Housing Policy Debate

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rhpd20

Gentrification, Mobility, and Exposure to Contextual Determinants of Health

Arthur Acolin, Kyle Crowder, Ari Decter-Frain, Anjum Hajat & Matt Hall

To cite this article: Arthur Acolin, Kyle Crowder, Ari Decter-Frain, Anjum Hajat & Matt Hall (2022): Gentrification, Mobility, and Exposure to Contextual Determinants of Health, Housing Policy Debate, DOI: 10.1080/10511482.2022.2099937

To link to this article: https://doi.org/10.1080/10511482.2022.2099937

Published online: 18 Aug 2022.

HOUSING POLICY DEBATE
https://doi.org/10.1080/10511482.2022.2099937

Gentrification, Mobility, and Exposure to Contextual Determinants of Health

Arthur Acolin[a], Kyle Crowder[a], Ari Decter-Frain[b], Anjum Hajat[a] and Matt Hall[b]

[a]University of Washington, Seattle, WA, USA; [b]Cornell University, Ithaca, NY, USA

ABSTRACT

This study examines exposure to four contextual Determinants of Health (cDOH): healthcare access (Medically Underserved Areas), socioeconomic condition (Area Deprivation Index), air pollution (Nitrogen Dioxide (NO_2), Particulate Matter 2.5 (PM 2.5) and Particulate Matter 10 (PM 10)), and walkability (National Walkability Index) among residents of gentrifying and not gentrifying lower income neighborhoods in central cities for the 100 largest metropolitan regions in the US using their location in 2006 and 2019 based on individual level consumer trace data. Individuals who lived in gentrifying neighborhoods as of 2006 had more favorable cDOH in terms of MUA, ADI and Walkability Index and similar levels of pollution. Between 2006 and 2019, they experienced worse changes in MUAs, ADI, and Walkability Index but a greater improvement in exposure to air pollutants. The negative changes are driven by movers, while stayers actually experience a relative improvement in MUAs and ADI and larger improvements in exposure to air pollutants. The findings indicate that gentrification may contribute to health disparities through changes in exposure to cDOH through mobility to communities with worse cDOH among residents of gentrifying neighborhoods although results in terms of exposure to health pollutants are mixed.

ARTICLE HISTORY
Received 31 August 2021
Accepted 6 July 2022

KEYWORDS
Gentrification; contextual social determinants of health; mobility

The health and well-being of residents of gentrifying areas is an area of growing research and policy attention (Gibbons et al., 2018; Schnake-Mahl et al., 2020; Smith et al., 2020). Gentrification can be defined as the process through which communities with relatively low- and moderate-income residents experience a rapid rise in their relative socioeconomic position. Gentrification affects housing affordability for both owners and renters, leading to potential constrained out-migration. There is evidence both of endogenous changes in factors such as improved green spaces that may affect health in gentrifying neighborhoods differently for residents with varying socioeconomic status (Cole et al., 2019; Pearsall & Eller, 2020) and of changes in neighborhood environment for residents who move out of gentrifying neighborhoods (Brummet & Reed, 2019). There is also strong evidence of disparities in terms of health outcomes and contextual (i.e., area-level) determinants of health (cDOH) across communities (Braveman et al., 2011; Braveman & Gottlieb, 2014; Diez Roux & Mair, 2010). The main contribution of the present study is to provide evidence of the contribution of mobility to changes in contextual exposures using information about origins and destinations for a large sample of movers.

CONTACT Arthur Acolin acolin@uw.edu

This study analyzes cDOH for residents of gentrifiable neighborhoods, defined as low- and moderate-income tracts with household median income below 80% of the metropolitan region median income, as of 2000. It uses their location in 2006 and 2019 in consumer trace data to examine how residing in neighborhoods categorized as gentrifying between 2000 and 2019 and the resulting different mobility patterns of residents led to changes in exposure to selected cDOH for residents of gentrifying tracts relative to residents of tracts that are not gentrifying, in the principal cities of the 100 largest metropolitan regions. We focus on the following four key types of cDOH that have been shown to contribute to disparities in health outcomes (Diez Roux & Mair, 2010; Schnake-Mahl et al., 2020; Smith et al., 2020) and for which measures are available nationwide: healthcare access, socioeconomic condition, air pollution, and walkability.

The findings show that residents of gentrifying neighborhoods tend to have cDOH that are more favorable than those of other low- and moderate-income households; however, mobility patterns in gentrifying neighborhoods lead to worsening cDOH exposure. These findings indicate that changes in exposure to cDOH may be a pathway through which gentrification can affect health disparities.

The first section reviews the evidence on the connection between gentrification and changes in exposure to social determinants of health. The second section presents the consumer trace data used in this paper, along with the measures of cDOH and the analytic model. The third section reports the findings of worse changes in terms of healthcare access, socioeconomic condition, and walkability for residents of gentrifying neighborhoods, and mixed findings in terms of exposure to air pollution. The fourth section discusses the implications for research on the link between gentrification and health.

Background: Relationship of Gentrification to Social Determinants of Health Through Residential Mobility and Changes to the Built and Social Environment

Place and Health: The Importance of Contextual Social Determinants of Health

The impact of neighborhoods on health is well established, along with the effect of differences in residential environments on social and racial/ethnic inequities in health (Braveman et al., 2011; Braveman & Gottlieb, 2014; Diez Roux & Mair, 2010), including specifically in the context of gentrification (Gibbons et al., 2018; Schnake-Mahl et al., 2020; Smith et al., 2020). Analysis from the National Center for Health Statistics for the 2010–2015 period shows that life expectancy can vary greatly across small areas (Arias et al., 2018). In Philadelphia, for example, life expectancy at birth varies from 70 in the lower income and not gentrifying neighborhood of Greys Ferry, to 76 in gentrifying Point Breeze, to 84 in the higher income neighborhood of Fitler Square (Robert Wood Johnson Foundation, 2021). This represents a 14-year range in life expectancy in neighborhoods that are located within less than 1.5 miles of each other.

There is extensive research on how differences in the neighborhood environment impact health outcomes (Braveman et al., 2011; Diez Roux & Mair, 2010). The natural, built and social environment in which individuals reside impacts their health outcomes both directly through increased exposure to pollutants, or more costly (financially and in terms of time) access to health services or physical activity and indirectly by affecting behaviors in health-promoting or -deleterious ways. We adopt the term of contextual determinants of health (cDOH) to refer to these place-based determinants of heath that operate through the residential environment to which individuals are exposed.

Key cDOH that have been identified and analyzed in the literature include pollution, access to green spaces, neighborhood deprivation, crime, smoking and drinking behaviors, and access to healthcare, with evidence of negative impact on a range of health outcomes including chronic diseases (specifically obesity and related risk factors and outcomes like heart diseases and diabetes) and mental health (specifically depression) (Braveman et al., 2011; Brown et al., 2016; Diez

Roux & Mair, 2010; Duncan et al., 2012; Gentili et al., 2015; Schnake-Mahl et al., 2020; Schnake-Mahl & Sommers, 2017; Scribner et al., 2017; Shi et al., 2005; Wen et al., 2013). These place-based factors are often correlated with each other, with the same neighborhoods having high levels of deprivation as captured through an area deprivation index (ADI) also having high levels of crime and limited access to healthy food. Given the lack of data available at the neighborhood level for some of these indicators, the ADI can serve as a proxy for overall neighborhood condition, but direct measures of crime or health-deleterious behaviors at small geographies deserve further study.

The impact of other cDOH, such as social capital or availability of healthy food options, also has conceptual grounding (Carpiano, 2006) and suggestive but still uncertain empirical evidence of impact on health outcomes (Ahnquist et al., 2012; Braveman et al., 2011; Braveman & Gottlieb, 2014; Carlson & Chamberlain, 2003; Diez Roux & Mair, 2010) despite a potential important relationship with gentrification. In particular, with regards to social capital, measures of social cohesion based on willingness, belonging and trust developed through survey responses (Gibbons & Barton, 2016) have been shown to be associated with positive reported health outcomes. Such measures would be helpful given that gentrification has been linked to changes in social cohesion (Gibbons & Barton, 2016; Schnake-Mahl et al., 2020) but are not available at the neighborhood level nationwide.

There is well-established evidence of inequality in exposure to cDOH based on individual sociodemographic characteristics, with lower income individuals experiencing substantially worse cDOH, and minority households more likely to experience worse cDOH as well (Braveman et al., 2011; Diez Roux & Mair 2010; Gentili et al., 2015; Schnake-Mahl & Sommers, 2017). In particular, there is evidence of worse access to healthcare (Streeter et al., 2020), worse exposure to air pollution (Kravitz-Wirtz et al., 2016; Kravitz-Wirtz et al., 2018; Liu et al., 2021), and lower walkability (Duncan et al., 2012) in low- and moderate-income neighborhoods. In addition, there is evidence that migration patterns can exacerbate environmental inequality when examining exposure to industrial hazard (Crowder & Downey, 2010; Pais et al., 2014).

In this study, we focus on key cDOH that have been shown to directly affect mental and physical health outcomes and contribute to socioeconomic and racial/ethnic health disparities (Diez Roux & Mair, 2010; Schnake-Mahl et al., 2020; Smith et al., 2020). Based on recent reviews of the literature on the relationship between gentrification and health (Cole 2020; Firth et al., 2020; Gibbons et al., 2018; Schnake-Mahl et al., 2020; Smith et al., 2020), we selected cDOH that operate based on place of residence and for which adequate proxy measures can be obtained nationwide.

Gentrification and Health

Empirical evidence has linked gentrification to increased health disparities. Within the wider literature on cDOH, the role of gentrification is an area of recent attention (Cole, 2020; Firth et al., 2020; Gibbons et al., 2018; Schnake-Mahl et al., 2020; Smith et al., 2020). The increased attention to the relationship between gentrification and health has coincided with a rise in the share of low- and moderate-income neighborhoods that experienced gentrification in the 2000s and 2010s (Martin, 2017). It also marks the increasing recognition that social forces like structural racism that result in residential segregation and are reinforced by spatial separation shape household access to neighborhoods in ways that exacerbate health disparities associated with individual characteristics (Acevedo-Garcia et al., 2003; Williams & Collins, 2016).

Gentrification may contribute to health disparities through increased housing instability, with displaced residents at higher risk of losing social connections and being exposed to more deleterious neighborhood environments (Bhavsar et al., 2020; Cole, 2020; Firth et al., 2020; Gibbons et al., 2018; Schnake-Mahl et al., 2020, Smith et al., 2020). Gentrification has potentially beneficial

impacts on the health outcomes of long-term residents who remain in their neighborhood, through increased public and private investments that lead to improvements in neighborhood physical and social environments. There is evidence in the literature of increased green space quantity and quality, health-promoting retail environments and services, and reductions in crime in gentrifying neighborhoods (Smith et al., 2020). On the other hand, gentrification may negatively impact the well-being and health of the original residents—more likely to be people of color—sthrough increases in housing cost burden (resulting in trade-offs on expenditures for basic goods and services such as food and healthcare) and changes to the physical and social environment leading to loss of community (Hwang & Lin, 2016; Smith et al., 2020). Renters on fixed incomes (elderly or disabled) are particularly at risk of displacement (Hwang & Lin, 2016). Smith et al., (2020) find that people of color in gentrifying neighborhoods are more likely to experience negative residential and health outcomes. The same processes of structural racism that maintain health disparities may also lead people of color to experience greater worsening in cDOH, in response to gentrification. An analysis of individual data for California finds that Black residents of gentrifying neighborhoods experienced increased levels of fair/poor self-rated health, but the same difference was not found for other racial/ethnic groups (Izenberg et al., 2018). Using national data from the Centers for Disease Control and Prevention (CDC)'s 500 Cities project, another study finds a positive association between levels of recent gentrification and self-rated health of neighborhood residents but significantly higher rates of poor self-rated health in gentrified tracts with larger Black and Hispanic populations (Gibbons et al., 2018). These studies are limited by the fact that they focus on residents remaining in, or moving to, gentrifying neighborhoods, and their inability to explore health outcomes for former residents of gentrified neighborhoods. To date, we have limited evidence about whether the destination neighborhoods of individuals who leave gentrifying neighborhoods have different characteristics in terms of cDOH that could result in greater exposure to health-enhancing or -deleterious environments.

Measuring Gentrification and Its Impact on Residential Trajectories

A challenge of the literature on the impact of gentrification has been to agree on definitions of gentrification. The extant research has developed different definitions of gentrification that can be derived from available census data at the neighborhood level (using census tracts), such as changes in resident socioeconomic characteristics (proxied by income and educational attainment) and local housing costs (generally rent) relative to costs in the broader metropolitan region (Bhavsar et al., 2020; Brummet & Reed, 2019; Dragan et al., 2020; Firth et al., 2020; Johnson et al., 2022; Preis et al., 2021). Alternative measures have been proposed that rely on the participation of local communities, attempting to incorporate dimensions such as loss of cultural anchors, and displacement risk (Bhavsar et al., 2020; Firth et al., 2020). Given the national scale of this study we rely on definitions that can be produced based on census data. We follow the existing literature and rely on existing definitions that have been implemented for large national samples of metropolitan areas based on changes in educational attainment, income and rent at the tract level (Brummet & Reed, 2019; Dragan et al., 2020), acknowledging how various definitions lead to different sets of neighborhoods being categorized as gentrifiable, gentrifying or gentrified, sometimes with limited overlap (Preis et al., 2021). The variation in which neighborhoods are classified as gentrifying is not only a measurement issue but has implications for agreeing on the magnitude of the phenomenon of gentrification and what neighborhoods are affected.

