of regulation in 2006 and change in chronic disease disparities by income in Metropolitan Statistical Areas (MSAs) across the U.S. from 2006 to 2018.
2. Analyze the association between the change in level of residential land use regulation and change in chronic disease disparities by income in MSAs across the U.S. from 2006 to 2018.

### **Methods**

#### *Data Sources*

This study relied on two sources of publicly available data. The first was the Wharton Residential Land Use Regulation Index (WRLURI) from 2006 and 2018. This dataset is the result of survey responses from urban planners and land use regulatory bodies from over 2,450 communities across the United States.<sup>24</sup> The survey asked questions about local political pressure, court involvement, local zoning approval process, local assembly process, and many other aspects of land use regulation that cause a community to be more restrictive or permissive to the development of housing. The WRLURI dataset includes a single summary index also called WRLURI that captures overall level of residential land use regulation.

The WRLURI dataset was linked to the Selected Metropolitan/Micropolitan Area Risk Trends (SMART) by MSA. The SMART data is a portion of the Behavioral Risk Factor Surveillance System (BRFSS) aggregated by metropolitan area. BRFSS is a telephone-based survey that collects data on health outcomes from non-institutionalized adults residing in the US. It is a collaboration between the Center for Disease Control and Prevention (CDC) and US states and territories. It uses design rake weighting to develop representative population-based estimates of demographic and health information.

The primary years of analysis are 2006 and 2018 because those are the only years in which WRLURI is available. However, SMART does not survey the same number of people in each geography each year and only includes metropolitan areas with over 500 respondents for a given year. Therefore, the MSAs included in the final SMART dataset differ from year to year. To increase study power and generalizability, MSAs that are in SMART within the years 2005-2007 and 2017-2019 were included when data for 2006 or 2018 was not available. If data from 2006 was not available, data from 2005 was used and if data from 2005 was unavailable then data from 2007 was used. Similarly, if data from 2018 was not available, data from 2019 was used and then data from 2017.

### *Variables*

The exposure of interest was the WRLURI. The WRLURI is the single summary measure that captures all types of residential land use regulation in a community. It was calculated from 12 subindices of different types of regulation, which were calculated from the responses to survey questions, and then aggregated by metropolitan area. The WRLURI is a unitless, continuous variable that is mean centered around zero in each year and ranges from -1.17 for the lightly regulated Wichita, KS, where the average rezoning project approval time is less than three months, to 2.06 for the strictly regulated Worcester, MA where it takes over a year.<sup>24</sup>

The outcome of interest was a calculated health disparities index (HDI) that measures the relative risk differences in chronic disease prevalence between higher- and lower- income individuals in each metropolitan area compared to the relative risk differences in chronic disease prevalence between higher- and lower- income individuals for the United States. The HDI is described by Webb et al.<sup>25</sup> This variable is a relative risk difference calculated using prevalence data on diabetes, cardiovascular disease, and asthma from three separate questions that ask the respondent if a medical professional has ever told them that they have each of the three respective conditions. To calculate HDI, first, a disparity variable will be created by subtracting the prevalence of disease in respondents with high incomes (defined as above 400% of the federal poverty line) from the prevalence of disease in respondents with low incomes (defined as below 200% of the federal poverty line) and divide that difference by the prevalence of disease in respondents with low incomes. This disparity measurement is calculated for each metro area as well as for the entire US. The HDI for each disease is the ratio of the metro disparity value to the national disparity value. For both 2006 and 2018, the average across the three individual HDIs for heart disease, diabetes, and asthma, was calculated. This average is the HDI that is the outcome variable for analysis. An HDI of 1 means that the level disparity in the metro area is the same as the national average disparity. An HDI of less than 1 means that the metro area exhibits less health disparity by income than

the national average, and conversely, an HDI of greater than 1 means that the metro area exhibits more health disparity by income than the national average.

The linear regression model controlled for the following baseline confounding variables: population size, region, and median age. Prior literature shows that all three confounding variables are associated with land use regulation and the chronic diseases captured in the outcome variable.<sup>1,23,26–29</sup> Median age from the 2010 census was used as ACS estimates are not available before then.

### *Statistical Analysis*

To address the first research aim I will fit the following multivariate linear regression model of the change in HDI from 2006 to 2018 on the baseline level of WRLURI in 2006. The purpose of this analysis is to account for the potential lag in the effects of this type of regulation. To address the first research aim, I will fit the linear regression model of the following form:

$$\Delta HDI = \beta_0 + \beta_1 * WRLURI + \beta_2 * Population + \beta_3 * Age + \beta_4 * Midwest + \beta_5 * West + \beta_6 * Northeast + \epsilon$$

To address the second research aim, I fit the following first-difference regression model of the following form:

$$\Delta HDI = \beta_0 + \beta_1 * \Delta WRLURI + \Delta \epsilon$$

This model will assess the association between the change in WRLURI and the change in HDI from 2006 to 2018. The purpose of the first-difference model is to remove effects of confounding variables that do not vary by time even if they are unmeasured.<sup>30</sup> The parameter  $Z$  represents variables at the MSA-level that are unmeasured and unchanging between 2006 and

2018.. As mentioned, in the first difference model, all possible time-invariant confounding variables within the metropolitan areas would fall out of the model.<sup>30</sup>

A p-value of 0.05 was used for all significance tests, and all analyses will be conducted using R software.

## Results

There were 113 and 103 MSAs in the WRLURI dataset in 2006 and 2018, respectively. There were 212 and 164 MSAs in SMART in 2005-2007 and 2017-2019, respectively. Table 1 shows the 51 MSAs that make up the analysis data set that had data in both datasets and for both time points. These areas include the eleven largest metro areas by 2018 population, 17 of the largest 20, and 24 of the largest 30. The larger cities were most likely to be included in the sample because they were more likely to have 500 or more respondents to the BRFSS. A few notable cities without full data and therefore dropped from the analysis are San Francisco (CA), San Jose (CA), Detroit (MI), San Diego (CA), Baltimore, and Las Vegas (NV). Baltimore was missing from 2018 WRLURI, Las Vegas was missing 2006 WRLURI, and San Diego, San Francisco and San Jose were missing SMART data. MSAs with a higher WRLURI in 2006 tend to be from west and northeast regions of the US and have a larger population compared to the MSAs with lower levels of regulation. The populations in all cities aged from 2006 to 2018.

Table 2 and Table 3 display the estimated coefficients for Model 1 and Model 2, respectively. The results from Model 1 suggest a positive relationship between the WRLURI and HDI. After adjusting for population size, median age, and region, each one-unit difference in WRLURI at baseline was associated with an increase in HDI from 2006 to 2018 of 0.17 (95% CI: -0.25, 0.59). This suggests that an MSAs with stricter residential land use regulation at baseline were more likely to see increases in chronic disease disparities over the next 12 years, on average. The results from the Model 2 suggest that a one-unit change in the level of regulation from 2006 to 2018 is associated with a 0.08 (95% CI: -0.26, 0.42) increase in HDI on

average. This suggests that MSAs that increased the strictness of its residential land use regulation, on average, also observed increased chronic disease disparities by income. However, this association was imprecise and could have arisen by chance.

## **Discussion**

This study sought to explore a potential relationship between residential land use regulation and disparities in chronic disease prevalence between MSA residents with high incomes compared to residents of the same MSA with low incomes. The results of this study suggest a positive relationship, but estimates were too imprecise to rule out chance.