Recent research has shown that although most low- and moderate-income tracts are not gentrifying, the pace of gentrification has accelerated over the last few decades in cities across the U.S., increasing the relevance of its potential impacts on health (Brummet & Reed, 2019; Ding et al., 2016; Dragan et al., 2020; Maciag, 2015; Martin, 2017). Martin (2017) finds that the share of

neighborhoods classified as gentrifying increased from 3.5% between 1980 and 1990 to 7.1% between 2000 and 2010 under a strict definition of gentrification.

The increased prevalence of gentrification in urban centers reflects the increased demand for central locations by higher income households with higher levels of education (Brummet & Reed, 2019; Couture & Handbury, 2020). In some regions, the increased demand for centrally located neighborhoods that have good access to employment and consumption amenities results in increased housing costs that lead to mobility out of those neighborhoods by long-term residents who cannot afford the new rents or the increased property taxes (Hwang and Lin, 2016). In many other cities, disinvestment in central neighborhoods continues to be the main challenge, particularly in legacy cities (Brophy, 2016).

Some progress has recently been made in establishing mobility patterns for gentrifying neighborhoods, but important debates remain about the prevalence and magnitude of displacement, defined as forced move out of gentrifying neighborhoods. Existing quantitative research on gentrification has focused on estimating whether gentrification leads to higher levels of mobility (Brummet & Reed, 2019; Ding et al., 2016; Dragan et al., 2020) and how gentrification affects household welfare (Couture et al., 2019; Su, 2018) with a particular focus on outcomes for children (Brummet & Reed, 2019; Dragan et al., 2019).

The link between gentrification and displacement, defined as constrained moves that force residents out of their original community into other neighborhoods, is a source of major concern for community organizations and policymakers as well as researchers (Brummet & Reed, 2019; Gibbons & Barton, 2016). The hypothesized link between gentrification and displacement is supported by the fact that a defining feature of gentrification is an increase in housing costs that would lead households who cannot afford these costs to move to more affordable neighborhoods. However, empirical evidence has failed to produce estimates of high levels of increased mobility, including outmigration as a result of gentrification (Brummet & Reed, 2019; Ding et al., 2016). The evidence to date suggests that gentrification has a moderate to nonexistent impact on overall mobility, including mobility out of gentrifying neighborhoods (Brummet & Reed, 2019; Ding et al., 2016; Dragan et al., 2020). However, when residents of gentrifying neighborhoods do move, they tend to migrate longer distances than similar residents in nongentrifying neighborhoods do, a process that may be indicative of displacement (Brummet & Reed, 2019).

Whether gentrification causes substantially higher levels of residential mobility is still an unsettled question but might reflect the overall high level of residential mobility (or instability) among low- and moderate-income households and the high level of neighborhood migration, with gentrification forces only marginally worsening levels of mobility but resulting in different forms of mobility as a result of the displacement nature of the moves. Displacement and the strains associated with the fear of displacement have been tied to negative mental and physical health outcomes (Fullilove, 1996, 2016; Gibbons & Barton, 2017; Manzo, 2003). Even if gentrification does not cause higher mobility beyond the already high level of mobility experienced by residents of low- and moderate-income neighborhoods, original residents of gentrifying neighborhoods might still experience worse outcomes in terms of cDOH when they move if their destination neighborhood has less desirable characteristics than their neighborhood of origin did. The issues of (a) whether gentrification results in higher levels of mobility and (b) whether displacement through gentrification results in changes in exposure to cDOH are both unsettled.

In terms of changes in environment, there is evidence that adults and children who are able to stay in gentrifying neighborhoods experience some improvements in terms of economic opportunity (Brummet & Reed, 2019) and health outcomes (Dragan et al., 2019) but that those who move experience negative outcomes such as longer commutes and negative health outcomes (Dragan et al., 2019; Lim et al., 2017). Dragan et al., (2019) look at health outcomes of children enrolled in Medicaid in New York City and do not find an overall effect of experiencing gentrification on health system use or diagnoses of asthma and obesity but do find a moderate increase in diagnoses of anxiety and depression. Lim et al., (2017), also in New York City, look at

emergency visits and hospitalization and find higher likelihood among movers relative to those who remained, mainly due to mental health issues.

Among studies looking at the outcomes of gentrification on original residents, Brummet and Reed (2019) are able to produce robust population-level estimates using restricted-access census microdata from the 2000 decennial census and the 2010–2014 American Community Survey (ACS) to examine the potential impact of gentrification on intergenerational economic mobility in the top 100 metropolitan areas. These data allow the authors to identify mobility for a large and representative sample, but their analysis focuses on economic opportunity and does not include cDOH measures.

The findings from the other studies rely on large trace data: Medicaid data for New York City for Dragan et al., (2020) and credit data from the Federal Reserve Bank of New York (FRBNY) Consumer Credit Panel/Equifax (CCP) data for Ding et al., (2016). The consumer data used in this study represent another source of trace data that has been used to examine migration (Phillips, 2020). Trace data allow researchers to obtain detailed location information for a broad number of individuals, but that information is an outcome of regular operations such as the operation of the Medicaid program or establishing a credit profile for the CCP and is not collected for research purposes. The location signal associated with the address of the individuals in these databases is valuable to identify mobility, but external validity is limited by the data coverage and the source ability to link individual records over time. The present study benefits from the fact that the consumer trace data are mostly used for mail advertising purposes, and accurate mailing information is therefore a key feature of the data set. In addition, it comprises a broader range of households than credit data by including households that may lack credit activity.

Data and Methods

We use individual-level consumer data with high spatial specificity (with geographic coordinates corresponding to addresses) provided by Data Axle for the period 2006–2019 and block group-level measures of cDOH in the 100 largest U.S. metropolitan regions. This allows us to examine how gentrification affects exposure to key cDOH known to contribute to social and racial/ethnic disparities in health outcomes through differences in mobility patterns for residents of low- and moderate-income neighborhoods that are gentrifying or not. Table 1 summarizes the variables used in the study.

Consumer Trace Data: 2006–2019 Location for Residents of Low- and Moderate-Income Households in the 100 Largest Metropolitan Regions as of 2006

Consumer trace data such as the Data Axle data have recently emerged as a source with which to measure mobility for research purposes (Mast, 2021; Asquith et al., 2021; Phillips, 2020). Data Axle is one of the main vendors of consumer trace data, along with LexisNexis and Infutor, and these data have been shown to produce reliable population and migration estimates. The Data Axle database is assembled from a variety of current sources including credit card billing statements, utility records, voter registrations, real estate tax assessments and deed transfers, public records (bankruptcies, licenses and registrations), and mailing address changes. Data Axle clients mainly use the data to distribute targeted mail or to locate customers. To meet this need, Data Axle aims to ensure residential information is as current, accurate, and comprehensive as possible. In other words, a crucial feature of the data is the ability to contact potential customers in real time using their residential addresses.

The data from Data Axle used in this study contain a unique and time-invariant family identifier and individual identifier for up to five adults in the family unit, which enables us to identify changes in location over time. This allows us to identify the origins and destinations of 5.5

Table 1. Key variables.

Key variable	Definition	Geographic level	Source
Outcomes			
Medically underserved areas	Categorical (0 = no, 1 = yes) variable at the tract level defining medically underserved areas (MUA), 2006–2019.	Census tract	HRSA
Social deprivation	Area deprivation index (ADI): percentile at state and national level based on 17 variables capturing income, education, employment, occupation, housing costs and tenure, household composition and housing condition, summarized using principal component analysis for 2000 and 2015–2019.	Block group	2000 U.S. Census and 2015–2019 ACS
Air pollution	Continuous annual-average estimates of outdoor concentrations for three pollutants (NO_2, PM_{10}, and $PM_{2.5}$) at the block group level, 2006–2015.	Block group	CACES
Walkability	National Walkability Index score (expressed as percentile from least to most walkable) calculated in 2019 based on measures of the built environment that affect the probability of whether people walk as a mode of transportation: street intersection density, proximity to transit stops, and diversity of land uses.	Block group	EPA
Individual controls	Age, household size, tenure, race and ethnicity, length of residence.	Individual	Data Axle
Contextual controls	Tract median income, poverty (%), homeownership (%), White non-Hispanic residents (%), adults with a college degree (%), households that moved within last year (%), median house value and median gross rent, vacancy rate, distance from the tract centroid to the city center—as of 2000.	Census tract	2000 Census

million adults living in gentrifiable tracts, for the 100 largest metros as of the year 2000, including 678,000 living in gentrifying tracts. We know these individuals' location in 2006 and 2019 along with their estimated race/ethnicity, number of children, tenure, marital status, age and length of residence at current address. The data set also includes information about household income and wealth but we chose not to include these variables in our analysis because of uncertainty regarding their reliability due to their modelled nature.

Prior work established the usability of the Data Axle data to produce small-area demographic estimates (Acolin et al., 2021). In 2010, there were 121.5 million households in the U.S. based on the decennial census and 111.5 million households recorded in the Data Axle data. The average coverage ratio (5-year estimates based on Data Axle estimates/ACS estimates) at the tract level between 2009 and 2019 was 93%, and about 80% of tract estimates fall within 20% of the ACS estimates. In addition, when looking specifically at gentrifiable tracts, the average coverage was 85%. This is lower than for all tracts, but remains substantially higher than the coverage of low- and moderate-income tracts in credit records (Brevoort et al., 2015). Although it is not possible to directly assess representativeness bias, individuals with more limited consumer traces are likely to be those with lower levels of consumption, reflecting lower income and potentially higher vulnerability to gentrification.

We also validated Data Axle-provided coordinates by regeocoding half a million addresses for each year. The results at the national level indicated that about 90% of Data Axle records had location information with sufficient details to be independently geocoded at address level (the rest at street or zip code level) and that for these records, the median distance between the

regeocoded points and the Data Axle coordinates was stably between 60 and 62 m and overall the performance was consistent across states. We also regeocoded the addresses using parcel-level reference files for King County, Washington. Only 1.5% of Data Axle coordinates were more than 100 m from the correct parcel centroid. This validation exercise demonstrated the reliability of the Data Axle location information across locations and over time.

Contextual Social Determinants of Health: Block Group Measures

We use measures of cDOH for four domains: healthcare access, socioeconomic condition, air pollution, and walkability. The cDOH measures are based on well-established research operationalizing these conceptual factors (Brown et al., 2016; Liu et al., 2021; Messer et al., 2006; Pope et al., 2019; Sass et al., 2017; Streeter et al., 2020). Data on the measures we use are available nationwide, but their geographic and temporal coverage varies.

In this project, we focus on cDOH determined by the physical (air pollution), social (neighborhood deprivation and medically underserved areas) and built environments (walkability). These allow us to examine to what extent endogenous changes in gentrifying neighborhoods' characteristics (when several time periods are available) combined with mobility of original residents are associated with changes in exposure to cDOH in ways that may reinforce disparities in exposure to health promoting or deleterious environments.

We selected key cDOH that are expected to vary by location, including at neighborhood scales, and which (except for walkability) have been measured consistently over time. The measures we adopt have been developed, validated and used in the literature on cDOH. Other cDOH would be worth exploring in future research, including crime and access to healthy food, for example. Whenever possible we attempt to create measures that best reflect the individual exposure, adopting the approach developed by Kwan (2009, p. 1312) to define measures of exposure that take "the actual spatial and temporal 'configuration' of exposure into account." We match, to the extent possible, the year in which the cDOH is measured to the observation period. In cases where the indicators are not updated annually, or not available for the entire period, we rely on the closest year. We display the cDOH measures in Figure 1 for four different cities showing spatial variations that overlap with areas that are defined as gentrifying or not.

For healthcare access, we use medically underserved areas (MUAs)—tracts or counties designated by the Health Resources and Services Administration (HRSA) as lacking access to primary care services—expressed as a binary yes or no. Areas that were designated as such in December 2006 and December 2019 are used. This provides a measure of disparity in access to care that has been shown to be associated with worse health outcomes (Brown et al., 2016; Gentili, 2015).

For socioeconomic conditions, we use the ADI based on a measure created by the HRSA and refined, adapted and validated by the University of Wisconsin Madison at the block group level (Kind and Buckingham, 2018). The ADI is based on 17 variables capturing income, education, employment, occupation, housing costs and tenure, household composition and housing condition and is estimated using principal component analysis (PCA). We use this measure estimated based on the 2000 census and 2015–2019 ACS data and expressed as percentile at the national and state level, with higher percentiles reflecting more disadvantaged neighborhoods. A higher level of neighborhood deprivation, estimated through higher ADI rank, has been linked to worse health outcomes (Hu et al., 2018; Kind et al., 2014; Lantos et al., 2018; Link & Phelan, 1995; Ludwig et al., 2011). In addition to the measures included in the ADI, many other cDOH that we are not able to include in this study (crime, food access, etc.) are likely highly correlated with ADI.