The results suggest that stricter residential land use regulations may be weakly associated with increases in health disparities, but the results are not significant. Commercial land use regulations have been used to address health concerns such as maintaining clean air and water from industries and as attempts restrict fast food restaurants from opening in certain areas (citation).<sup>31</sup> Other forms of land use regulation are used in hopes of improving population health by preserving green space and increase walkability which encourage physical activity.<sup>32</sup> However, residential land use regulation, its effects on the availability and distribution of housing in a metro area, and the downstream effects on health represents a gap in the literature. There is strong evidence in the literature on the association between urban sprawl and heart disease. Some of the strongest evidence that urban sprawl affects stress and mental health which are associated with chronic diseases such as cardiovascular disease.<sup>23</sup> It is possible that effect of residential land use regulation on urban sprawl contribute to mental health issues resulting in increased in risk of chronic disease.

This study contributes to the literature on land use regulation and its effects on society, yet further investigation is needed into barriers that prevent people from moving into more productive, safer, and healthier neighborhoods. Future work could include longitudinal studies in a single geographic area that are powered to detect small effect sizes. Future natural

experiments on cities that recently banned certain types of residential land use regulation will also add to body of literature.

There are several limitations to this study that are important to consider. This study should be treated as an exploratory analysis of association and is not able to rule out reverse causality and possibly includes residual confounding. First, sample size is a major limitation of the study. With only 51 MSAs included in the final dataset, this study was not powered to detect small effect sizes if they exist. Second, as mentioned, there are a handful of large metropolitan areas that are not represented in both datasets and/or in both time points and they may not be missing completely at random. Third, MSAs might be too large of a geographic area to capture heterogeneities that are present at the neighborhood level. While bias is typically a limitation of self-reported data, bias in reporting of the outcome is not expected because disease diagnoses by a medical professional are memorable events. Bias in survey responses from urban planners across the country is also unlikely to be cause for concern. These surveys include mostly questions of objective fact about whether approval process involves state-level officials, the number of approvals needed, the existence of an affordable housing program, the existence of density restrictions, the existence of ballot initiatives, and many others.

Given the growing body of evidence on economic and racial impacts of residential land use regulations, some city and state governments have proposed measures intended to reduce these regulations. For example, in 2019, Minneapolis introduced the Minneapolis 2040 plan which included legislation that banned zoning a neighborhood for only single-family housing. Portland, Oregon passed legislation to increase density and remove minimum parking requirements in higher density areas.<sup>33</sup> As more residential land use regulations are made less strict in these localities, research is needed to assess their impacts.

In conclusion, there is no evidence of a relationship between the level of residential land use regulation in US metropolitan areas and the relative difference in risk of chronic disease between those who earn higher incomes compared to those who earn lower incomes. More

research is needed to learn about the specific mechanisms in which land use regulation impacts health in metropolitan areas.

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## Tables

**Table 1.** Characteristics of MSAs by tertile of regulation.

Covariates	Tercile of WRLURI 2006		
	Low	Medium	High
Population in 2006	1,646,160	2,265,351	4,459,368
Population in 2018	1,981,937	2,455,859	4,930,624
Median Age in 2010	36	37.2	36.2
Median Age in 2018	37	38.6	37.4
Northeast	1	3	7
Midwest	9	7	1
South	7	5	4
East	0	2	5

**Table 2.** Results of Model 1. The association between baseline level of regulation in 2006 and change in chronic disease disparities by income in MSAs across the U.S. from 2006 to 2018.

Variable	Point Estimate	95% Confidence Interval	P-value
Intercept	1.04	(-3.31, 5.4)	0.64
WRLURI 2006	0.17	(-0.25, 0.59)	0.55
Population	0	(0, 0)	0.75
Median Age	-0.03	(-0.15, 0.09)	0.67
Midwest	-0.26	(-0.97, 0.45)	0.47
West	-0.11	(-0.77, 0.55)	0.82
Northeast	-0.06	(-0.72, 0.61)	0.91

**Table 3.** Results of Model 2. The association between the change in level of residential land use regulation and change in chronic disease disparities by income in MSAs across the U.S. from 2006 to 2018.

Variable	Point Estimate	95% Confidence Interval	P-value
Intercept	-0.08	(-0.34, 0.17)	0.53

Difference in WRLURI 0.08

(-0.26, 0.42)

0.74