For air pollution, we use average annual outdoor concentration measures estimated for block groups by the Center for Air, Climate, and Energy Solutions (CACES) for three pollutants: one gas, nitrogen dioxide (NO_2), expressed in parts per billion; and two aerosols—particulate matter

less than 10 μg/m^3 (PM_{10}) and particulate matter less than 2.5 μg/m^3 ($PM_{2.5}$)—from 2006 to 2015 (Kim et al., 2020). We use the 2006 and 2015 estimates. The measures updated to 2019 are not available.

For walkability, we use the National Walkability Index for block group levels provided by the U.S. Environmental Protection Agency (EPA) at the block group level as of 2019. The index captures characteristics of the built environment that affect the likelihood people will use walking as a mode of transportation. The transformed walkability index values represent national percentiles and range from least walkable to most walkable. The index is calculated based on street intersection density, proximity to transit stops, and diversity of land uses (defined based on employment and household mix). The National Walkability Index is only available as a one-time estimate. The built environment characteristics used to build the index are likely to only change slowly, so the relative rankings of neighborhoods in 2006 and 2019 are likely very comparable. However, that means that the estimated difference between residents of gentrifying and nongentrifying neighborhoods will come exclusively from the difference in mobility patterns between the two for movers.

Definition of Gentrifiable and Gentrifying Neighborhoods

We adopt a definition of gentrification as a process through which formerly low- and moderate-income neighborhoods experience an increase in demand by higher income, higher educated households, resulting in a rise in housing costs. We do not propose a new measure of gentrification but rather build on existing rule-based measures of gentrification and apply them to classify tracts in the 100 largest metropolitan regions as of 2000. As discussed in the previous section, we acknowledge the limits of rule-based approaches that have been identified in the literature and the lack of consensus in conceptualizing and operationalizing measures of gentrification (Firth et al., 2020; Preis et al., 2021). However, given the national scale of the study and the need to have a measure consistent across metropolitan regions, relying on census variables and examining the sensitivity of the results to different thresholds remained the best option. This provides a measure of gentrification defined as changes in socioeconomic characteristics that may affect original residents' residential trajectories.

We follow the recent literature in defining 'gentrifiable' neighborhoods as tracts within a metropolitan area's central city that have median incomes less than 80% of the median income for the metropolitan area as of 2000 (Martin, 2017).[1] We then adopt the definition proposed by Brummet and Reed (2019) in focusing on the share of adults with college degrees and add median rent and median income. We assign the label of 'gentrifying' to those gentrifiable tracts that between 2000 and 2015–2019 experienced above-median growth in at least two of the following three characteristics: the share of adults with college degrees, median rent or median income. This results in the classification reported in Figure 1.

We chose the 2000 to 2015–2019 period to capture neighborhoods that might have started gentrifying before our first year of observation (2006) and experienced an increase in educational attainment, income and rent relative to the rest of the metropolitan region over almost two decades, indicating a sustained pattern of neighborhood change.

We explored the robustness of our classifications and results to alternative measures used in the recent literature (Brummet & Reed, 2019; Dragan et al., 2020; Martin, 2017). In particular, we produced an alternative classification using lower levels of median income of the metropolitan area (60%) to define gentrifiable neighborhoods. We also used the central city median income instead of the metropolitan area median income. Furthermore, we used an alternative threshold for gentrification defined as growth rate within the top 25th percentile (instead of above the median). To examine sensitivity to the beginning period we also used the 2006–2010 ACS as the

starting point instead of the 2000 census. Overall, the main results are qualitatively robust to these alternative definitions of gentrifiable and gentrifying (Appendix Table A2).

Estimation Approach

Among low- and moderate-income neighborhoods, those that gentrify have characteristics that distinguish them from those that do not. Gentrification is not a process that occurs randomly but rather reflects increased demand for a community that is driven by its location, the characteristics of its built environment, and its residents. The literature has shown that neighborhoods closer to the center of the city and with a higher share of White non-Hispanic residents are more likely to gentrify (Freeman, 2009). In addition, residents of low- and moderate-income neighborhoods that gentrify or not also differ on observable, and likely unobservable, characteristics in ways that can affect their propensity to move and levels of constraints in accessing the unit of their choice in their preferred neighborhood. Estimated gentrification effects may be biased downward by gentrifying neighborhoods' relatively more favorable attributes and trajectories.

Another limit to estimating the impact of gentrification on existing residents of gentrifying neighborhoods is that the Data Axle information is not a representative data set collected to produce population-level estimates. Although the Data Axle data have broad coverage and we are able to link a large number of individuals between 2006 and 2019, the linked data set does not have full population coverage and may incorporate biases that cannot be fully assessed without merging to a full population registry. The sample captures adult individuals who reside in gentrifiable tracts as of 2006 and for whom we are able to observe location in 2019. Prior research with consumer trace data has found that they underrepresent individuals with more limited consumption activity who are less likely to be represented in the database and to be reliably linked over time. These include renters and younger individuals with lower income (Acolin et al., 2021; Mast, 2021; Phillips, 2020). In addition, Infutor, another consumer trace data set, has been shown to substantially undermeasure moves relative to measures based on census data (Mast, 2021).

The direction of the bias caused by underrepresentation of vulnerable residents is difficult to assess in the context of this work. Most vulnerable residents likely constitute a higher share of residents in not gentrifying neighborhoods, but the effect of gentrification is likely to lead to worse outcomes for these residents by pushing them to potentially less desirable locations. Despite these limitations, the consumer trace data follow the location of a large number of individuals over more than a decade, allowing us to examine the origin and destination context of residents of gentrifiable neighborhoods in a way that is not possible with longitudinal surveys that do not include a sufficiently large sample of households living in these communities.

The lack of exogenous shock to explain gentrification and the fact that we are not able to observe the 2019 location for all original residents are limits to identifying a causal effect of gentrification on exposure to cDOH. At the same time, this study benefits from the well-established literature aiming to estimate the impact of gentrification in the absence of experimental or quasi-experimental data. In particular, the factors associated with gentrification and mobility are well established, allowing us to include a robust set of control variables used in previous studies. Our empirical approach follows mainly Brummet and Reed (2019) and attempts to address selection and omitted variable concerns by including an extensive set of neighborhood controls that have been shown to be associated with gentrification. We also use an estimator developed by Oster (2019) to assess the robustness of the results to potential selection and omitted variables.

We specify the following model using Ordinary Least Squares (OLS) and probit (for MUA) estimates for individual i in tract j in Core-Based Statistical Area (CBSA) m adapted from Brummet and Reed (2019):

$$y_{ijmt} = \beta_0 + \beta_1 Gentrify_j + \beta_2 Period_t + \beta_3 Move_i + \beta_4 Gentrify_j * Period_t + \beta_6 X_i + \beta_7 N_j + u_m + \epsilon_{ijmt}$$

y_{ijmt}, the dependent variable, is the cDOH measure for the location of individual *i* based on their location *jm* in either *t* period 0 (2006) or period 1 (2019). We run a model with the dependent variable in its original unit as reported in Table 1 and standardized using a *z* score with mean 0 and standard deviation 1. *Gentrify* is a dummy variable capturing whether the tract of residence in the first period gentrified between 2000 and 2015–2019; *Period* is a dummy variable indicating whether the observation is for 2006 (period 0) or 2019 (period 1); the main coefficient of interest is for the interaction term between G*entrify* and *Period* that estimates the change in cDOH for individuals in gentrifying tracts relative to nongentrifying tracts in 2006 based on the change in cDOH (with the exception of walkability) and the change in their location in 2006 and 2019. We also run separate estimates stratifying the sample based on residents of gentrifying neighborhood who stayed in the same location (for which we are not able to produce estimates for walkability) or moved. *X* is a vector of variables that capture individual and household characteristics available in Data Axle: age group, race/ethnicity, marital status, number of children, length of residence at current address as of 2006, and distance from the center of the metropolitan region;[2] and *N* is a vector of variables that capture characteristics of the original neighborhood as of 2000: share of movers, share of college graduates, share of White non-Hispanic residents, poverty rate, median income, median rent, median house value, share of units vacant and share of occupied units owned, from the decennial census. All models include CBSA fixed effects (u_m) and standard errors clustered at the tract level.

We also implement an estimator, developed by Oster (2019) and used by Brummet and Reed (2019), to estimate the potential influence of remaining unobservables on differences in mobility patterns and locational outcomes by running a version of the models with only gentrification and CBSA fixed effects and then the full version of the model. The Oster estimator provides a gentrification coefficient estimate that corrects for the possible bias from remaining unobservables based on assumptions about the maximum possible R^2 and the influence of remaining unobservables relative to the influence of the included controls.[3] Thus, it creates bounded estimates of the potential causal impact of gentrification on mobility patterns and locational outcomes. This approach requires control variables that capture a substantial amount of observable variations. Given the well-established set of individual and neighborhood controls used to explain measured cDOH outcomes and the relatively high R^2 value for most variables, the Oster estimates can provide a helpful bound on the gentrification coefficient estimate that incorporates bias from remaining observables.

Results

Table 2 reports the descriptive statistics for our overall sample of individuals, broken down by not gentrifiable, gentrifying and nongentrifying tracts. The overall sample consists of 5.5 million adults living in gentriafiable neighborhoods as of 2006 and with information about location in 2006 and 2019. Among them, as of 2006, 12.4% resided in neighborhoods (4,573 census tracts) classified as gentrifying. Among residents of gentrifiable tracts, about one third moved between 2006 and 2019, with a 3 percentage point higher rate among residents of gentrifying tracts relative to those of nongentrifying tracts. Residents in gentrifying tracts are less likely to be Black/African American residents, or Hispanic/Latinx residents, than those in not gentrifying tracts (13 vs. 27% and 11 vs. 20%, respectively) and more likely to be White non-Hispanic residents (56 vs. 39%). In terms of age, residents of gentrifying tracts are younger. Residents in gentrifying neighborhoods are less likely to own a home and are closer to the city center. Tract-level information also shows higher levels of mobility and lower rates of ownership in gentrifying tracts. However, gentrifying tracts have a higher share of adults with college degrees, and higher median income,

Table 2. Individual and neighborhood characteristics by gentrification status.

	Not gentrifiable	Gentrifying	Not gentrifying
Gentrification status	67.1%	4.1%	28.8%
Individual level			
Moved	27.3%	34.3%	31.2%
Race/ethnicity			
Black or African American	6.2%	13.3%	27.2%
Hispanic or Latinx	11.0%	10.9%	19.7%
Other race or ethnicity	19.6%	19.6%	14.4%
White non-Hispanic	63.3%	56.2%	38.7%
Age group			
Less than 30	5.6%	11.2%	7.2%
30–39	18.3%	24.5%	20.9%
40–49	26.6%	24.7%	25.6%
50–59	25.4%	20.5%	22.5%
60+	24.2%	19.1%	23.6%
Length of residence	12.2	10.1	11.9
Number of children in household	0.2	0.10	0.16
Own	76.7%	42.8%	53.8%
Married	64.0%	33.6%	45.2%
Distance to CBD (km)	15.7	9.1	12.3
Tract level (2000 census)			
Moved	47.3%	55.2%	47.5%
College degree	43.5%	37.3%	18.5%
Poverty rate	7.9%	21.9%	25.6%
Median income	57,115	31,756	27,986
Median rent	743	577	474
Median house value	208,917	168,195	108,077
White non-Hispanic	66.3%	49.5%	29.9%
Vacant	4.8%	8.7%	8.3%
Own	65.5%	31.5%	40.5%
N	11,176,224	678,493	4,791,436

Note. Characteristics are based on the 2006 individual-level location and characteristics and the 2000 tract-level characteristics.

rent, and house value, along with a lower share of poverty. This indicates that among gentrifiable neighborhoods, those classified as gentrifying between 2000 and 2019 had more favorable sociodemographic characteristics as of 2000. However, both gentrifying and not gentrifying tracts are more similar to each other than to not gentrifiable tracts, in which a smaller share of residents moved and a larger share are White non-Hispanic, own their homes, are married, and are farther from the CBD; and ACS neighborhood-level characteristics indicate higher levels of educational achievements, substantially lower poverty rate, and higher income, rent and house value.

Table 3 reports the average values of the cDOH measures overall and for individuals in not gentrifiable, gentrifying, and not gentrifying tracts based on their location in 2006 and 2019 and broken down by moving status. As of 2006, residents of gentrifying tracts face more favorable outcomes in terms of ADI, walkability and MUA. The initial differences in terms of air pollution between residents of gentrifying and not gentrifying tracts are limited. For residents of gentrifying neighborhoods as of 2006, these descriptive statistics indicate overall worsening cDOH between 2006 and 2019, except for the share of residents in MUAs that experienced a slight decline and for the air pollution measures that have declined over time across the country.

Table 4 reports the coefficient of the interaction term for Gentrifying tract*Period and Gentrifying tract*Period*Move from the probit (MUA) and OLS estimates (the full output is reported in Appendix Table A1). The coefficients in Panel A are interpreted as the change in a given cDOH for individuals who as of 2006 were living in tracts classified as gentrifying relative to individuals who were living in not gentrifying tracts in 2006 based on the cDOH measure for their location in 2006 and 2019, controlling for individual and initial tract characteristics. Panel B reports the coefficients for *z*-transformed outcomes, and Panel C presents the Oster estimates.

Table 3. Contextual social determinant of health by gentrifiable and gentrifying status.

	Not gentrifiable		Gentrifying		Not gentrifying	
All	2006	2019	2006	2019	2006	2019
MUA (1 = yes)	5.9%	6.3%	17.5%	15.2%	19.6%	17.2%
ADI national rank (percentile)	31.6	31.8	43.7	45.3	63.5	58.5
ADI state rank (percentile)	38.4	38.4	54.6	56.5	74.4	68.0
NO_2 (parts per billion)	14.8	9.5	18.6	12.3	16.5	11.1
PM_{10} ($\mu g/m^3$)	23.6	19.8	24.5	19.2	24.1	19.7
$PM_{2.5}$ ($\mu g/m^3$)	11.7	8.4	12.5	8.9	12.4	9.0
National Walkability Index (percentile)	62.0	60.5	70.5	68.0	66.3	64.0
	Not gentrifiable		Gentrifying		Not gentrifying	
Stayers	2006	2019	2006	2019	2006	2019
MUA (1 = yes)	6.0%	6.4%	18.4%	16.7%	20.7%	18.9%
ADI national rank (percentile)	31.8	31.8	44.9	44.0	64.1	60.5
ADI state rank (percentile)	38.1	37.9	56.1	55.7	74.4	69.8
NO_2 (parts per billion)	14.7	9.5	18.5	12.5	16.4	11.2
PM_{10} ($\mu g/m^3$)	23.6	19.8	24.5	19.3	24.0	19.8
$PM_{2.5}$ ($\mu g/m^3$)	11.7	8.4	12.5	9.0	12.4	9.0
National Walkability Index (percentile)	61.5	61.5	70.2	70.2	66.1	66.1
	Not gentrifiable		Gentrifying		Not gentrifying	
Movers	2006	2019	2006	2019	2006	2019
MUA (1 = yes)	5.6%	6.3%	12.6	16.2%	17.7%	13.7%
ADI national rank (percentile)	31.5	32.3	42.1	48.6	62.9	54.9
ADI state rank (percentile)	39.1	39.7	53.4	58.6	74.3	64.0
NO_2 (parts per billion)	15.3	9.4	19.0	12.0	16.8	10.8
PM_{10} ($\mu g/m^3$)	23.8	19.7	24.6	19.1	24.0	19.6
$PM_{2.5}$ ($\mu g/m^3$)	11.7	8.3	12.5	8.8	12.4	8.9
National Walkability Index (percentile)	63.2	58.4	70.7	65.0	66.4	61.2

Note. MUA = Medically Underserved Areas; ADI = Area Deprivation Index; NO_2 = Nitrogen Dioxide; PM 10 = Particulate Matter 10; PM 2.5 = Particulate Matter 2.5.

The results for MUAs indicate a 1.5-percentage-point increased chance of living in a MUA for original residents of gentrifying tracts (1.9 percentage points among movers). The average share of residents of gentrifying neighborhoods living in MUAs is 17.5% as of 2006, so this represents a meaningful difference. This is consistent with the hypothesis that gentrification of centrally located neighborhoods leads to mobility to areas with worse access to healthcare.

The results for the ADI ranking at the national and state level indicate that residents of gentrifying tracts experience a relative percentile increase of 3.9 at the national level and of 4.0 at the state level, indicating that they are located in relatively more deprived neighborhoods. For movers, the difference is 5.5 at both levels. The estimated coefficients are 0.2 standard deviations overall and are of similar magnitude to the difference in ADI between White non-Hispanic and Black or African American individuals. This means that although among gentrifiable tracts gentrifying tracts have generally lower ADI than not gentrifying tracts, on average original residents of gentrifying neighborhoods experienced a relative worsening in ADI through movers ending up in neighborhoods with relatively higher ADI.

The results for the measures of air pollutants indicate an improvement for residents of gentrifying tracts in terms of exposure to NO_2, PM_{10}, and $PM_{2.5}$. The estimated changes are between 0.1 and 0.2 standard deviations for these measures, representing substantial improvements. These improvements may reflect moves farther from the sources of emissions located in the center of urban areas, but this requires further investigation.

The results for the National Walkability Index indicate that original residents of gentrifying tracts lived in neighborhoods with higher levels of walkability but experienced a 1.9 percentile decrease in the Walkability Index on average relative to the original residents of

Table 4. Gentrification association with cDOH among original residents.

Panel A: Raw measures

	Medically underserved area	ADI national rank	ADI state rank	Nitrogen dioxide	PM_{10}	$PM_{2.5}$	National Walkability Index
Gentrifying tract*Period	0.015***	3.104***	3.952***	−0.784***	−1.020***	−0.193***	−1.895***
	(0.003)	(0.0195)	(0.0246)	(0.0026)	(0.0036)	(0.0010)	(0.0235)
N	10,779,622	10,651,860	10,777,539	10,777,539	10,777,539	10,779,345	10,651,860
R^2 or pseudo R^2	0.06	0.29	0.30	0.67	0.41	0.81	0.27

Panel B: normalized measures (*z* score with mean 0 and standard deviation 1)

	ADI national rank	ADI state rank	Nitrogen dioxide	PM_{10}	$PM_{2.5}$	National Walkability Index
Gentrifying tract*Period	0.151***	0.179***	−0.146***	−0.180***	−0.074***	−0.060***
	(0.0009)	(0.0011)	(0.0006)	(0.0008)	(0.0005)	(0.0087)
N	10,651,860	10,651,860	10,777,539	10,777,539	10,777,539	10,779,345
R^2 or pseudo R^2	0.29	0.30	0.67	0.41	0.81	0.27

Panel C: Oster estimates

	Medically underserved area	ADI national rank	ADI state rank	Nitrogen dioxide	PM_{10}	$PM_{2.5}$	National Walkability Index
Gentrifying tract*Period	0.0192	5.32	8.553	−0.535	−1.042	−0.211	−1.051

Note. All results are for specifications including individual and neighborhood controls, MSA fixed effects, and standard errors clustered at the tract level. MUA is not included in Panel B because its *z* score is not meaningful for the binary indicator.

not gentrifying tracts, or 0.1 standard deviations. As mentioned earlier, the walkability measure is only available for a single period in time, meaning that the change is coming from movers, who may be relocating farther from the center of the region in less walkable environments.

Looking at the Oster estimates, the betas are of similar magnitude but generally slightly larger, with the exception of the NO_2 and walkability measures, for which they are relatively smaller. The relative stability of the coefficients suggests that although selection on unobservable characteristics is likely, its impact on the estimated gentrification coefficient may be moderate and toward an underestimation of a potential causal effect.

Table 5 reports the results broken down by original residents of gentrifying neighborhoods who stayed at the same address (Panel A) or moved (Panel B) between 2006 and 2019. Movers could have moved to a home in a gentrifying, not gentrifying or not gentrifiable tract. Overall, residents who stayed in gentrifying neighborhoods experienced a relative improvement in the likelihood of their neighborhood being a MUA, in their ADI ranking, and in their exposure to air pollutants, whereas movers experienced a relative worsening in terms of MUA and ADI but also experienced a relative improvement in terms of air pollutants (although less so than stayers). Overall, these results indicate relatively worse outcomes for movers and the need for further research looking specifically at mover outcomes and differences across race/ethnicity, whether they own or rent, and local market characteristics.

Appendix Table A2 reports results based on different definitions of gentrifiable and gentrifying. The magnitude is generally similar across outcomes whether using the 2006–2010 ACS data

Table 5. Gentrification association with cDOH among original residents stratified by stayers and movers.

	Medically underserved area	ADI national rank	ADI state rank	Nitrogen dioxide	PM_{10}	$PM_{2.5}$	National walkability index
Panel A: Stayers							
Gentrifying tract*Period	−0.004***	−2.312***	−1.950***	−1.103***	−1.108***	−0.244***	NA
	(0.0005)	(0.0266)	(0.0333)	(0.0036)	(0.0050)	(0.0015)	
N	7,422,181	7,337,615	7,337,615	7,420,967	7,420,967	7,420,967	7,421,909
R^2 or pseudo R^2	0.07	0.30	0.32	0.66	0.41	0.81	0.19
Panel B: Movers							
Gentrifying tract*Period	0.019***	5.524***	5.498***	−0.627***	−0.964***	−0.178***	−1.955***
	(0.0004)	(0.0209)	(0.0263)	(0.0028)	(0.0039)	(0.0011)	(0.0436)
N	3,357,441	3,314,245	3,314,245	3,356,572	3,356,572	3,356,572	3,357,278
R^2 or pseudo R^2	0.04	0.26	0.27	0.70	0.41	0.81	0.16

Note. All results are for specifications including individual and neighborhood controls, MSA fixed effects, and standard errors clustered at the tract level.

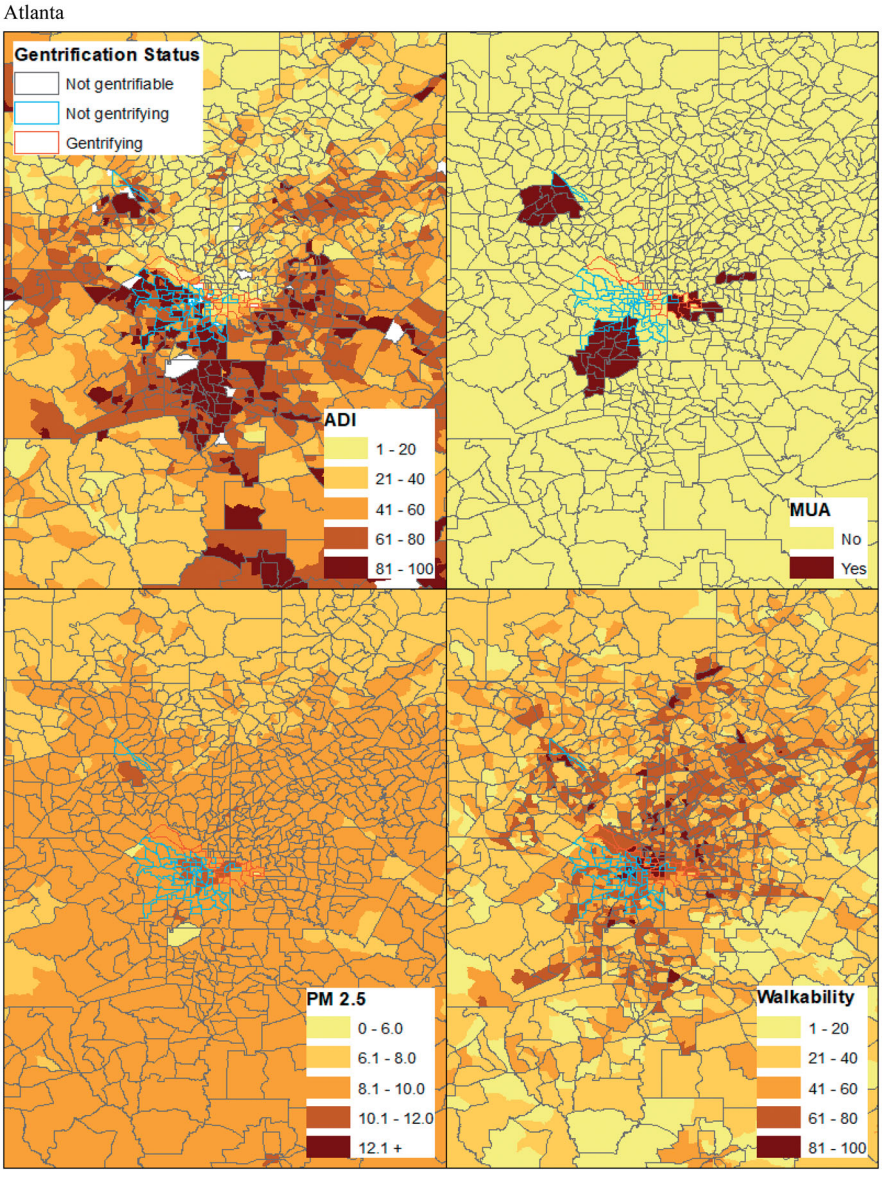

Figure 1. cDOH measures by gentrifying and not gentrifying status for selected regions.

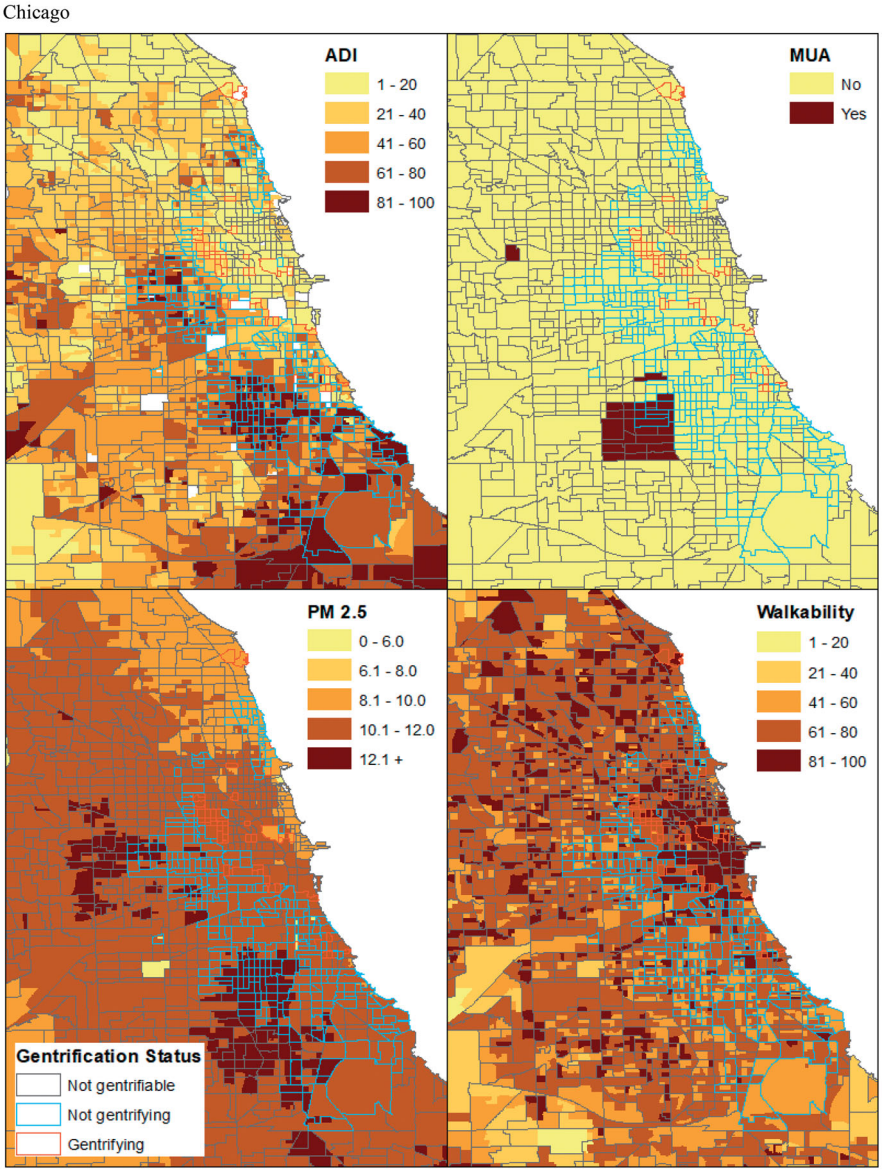

Figure 1. Continued.

instead of the 2000 census data for the beginning period, the center city median income instead of the metropolitan region median income, 60% of Area Median Income (AMI) instead of 80% of AMI to define gentrifiable tracts, and changes in the top 25th percentile instead of above median to define gentrifying tracts. The relative stability of the estimates indicates that our findings are not based on a particular definition of gentrification, although alternate definitions or variations in the magnitude of the relationship across regions are certainly worth exploring.

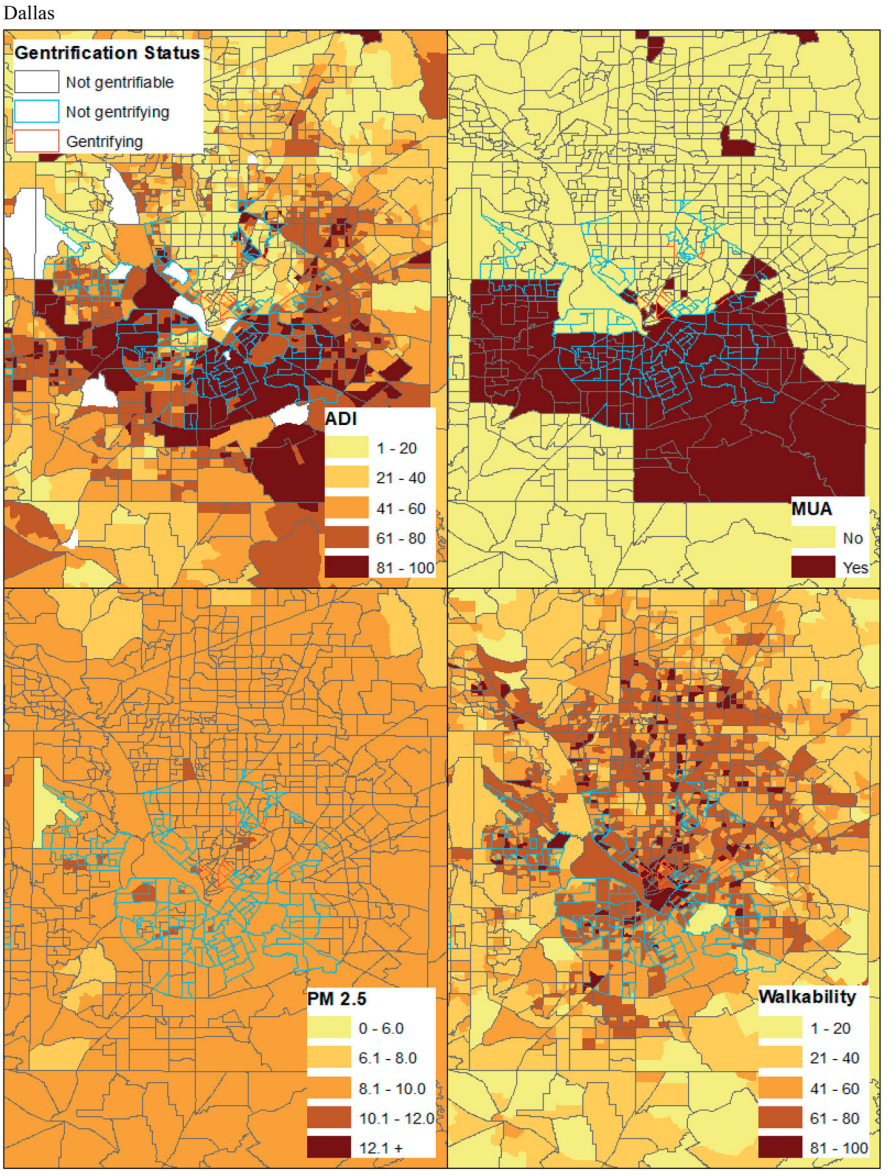

Figure 1. Continued.

Discussion

Among the six cDOH measures for which we have temporal variations of original residents of gentrifiable neighborhoods, whether gentrifying or not, both movers and stayers experienced lower exposure to air pollution. On average, stayers experienced an improvement in the MUA and ADI measures among both gentrifying and not gentrifying tracts. Movers from gentrifying tracts experienced a worsening in terms of MUA and ADI and in the measure that is not time varying (walkability). Looking at the interaction of gentrification and period and controlling for individual and location characteristics, we find that individuals who as of 2006 were living in neighborhoods that were classified as gentrifying experienced a relative decline in their

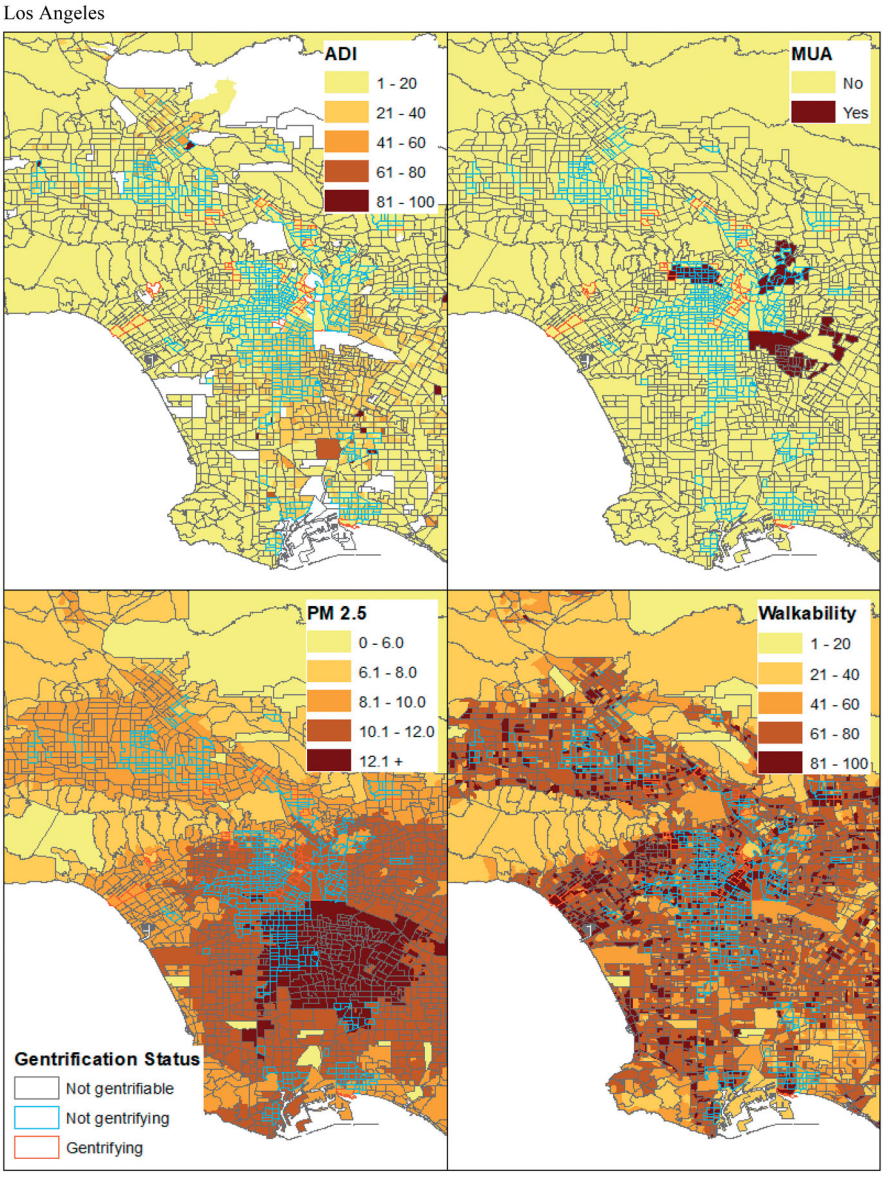

Figure 1. Continued.

neighborhood healthcare access, socioeconomic condition, and walkability and improvements in air pollutants between 2006 and 2019 relative to residents of low- and moderate-income neighborhoods that did not gentrify. When looking at differences for residents of gentrifying neighborhoods who moved or stayed, the main driver of the changes in healthcare access, ADI and walkability appear to be differential outmigration to neighborhoods with relatively worse measures on these variables for residents of gentrifying neighborhoods. The results for air pollution reflect an overall improvement in air quality in the U.S. over time and a decline in absolute and relative racial/ethnic exposure disparities (Liu et al., 2021). For air pollution, the relevant question is to understand why gentrifying neighborhoods see greater improvements in air quality relative to nongentrifying areas.

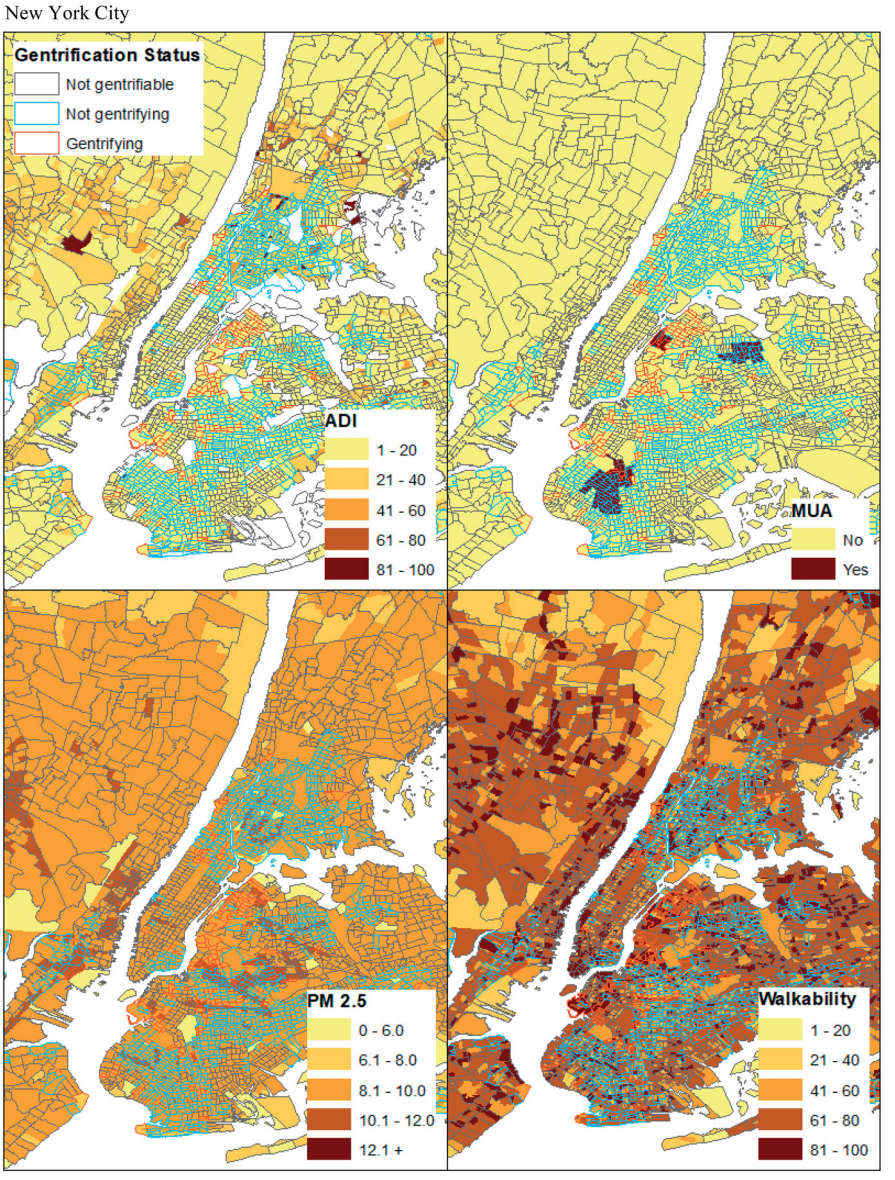

Figure 1. Continued.

The existing literature on the impact of gentrification on health finds evidence that adults and children who are able to stay in gentrifying neighborhoods experience some improvements in terms of health outcomes (Dragan et al., 2019), whereas those who move experience negative health outcomes (Dragan et al., 2019; Lim et al., 2017). In addition, there is evidence of differences in relationships across racial/ethnic groups, with Black residents of gentrifying neighborhoods reporting increased levels of fair/poor self-rated health in California whereas the same difference was not found for other racial/ethnic groups (Izenberg et al., 2018), and with gentrification in minority areas being associated with higher rates of poor self-rated health at the national level (Gibbons et al., 2018). Besides Dragan et al., (2019) and Lim et al., (2017), these studies generally focus on outcomes for residents who remain in gentrifying neighborhoods, due to the difficulty

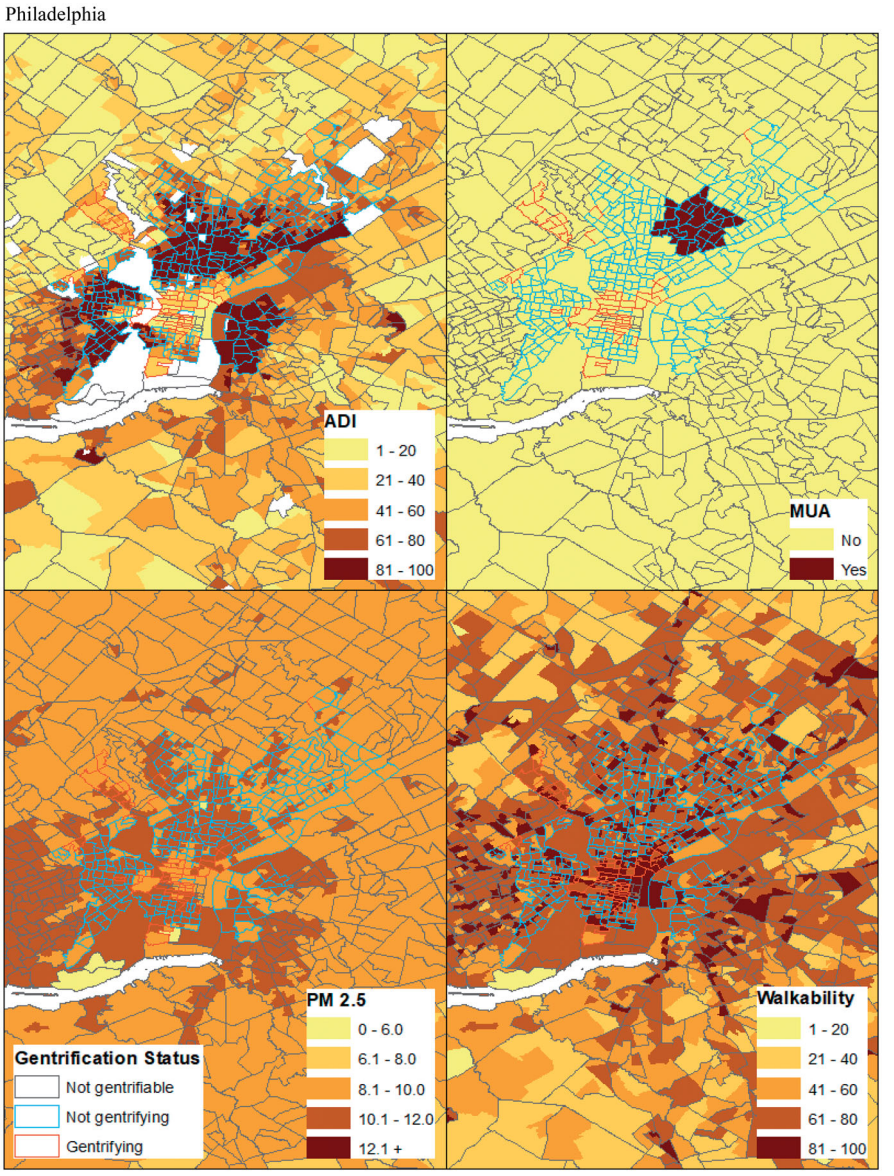

Figure 1. Continued.

of observing those who moved out. As discussed above, gentrification may have positive and negative impacts on cDOH for stayers through changes in neighborhood composition and availability of public and private goods and services. However, gentrification has been shown to be a particular source of disruption for residents who are not able to continue living in their original community and thus experience a loss of community. A particular concern around displacement has been about whether households end up moving to neighborhoods with worse characteristics for residents' well-being and intergenerational economic mobility. Therefore, the ability to measure changes in neighborhood environments for movers is of particular interest.

The results of this paper indicate that on several dimensions gentrification seems to be associated with relatively worsening cDOH for original residents, mostly through outmigration to

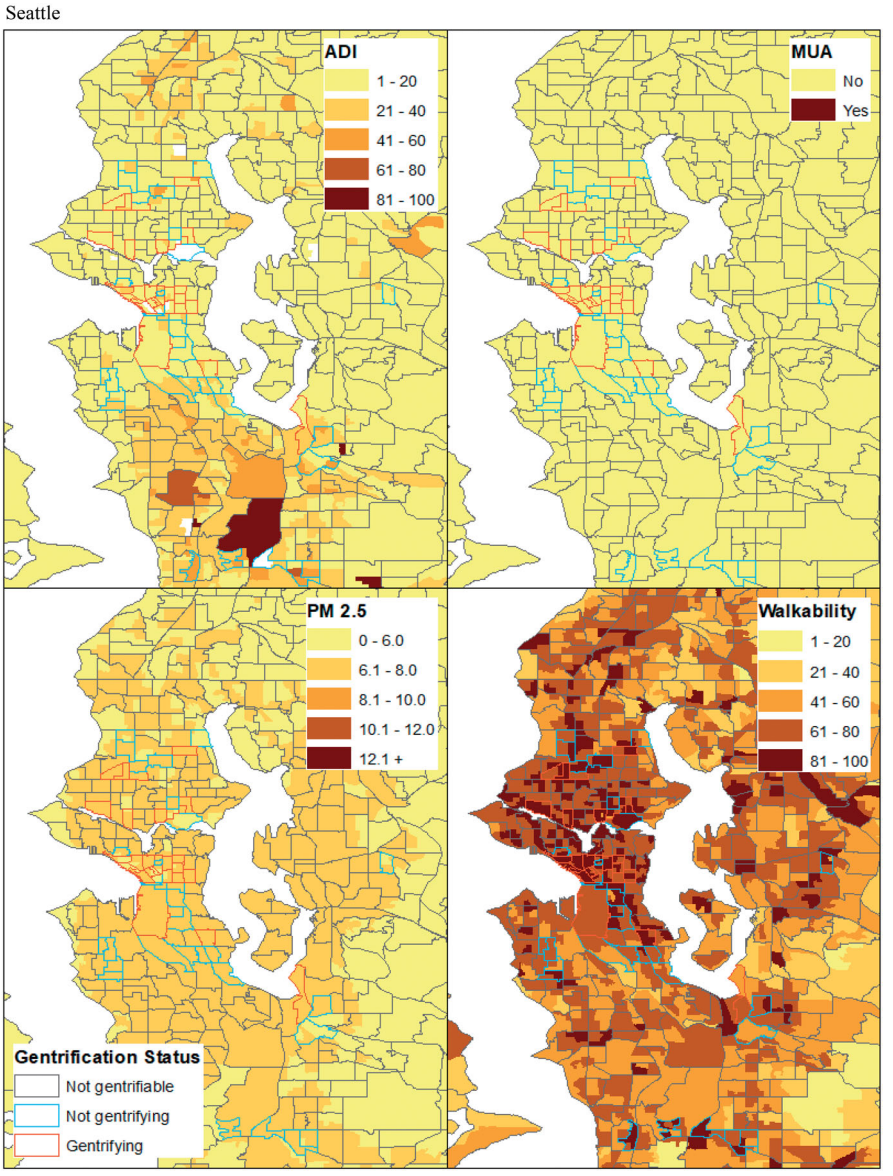

Figure 1. Continued.

neighborhoods with lower levels of cDOH relative to the pattern for residents of gentrifiable but not gentrifying neighborhoods. When it comes to the select cDOH examined here, individuals in gentrifying neighborhoods appear to experience a relative worsening of their position compared to similar individuals in nongentrifying tracts over the 2006–2019 period, although not in terms of air pollutants. Examining additional cDOH, including access to healthy food and crime, is necessary to understand to what extent the relationship between gentrification and exposure to cDOH varies across types of cDOH and the overall impact of gentrification on health environments.

Further work is also needed to examine how these results vary for different groups of residents and in different locations. More vulnerable households are more likely to experience forced

moves as a result of gentrification, with renters expected to be most affected because they are more directly exposed to the impact of changes in housing costs. The impact of gentrification on locational outcomes is likely to be larger in tighter housing markets at the regional level as residents may not find adequate affordable options or have to move considerable distances, but evidence on the magnitude of these differences is needed. The regional context may also interact with the impact of gentrification, particularly in regions with higher levels of segregation where neighborhood options for minority households may be further constrained. It is important to further explore these variations to understand for whom and when gentrification may be associated with a worsening in health environments and in community health and how policies can be targeted to support households most negatively affected by gentrification. Given the relatively worse outcomes for movers, policies aimed at limiting displacement and enabling original residents to remain in their community despite gentrification forces or to move to communities with health-enhancing cDOH could have beneficial impacts on households' health outcomes and overall well-being.

Acknowledgements

The authors thank *Housing Policy Debate* Editors, Dr. Vincent Reina and Dr. George Galster, the Editors of the Special Issue on "Gentrification, Housing, and Health Outcomes", Dr. Joseph Gibbons and Dr. Derek Hydra and three anonymous reviewers for their useful comments and suggestions during the review process. The authors are grateful to the Center for Studies in Demography & Ecology at the University of Washington, the University Washington and the Runstad Department of Real Estate for purchasing the consumer data. The support of Phil Hurvitz and the University of Washington Data Collaborative in providing the data infrastructure to access the data is also much appreciated. Partial support for this research came from a Eunice Kennedy Shriver National Institute of Child Health and Human Development research infrastructure grant, P2C HD042828, to the Center for Studies in Demography & Ecology at the University of Washington. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Notes

1. We acknowledge that gentrification can also take place in suburban (Markley, 2018) and rural (Sherman, 2021) communities but focus here on central cities due to shared historical patterns of disinvestment and reinvestment in public and private goods in their communities that are expected to be directly related to cDOH.
2. Distance to the center is estimated as the Euclidian distance in km between the individual address and City Hall for a central-city MSA, as determined and made available by the U.S. Census Bureau (https://www.census.gov/library/publications/2012/dec/c2010sr-01.html). This variable aims to capture the spatial location of the units within the urban system, with more central locations expected to be more desirable. See Holian (2019) for a discussion of the available measures of centrality.
3. Following the rule of thumb values developed by Oster (2019) and used by Brummet and Reed, we use Rmax $= 1.3$ times the R^2 for the model with full controls and little delta $= 1$, assuming the influence of remaining unobservables is proportional to the influence of full controls.

References

Acevedo-Garcia, D., Lochner, K. A., Osypuk, T. L., & Subramanian, S. V. (2003). Future directions in residential segregation and health research: A multilevel approach. *American Journal of Public Health*, *93*(2), 215–221.

Acolin, A., Decter-Frain, A., & Hall, M. (2021). *Small area population estimates from consumer trace data*. Working Paper.

Ahnquist, J., Wamala, S. P., & Lindstrom, M. (2012). Social determinants of health–a question of social or economic capital? Interaction effects of socioeconomic factors on health outcomes. *Social Science & Medicine (1982)*, *74*(6), 930–939. https://doi.org/10.1016/j.socscimed.2011.11.026

Arias, E., Escobedo, L. A., Kennedy, J., Fu, C., & Cisewski, J. A. (2018). *US small-area life expectancy estimates project: Methodology and results summary*. Hyattsville, MD: National Center for Health Statistics. DHHS publication 2018-1380. https://stacks.cdc.gov/view/cdc/58853

Asquith, B. J., Mast, E., & Reed, D. (2021). Local effects of large new apartment buildings in low-income areas. *The Review of Economics and Statistics*, 1–46. https://doi.org/10.1162/rest_a_01055

Bhavsar, N. A., Kumar, M., & Richman, L. (2020). Defining gentrification for epidemiologic research: A systematic review. *Plos One*, *15*(5), e0233361.

Braveman, P., Egerter, S., & Williams, D. R. (2011). The social determinants of health: Coming of age. *Annual Review of Public Health*, *32*, 381–398.

Braveman, P., & Gottlieb, L. (2014). The social determinants of health: It's time to consider the causes of the causes. *Public Health Reports*, *129*(1_suppl2), 19–31. https://doi.org/10.1177/00333549141291S206

Brevoort, K. P., Grimm, P., & Kambara, M. (2015). Credit invisibles. *Bureau of Consumer Financial Protection Data Point Series 15-1*, 11–15.

Brophy, P. C. (Ed.). (2016). *On the edge: America's middle neighborhoods*. American Assembly.

Brown, E. J., Polsky, D., Barbu, C. M., Seymour, J. W., & Grande, D. (2016). Racial disparities in geographic access to primary care in Philadelphia. *Health Affairs (Project Hope)*, *35*(8), 1374–1381.

Brummet, Q., & Reed, D. (2019). *The effects of gentrification on the well-being and opportunity of original resident adults and children*. Working Paper.

Carlson, E. D., & Chamberlain, R. M. (2003). Social capital, health, and health disparities. *Journal of Nursing Scholarship : An Official Publication of Sigma Theta Tau International Honor Society of Nursing*, *35*(4), 325–331.

Carpiano, R. M. (2006). Toward a neighborhood resource-based theory of social capital for health: can Bourdieu and sociology help? *Social Science & Medicine*, *62*(1), 165–175. https://doi.org/10.1016/j.socscimed.2005.05.020

Cole, H. V. (2020). A call to engage: Considering the role of gentrification in public health research. *Cities & Health*, *4*(3), 278–287. https://doi.org/10.1080/23748834.2020.1760075

Cole, H. V., Triguero-Mas, M., Connolly, J. J., & Anguelovski, I. (2019). Determining the health benefits of green space: Does gentrification matter? *Health & Place*, *57*, 1–11.

Couture, V., Gaubert, C., Handbury, J., & Hurst, E. (2019). *Income growth and the distributional effects of urban spatial sorting (No. w26142)*. National Bureau of Economic Research.

Couture, V., & Handbury, J. (2020). Urban revival in America. *Journal of Urban Economics*, *119*, 103267. https://doi.org/10.1016/j.jue.2020.103267

Crowder, K., & Downey, L. (2010). Interneighborhood migration, race, and environmental hazards: Modeling microlevel processes of environmental inequality. *American Journal of Sociology*, *115*(4), 1110–1149. https://doi.org/10.1086/649576

Diez Roux, A. V., & Mair, C. (2010). Neighborhoods and health. *Annals of the New York Academy of Sciences*, *1186*(1), 125–145.

Ding, L., Hwang, J., & Divringi, E. (2016). Gentrification and residential mobility in Philadelphia. *Regional Science and Urban Economics*, *61*, 38–51. https://doi.org/10.1016/j.regsciurbeco.2016.09.004

Dragan, K. L., Ellen, I. G., & Glied, S. A. (2019). Gentrification and the health of low-income children in New York City. *Health Affairs (Project Hope)*, *38*(9), 1425–1432.

Dragan, K., Ellen, I. G., & Glied, S. (2020). Does gentrification displace poor children and their families? New evidence from medicaid data in New York City. *Regional Science and Urban Economics*, *83*, 103481. https://doi.org/10.1016/j.regsciurbeco.2019.103481

Duncan, D. T., Aldstadt, J., Whalen, J., White, K., Castro, M. C., & Williams, D. R. (2012). Space, race, and poverty: Spatial inequalities in walkable neighborhood amenities? *Demographic Research*, *26*(17), 409–448.

Firth, C. L., Fuller, D., Wasfi, R., Kestens, Y., & Winters, M. (2020). Causally speaking: Challenges in measuring gentrification for population health research in the United States and Canada. *Health & Place*, *63*, 102350. https://doi.org/10.1016/j.healthplace.2020.102350

Freeman, L. (2009). Neighbourhood diversity, metropolitan segregation and gentrification: What are the links in the US? *Urban Studies*, *46*(10), 2079–2101. https://doi.org/10.1177/0042098009339426

Fullilove, M. T. (1996). Psychiatric implications of displacement: Contributions from the psychology of place. *American Journal of Psychiatry*, *153*, 12.

Fullilove, M. T. (2016). *Root shock: How tearing up city neighborhoods hurts America, and what we can do about it*. New Village Press.

Gentili, M., Isett, K., Serban, N., & Swann, J. (2015). Small-area estimation of spatial access to care and its implications for policy. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *92*(5), 864–909.

Gibbons, J., & Barton, M. S. (2016). The association of minority self-rated health with black versus white gentrification. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *93*(6), 909–922.

Gibbons, J., Barton, M., & Brault, E. (2018). Evaluating gentrification's relation to neighborhood and city health. *PloS One*, *13*(11), e0207432.

Holian, M. J. (2019). Where is the City's Center? Five measures of central location. *Cityscape*, *21*(2), 213–226.

Hu, J., Kind, A. J., & Nerenz, D. (2018). Area deprivation index predicts readmission risk at an urban teaching hospital. *American Journal of Medical Quality : The Official Journal of the American College of Medical Quality*, *33*(5), 493–501.

Hwang, J., & Lin, J. (2016). What have we learned about the causes of recent gentrification? *Cityscape*, *18*(3), 9–26.

Izenberg, J. M., Mujahid, M. S., & Yen, I. H. (2018). Health in changing neighborhoods: A study of the relationship between gentrification and self-rated health in the state of California. *Health & Place*, *52*, 188–195. https://doi.org/10.1016/j.healthplace.2018.06.002

Johnson, G. D., Checker, M., Larson, S., & Kodali, H. (2022). A small area index of gentrification, applied to New York City. *International Journal of Geographical Information Science 36*(1), 137–157.

Kim, S. Y., Bechle, M., Hankey, S., Sheppard, L., Szpiro, A. A., & Marshall, J. D. (2020). Concentrations of criteria pollutants in the contiguous US, 1979–2015: Role of prediction model parsimony in integrated empirical geographic regression. *PloS One*, *15*(2), e0228535. https://doi.org/10.1371/journal.pone.0228535

Kind, A. J. H., & Buckingham, W. R. (2018). Making neighborhood-disadvantage metrics accessible—the neighborhood atlas. *The New England Journal of Medicine, 378*(26), 2456. https://doi.org/10.1056/NEJMp1802313

Kind, A. J. H., Jencks, S., Brock, J., Yu, M., Bartels, C., Ehlenbach, W., Greenberg, C., & Smith, M. (2014). Neighborhood socioeconomic disadvantage and 30-day rehospitalization: A retrospective cohort study. *Annals of Internal Medicine*, *161*(11), 765–774.

Kravitz-Wirtz, N., Crowder, K., Hajat, A., & Sass, V. (2016). The long-term dynamics of racial/ethnic inequality in neighborhood air pollution exposure, 1990–2009. *Du Bois Review : Social Science Research on Race*, *13*(2), 237–259. https://doi.org/10.1017/S1742058X16000205

Kravitz-Wirtz, N., Teixeira, S., Hajat, A., Woo, B., Crowder, K., & Takeuchi, D. (2018). Early-life air pollution exposure, neighborhood poverty, and childhood asthma in the United States, 1990–2014. *International Journal of Environmental Research and Public Health*, *15*(6), 1114. https://doi.org/10.3390/ijerph15061114

Kwan, M. P. (2009). From place-based to people-based exposure measures. *Social Science & Medicine (1982)*, *69*(9), 1311–1313.

Lantos, P. M., Hoffman, K., Permar, S. R., Jackson, P., Hughes, B. L., Kind, A., & Swamy, G. (2018). Neighborhood disadvantage is associated with high cytomegalovirus seroprevalence in pregnancy. *Journal of Racial and Ethnic Health Disparities*, *5*(4), 782–786. https://doi.org/10.1007/s40615-017-0423-4

Lim, S., Chan, P. Y., Walters, S., Culp, G., Huynh, M., & Gould, L. H. (2017). Impact of residential displacement on healthcare access and mental health among original residents of gentrifying neighborhoods in New York City. *PloS One*, *12*(12), e0190139. https://doi.org/10.1371/journal.pone.0190139

Link, B. G., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior*, *35*, 80–94. https://doi.org/10.2307/2626958

Liu, J., Clark, L. P., Bechle, M. J., Hajat, A., Kim, S.-Y., Robinson, A. L., Sheppard, L., Szpiro, A. A., & Marshall, J. D. (2021). Disparities in air pollution exposure in the United States by race-ethnicity and income, 1990–2010. *Environmental Health Perspectives*, *129*(12), 127005. https://doi.org/10.1289/EHP8584

Ludwig, J., Sanbonmatsu, L., Gennetian, L., Adam, E., Duncan, G. J., Katz, L. F., Kessler, R. C., Kling, J. R., Lindau, S. T., Whitaker, R. C., & McDade, T. W. (2011). Neighborhoods, obesity, and diabetes—a randomized social experiment. *New England Journal of Medicine*, *365*(16), 1509–1519. https://doi.org/10.1056/NEJMsa1103216

Maciag, M. (2015). *Gentrification in America report*. Governing.

Markley, S. (2018). Suburban gentrification? Examining the geographies of New Urbanism in Atlanta's inner suburbs. *Urban Geography*, *39*(4), 606–630. https://doi.org/10.1080/02723638.2017.1381534

Manzo, L. C. (2003). Beyond house and haven: Toward a revisioning of emotional relationships with places. *Journal of Environmental Psychology*, *23*(1), 47–61. https://doi.org/10.1016/S0272-4944(02)00074-9

Martin, R. W. (2017). *Gentrification trends in the United States, 1970–2010*. Working Paper.

Mast, E. (2021). *The effect of new market-rate housing construction on the low-income housing market. Journal of Urban Economics*, in press. https://doi.org/10.1016/j.jue.2021.103383

Messer, L. C., Laraia, B. A., Kaufman, J. S., Eyster, J., Holzman, C., Culhane, J., Elo, I., Burke, J. G., & O'Campo, P. (2006). The development of a standardized neighborhood deprivation index. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *83*(6), 1041–1062.

Oster, E. (2019). Unobservable selection and coefficient stability: Theory and evidence. *Journal of Business & Economic Statistics*, *37*(2), 187–204. https://doi.org/10.1080/07350015.2016.1227711

Pais, J., Crowder, K., & Downey, L. (2014). Unequal trajectories: Racial and class differences in residential exposure to industrial hazard. *Social Forces*, *92*(3), 1189–1215. https://doi.org/10.1093/sf/sot099

Pearsall, H., & Eller, J. K. (2020). Locating the green space paradox: A study of gentrification and public green space accessibility in Philadelphia. *Landscape and Urban Planning*, *195*, 103708. https://doi.org/10.1016/j.landurbplan.2019.103708

Phillips, D. C. (2020). Measuring housing stability with consumer reference data. *Demography*, *57*(4), 1323–1344. https://doi.org/10.1007/s13524-020-00893-5

Pope, C. A., Lefler, J. S., Ezzati, M., Higbee, J. D., Marshall, J. D., Kim, S.-Y., Bechle, M., Gilliat, K. S., Vernon, S. E., Robinson, A. L., & Burnett, R. T. (2019). Mortality risk and fine particulate air pollution in a large, representative cohort of US adults. *Environmental Health Perspectives*, *127*(7), 077007. https://doi.org/10.1289/EHP4438

Preis, B., Janakiraman, A., Bob, A., & Steil, J. (2021). Mapping gentrification and displacement pressure: An exploration of four distinct methodologies. *Urban Studies*, *58*(2), 405–424. https://doi.org/10.1177/0042098020903011

Robert Wood Johnson Foundation. (2021). *Life expectancy: Could where you live influence how long you live?* Princeton, NJ: Robert Wood Johnson Foundation.

Sass, V., Kravitz-Wirtz, N., Karceski, S. M., Hajat, A., Crowder, K., & Takeuchi, D. (2017). The effects of air pollution on individual psychological distress. *Health & Place*, *48*, 72–79. https://doi.org/10.1016/j.healthplace.2017.09.006

Schnake-Mahl, A. S., Jahn, J. L., Subramanian, S. V., Waters, M. C., & Arcaya, M. (2020). Gentrification, neighborhood change, and population health: A systematic review. *Journal of Urban Health: bulletin of the New York Academy of Medicine*, *97*(1), 1–25.

Schnake-Mahl, A. S., & Sommers, B. D. (2017). Health care in the suburbs: An analysis of suburban poverty and health care access. *Health Affairs*, *36*(10), 1777–1785. https://doi.org/10.1377/hlthaff.2017.0545

Scribner, R. A., Simonsen, N. R., & Leonardi, C. (2017). The social determinants of health core: Taking a place-based approach. *American Journal of Preventive Medicine*, *52*(1S1), S13–S19.

Sherman, J. (2021). "Please don't take this": Rural gentrification, symbolic capital, and housing insecurity. *Social Problems*, *00*, 1–20. https://doi.org/10.1093/socpro/spab041

Shi, L., Macinko, J., Starfield, B., Politzer, R., Wulu, J., & Xu, J. (2005). Primary care, social inequalities, and all-cause, heart disease, and cancer mortality in US counties, 1990. *American Journal of Public Health*, *95*(4), 674–680. https://doi.org/10.2105/AJPH.2003.031716

Smith, G. S., Breakstone, H., Dean, L. T., & Thorpe, R. J. (2020). Impacts of gentrification on health in the US: A systematic review of the literature. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *97*(6), 845–856.

Streeter, R. A., Snyder, J. E., Kepley, H., Stahl, A. L., Li, T., & Washko, M. M. (2020). The geographic alignment of primary care Health Professional Shortage Areas with markers for social determinants of health. *PloS One*, *15*(4), e0231443.

Wen, M., Zhang, X., Harris, C. D., Holt, J. B., & Croft, J. B. (2013). Spatial disparities in the distribution of parks and green spaces in the USA. *Annals of Behavioral Medicine*, *45*(S1), 18–S27. https://doi.org/10.1007/s12160-012-9426-x

Williams, D. R., & Collins, C. (2016). Racial residential segregation: a fundamental cause of racial disparities in health. *Public Health Reports, 116*, 404–416.

Appendix

Table A1. Gentrification association with cDOH among original residents with controls.

Panel A: Medically underserved areas

	Medically underserved area
Gentrifying tract (reference= Gentrifiable not gentrifying)	−0.026***
	(0.0003)
Period (reference= 2006)	−0.013***
	(0.0003)
Gentrifying tract*Period	0.015***
	(0.0003)
Moved during period	−0.004***
	(0.0004)
Length of residence as of 2006	0.0004***
	(0.00001)
Race/ethnicity (reference = White non-Hispanic)	
Black or African American	0.029***
	(0.0003)
Hispanic or Latinx	0.018***
	(0.0003)
Other race or ethnicity	0.018***
	(0.0003)
Number of children	0.002***
	(0.0002)
Own	−0.004***
	(0.0002)

(*continued*)

Table A1. Continued.

Panel A: Medically underserved areas

	Medically underserved area
Married	0.001***
	(0.0002)
Age (reference = Less than 30)	
30–39	0.003***
	(0.0003)
40–49	0.005***
	(0.0003)
50–59	0.005***
	(0.0004)
60+	0.002***
	(0.0004)
Distance from Center (km)	
	−0.112***
2000 neighborhood controls	(0.0011)
Moved	−0.248***
	(0.0010)
College degree	0.145***
	(0.0014)
Poverty	−0.001***
	(0.00003)
Median income ($1000s)	0.0001***
	(0.000001)
Median rent	0.0002***
	(0.000001)
Median house value ($1000s)	0.035***
	(0.0005)
White non-Hispanic	−0.319***
	(0.0018)
Vacant	0.122***
	(0.0008)
Own	−0.003***
	(0.000007)
Constant	0.223***
	(0.0011)
N	10,779,622
Pseudo R^2	0.06
Metropolitan Statistical Area fixed effects	Yes
Standard errors clustered at tract level	Yes

Panel B: Area deprivation index

	ADI national rank	ADI state rank
Gentrifying tract (reference = Gentrifiable not gentrifying)	−8.97***	−11.18***
	(0.0170)	(0.0214)
Period (reference = 2006)	−3.397***	−4.278***
	(0.0176)	(0.0221)
Gentrifying tract*Period	3.104***	3.952***
	3.104***	3.952***
Moved during period	0.258***	0.434***
	(0.0224)	(0.0282)
Length of residence as of 2006	0.024***	0.021***
	(0.0007)	(0.0008)
Race/ethnicity (reference = White non-Hispanic)		
Black or African American	4.751***	6.165***
	(0.0154)	(0.0194)
Hispanic or Latinx	1.921***	2.692***
	(0.0155)	(0.0195)
Other race or ethnicity	0.633***	0.586***
	(0.0151)	(0.0190)
Number of children	0.153***	0.148***
	(0.0102)	(0.0128)
Own	−1.966***	−2.134***
	(0.0127)	(0.0159)

(*continued*)

Table A1. Continued.

Panel B: Area deprivation index

	ADI national rank	ADI state rank
Married	−1.646***	−1.905***
	(0.0107)	(0.0135)
Age (reference = Less than 30)		
30–39	0.114***	0.166***
	(0.0207)	(0.0260)
40–49	0.751***	1.030***
	(0.0206)	(0.0259)
50–59	0.964***	1.279***
	(0.0217)	(0.0273)
60+	1.254***	1.652***
	(0.0234)	(0.0294)
Distance from Center (km)		
	15.77***	22.72***
2000 neighborhood controls	(0.0677)	(0.0851)
Moved	−39.18***	−51.25***
	(0.0578)	(0.0728)
College degree	−2.518***	−5.231***
	(0.0865)	(0.1091)
Poverty	−0.441***	−0.544***
	(0.00152)	(0.0019)
Median income ($1000s)	0.007***	0.007***
	(0.0001)	(0.0001)
Median rent	−0.020***	−0.029***
	(0.0001)	(0.0001)
Median house value ($1000s)	−8.140***	−11.67***
	(0.0269)	(0.0338)
White non-Hispanic	−0.018	−6.691***
	(0.1082)	(0.1361)
Vacant	29.25***	35.89***
	(0.0484)	(0.0609)
Own	0.057***	0.0914***
	(0.0004)	(0.0005)
Constant	61.62***	74.79***
	(0.0682)	(0.0858)
N	10,651,860	10,651,860
R^2	0.29	0.30
Metropolitan Statistical Area fixed effects	Yes	Yes
Standard errors clustered at tract level	Yes	Yes

Panel C: Air pollution

	Nitrogen dioxide	PM_{10}	$PM_{2.5}$
Gentrifying tract (reference = Gentrifiable not gentrifying)	0.611***	0.568***	0.126***
	(0.0023)	(0.0031)	(0.000908)
Period (reference = 2006)	−4.870***	−4.103***	−3.264***
	(0.0024)	(0.0032)	(0.0009)
Gentrifying tract*Period	−0.784***	−1.020***	−0.193***
	(0.0026)	(0.0036)	(0.0010)
Moved during period	0.069***	0.010*	−0.008***
	(0.0030)	(0.0041)	(0.0012)
Length of residence as of 2006	0.007***	0.002***	0.003***
	(0.0001)	(0.0001)	(0.00004)
Race/ethnicity (reference = White non-Hispanic)			
Black or African American	−0.086***	−0.014***	0.059***
	(0.0021)	(0.0028)	(0.0008)
Hispanic or Latinx	0.383***	−0.067***	0.088***
	(0.0021)	(0.0029)	(0.0008)
Other race or ethnicity	0.064***	0.167***	0.030***
	(0.0020)	(0.0028)	(0.0008)
Number of children	−0.028***	0.009***	0.003***
	(0.0014)	(0.0019)	(0.0005)
Own	−0.135***	−0.009***	0.018***
	(0.0017)	(0.0023)	(0.0007)

(*continued*)

Table A1. Continued.

Panel C: Air pollution

	Nitrogen dioxide	PM_{10}	$PM_{2.5}$
Married	−0.085***	−0.011***	−0.008***
	(0.0014)	(0.0020)	(0.0006)
Age (reference = Less than 30)			
30–39	0.017***	0.044***	0.011***
	(0.0028)	(0.0038)	(0.0011)
40–49	0.042***	0.017***	0.004***
	(0.0028)	(0.0038)	(0.0011)
50–59	0.043***	0.003	−0.005***
	(0.0029)	(0.0040)	(0.0012)
60+	−0.001	−0.011**	−0.024***
	(0.0031)	(0.0043)	(0.0012)
Distance from Center (km)			
	−0.188***	0.613***	−0.0364***
2000 neighborhood controls	(0.0091)	(0.0124)	(0.0036)
Moved	−1.682***	−2.041***	−0.872***
	(0.0077)	(0.0105)	(0.0031)
College degree	1.808***	0.867***	0.837***
	(0.0116)	(0.0158)	(0.0046)
Poverty	0.033***	−0.009***	0.006***
	(0.0002)	(0.0003)	(0.0001)
Median income ($1000s)	−0.0004***	0.0010***	0.0001***
	(0.000009)	(0.00001)	(0.000004)
Median rent	−0.001***	0.001***	−0.0001***
	(0.00001)	(0.00001)	(0.000003)
Median house value ($1000s)	0.057***	0.486***	0.024***
	(0.0036)	(0.0050)	(0.0014)
White non-Hispanic	1.975***	0.408***	−0.084***
	(0.0145)	(0.0197)	(0.0057)
Vacant	−1.936***	1.144***	0.399***
	(0.0065)	(0.0088)	(0.0026)
Own	−0.099***	−0.032***	−0.022***
	(0.00007)	(0.00009)	(0.00002)
Constant	17.93***	22.77***	12.05***
	(0.0091)	(0.0124)	(0.0036)
N	10,777,539	10,777,539	10,777,539
R^2	0.67	0.41	0.81
Metropolitan Statistical Area fixed effects	Yes	Yes	Yes
Standard errors clustered at tract level	Yes	Yes	Yes

Panel D: walkability index

	National Walkability Index
Gentrifying tract (reference = Gentrifiable not gentrifying)	1.330***
	(0.0136)
Period (reference = 2006)	−1.522***
	(0.0141)
Gentrifying tract*Period	−1.895***
	(0.0235)
Moved during period	−0.681***
	(0.0179)
Length of residence as of 2006	−0.002***
	(0.0005)
Race/ethnicity (reference = White non-Hispanic)	
Black or African American	−0.522***
	(0.0123)
Hispanic or Latinx	0.783***
	(0.0125)
Other race or ethnicity	0.878***
	(0.0121)
Number of children	−0.013
	(0.0082)
Own	−0.340***
	(0.0102)

(*continued*)

Table A1. Continued.

Panel D: walkability index

	National Walkability Index
Married	−0.528***
	(0.0086)
Age (reference = Less than 30)	
30–39	0.613***
	(0.0165)
40–49	0.883***
	(0.0165)
50–59	0.969***
	(0.0173)
60+	0.807***
	(0.0187)
Distance from Center (km)	
	4.820***
2000 neighborhood controls	(0.0539)
Moved	5.548***
	(0.0459)
College degree	3.697***
	(0.0688)
Poverty	0.043***
	(0.0012)
Median income ($1000s)	−0.002***
	(0.0001)
Median rent	−0.001***
	(0.0001)
Median house value ($1000s)	2.519***
	(0.0216)
White non-Hispanic	22.01***
	(0.0857)
Vacant	−3.127***
	(0.0384)
Own	−0.382***
	(0.0004)
Constant	65.23***
	(0.0543)
N	10,779,187
R^2	0.27
Metropolitan Statistical Area fixed effects	Yes
Standard errors clustered at tract level	Yes

Table A2. Different definition of gentrifiable and gentrification.

	Medically underserved area	ADI national rank	ADI state rank	Nitrogen dioxide	PM_{10}	$PM_{2.5}$	National Walkability Index
Panel A: 2006–2010 ACS to 2015–2019 ACS							
Gentrifying tract*Period	0.012***	2.144***	2.704***	−0.454***	−0.747***	−0.045***	−1.047***
	(0.0003)	(0.0181)	(0.0226)	(0.00243)	(0.00337)	(0.0010)	(0.0030)
N	12,188,731	12,057,266	12,057,266	12,187,223	12,187,223	12,187,223	12,188,523
R^2 or pseudo R^2	0.06	0.26	0.28	0.67	0.38	0.80	0.18
Panel B: Relative income based on center city median income instead of MSA median income							
Gentrifying tract*Period	0.008***	3.09***	3.770***	−0.794***	−1.181***	−0.247***	−1.017***
	(0.0004)	(0.0259)	(0.0325)	(0.0035)	(0.0051)	(0.0014)	(0.0042)
N	6,222,892	6,129,766	6,129,766	6,221,412	6,221,412	6,221,412	6,222,667
R^2 or pseudo R^2	0.06	0.30	0.31	0.68	0.44	0.79	0.23
Panel C: Relative income based on 60% of MSA median income instead of 80%							
Gentrifying tract*Period	0.013***	2.589***	3.215***	−0.704***	−1.322***	−0.164***	−1.077***
	(0.0005)	(0.0316)	(0.0398)	(0.0042)	(0.0057)	(0.0016)	(0.0048)
N	4,482,304	4,400,776	4,400,776	4,481,125	4,481,125	4,481,125	4,482,174
R^2 or pseudo R^2	0.06	0.26	0.26	0.69	0.46	0.83	0.27
Panel D: Gentrification based on growth in education, income, or rent in the top 25th percentile instead of above the median							
Gentrifying tract*Period	0.032***	3.039***	3.843***	−0.800***	−1.030***	−0.204***	−1.225***
	(0.0003)	(0.0198)	(0.0248)	(0.0027)	(0.0037)	(0.0011)	(0.0032)
N	10,369,162	10,252,444	10,252,444	10,367,232	10,367,232	10,367,232	10,368,763
R^2 or pseudo R^2	0.05	0.29	0.30	0.67	0.40	0.81	0.24

Note. All results are for specifications including individual and neighborhood controls, MSA fixed effects, and standard errors clustered at the tract level.