HHS Public Access
Author manuscript
Soc Sci Med. Author manuscript; available in PMC 2024 June 18.

Published in final edited form as:
Soc Sci Med. 2023 November ; 336: 116222. doi:10.1016/j.socscimed.2023.116222.

Association of census-tract level gentrification and income inequality with 6-year incidence of metabolic syndrome in the Hispanic Community Health Study/Study of Latinos, an epidemiologic cohort study☆

Catherine M. Pichardo[a,b,*], **Earle C. Chambers**[c], **Lisa A.P. Sanchez-Johnsen**[b,d], **Margaret S. Pichardo**[e], **Linda Gallo**[f], **Gregory A. Talavera**[f], **Amber Pirzada**[g], **Amanda Roy**[b], **Sheila F. Castañeda**[f], **Ramon A. Durazo-Arvizu**[h], **Krista M. Perreira**[i], **Yanping Teng**[j], **Carmen B. Rodriguez**[k], **Matthew Allison**[l], **Jordan A. Carlson**[m], **Martha L. Daviglus**[g], **Jesse J. Plascak**[n]

[a]National Cancer Institute, National Institute of Health, 9609 Medical Center Drive, Rockville, MD 20815, USA

[b]University of Illinois at Chicago, Department of Psychology, 1007 W Harrison St, Chicago, IL, 60607, USA

[c]Albert Einstein College of Medicine, 1300 Morris Park Ave, The Bronx, NY, 1046, USA

[d]Medical College of Wisconsin (MCW), Institute for Health and Equity, Department of Psychiatry and Behavioral Medicine, and MCW Cancer Center, 8701 Watertown Plank Rd., Milwaukee, WI 53226, USA

[e]Hospital of the University of Pennsylvania, Department of Surgery, 3400 Spruce St # 4, Philadelphia, PA, 19104, USA

☆Catherine Pichardo conducted this work while at the University of Illinois at Chicago. The participation of this individual or the materials should not be interpreted as representing the official viewpoint of the U.S. Department of Health and Human Services, the National Institutes of Health, or the National Cancer Institute, except where noted.

*Corresponding author. catherine.pichardo@nih.gov (C.M. Pichardo).

CRediT author statement
Conceptualization: C.M.P., J.J.P; A.P.; E.C.C; L.C.G; G.A.T.; L.A.P.S.J; S.F.C; Methodology: C.M.P., J.J.P; A.P.; L.C.G; R.A.D; Coding: C.M.P., J.J.P.; C.R., M.S.P; Formal Analysis: C.M.P. J.J.P; Resources: J.J.P; L.C. G; G.A.T; Writing: Original Draft Preparation: C.M.P; Writing – Review & Editing: Writing – Review & Editing: C.M.P., J.J.P; A.P.; E.C.C; L.G.; G. A.T.; L.A.P.S. J; S.F.C. R.A.D.; M.S.P; A.L.R; J.C; M.A.; K.M.P; C.B.R; M.D; Supervision: A.R.; L.A.P.S.J; J.J.P.; G.A.T.; L.C.G.
The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Transparency statement
The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no important aspects of the study have been omitted; and any discrepancies from the study as originally planned have been explained.

Declaration of competing interest
Regarding support for the submitted work, Linda Gallo reported receiving support from the National Heart Lung and Blood Institute and National Institute of Diabetes and Digestive and Kidney Diseases; Krista Perreira from the National Heart Lung and Blood Institute and Amber Pirzada and Martha Daviglus from the National Institute of Health. In the previous three years regarding grants and contracts, Earle Chambers reported receiving support from the National Institute of Diabetes and Digestive and Kidney Diseases; Jordan Carlson from the National Institutes of Health, Centers for Disease Control and Prevention, Environmental Protection Agency, Enid and Crosby Kemper Foundation, Claire Giannini Fund, United States Department of Health and Human Services, Office of Minority Health, and Office of Women's Health, Jackson County, MO Health Dept, and the Cincinnati Children's Hospital; Jesse J. Plascak from the National Institute of Health; and Krista Perreira received consulting fees from the Urban Institute.

[f]San Diego State University, Department of Psychology, 5500 Campanile Drive; San Diego, CA, 92182-4611, USA

[g]University of Illinois at Chicago, Institute for Minority Health Research, College of Medicine West (MC 764) 1819 West Polk Street, Suite 246, Chicago, IL, 60612, USA

[h]Children's Hospital Los Angeles, Los Angeles, 4650 Sunset Blvd, Los Angeles, CA, 90027, USA

[i]University of North Carolina at Chapel Hill School of Medicine, 321 S Columbia St, Chapel Hill, NC, 27599, USA

[j]University of North Carolina at Chapel Hill Gillings School of Global Public Health, 123 W. Franklin Street, Suite 450 CB #8030 Chapel Hill, NC, 27516, USA

[k]Harvard T.H. Chan School of Public Health, 677 Huntington Ave, Boston, MA, 02115, USA

[l]University of California San Diego, School of Health Sciences, 9500 Gilman Drive, La Jolla, CA, 92093, USA

[m]Children's Mercy Kansas City Hospital, 2401 Gillham Rd, Kansas City, MO, 64108, USA

[n]Ohio State University Comprehensive Cancer Center, Starling-Loving Hall, 320 W 10th Ave b302, Columbus, OH, 43210, USA

Abstract

Background: Metabolic syndrome varies by socio-demographic characteristics, with younger (18–29 years) and older (50–69 years) Hispanic/Latino having higher prevalence compared to other groups. While there is substantial research on neighborhood influences on cardiometabolic health, there are mixed findings regarding the effects of gentrification and few studies have included Hispanic/Latinos. The role of neighborhood income inequality on metabolic health remains poorly understood.

Objectives: Examined associations of neighborhood gentrification and income inequality with metabolic syndrome (MetSyn) using data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL).

Design, Setting and Participants: The HCHS/SOL is a community-based cohort of adults of Hispanic/Latinos (aged 18–74). Analyses included 6710 adults who did not meet criteria for MetsS at baseline (2008–2011) and completed the visit 2 examination (2014–2017). Poisson regressions estimated odds ratios (IRR) and 95% confidence intervals (CI) for neighborhood gentrification and change in income inequality with MetSyn incidence.

Main outcome and exposure measures: Gentrification was measured with an index that included changes (2000 to 2006–2010) in education, poverty, and income. Change in neighborhood income inequality (2005–2009 to 2012–2016) was measured using the Gini coefficient of income distribution. MetSyn was defined using National Cholesterol Education Program Adult Treatment Panel III criteria.

Results: Among 6647 Hispanic/Latino adults, 23% (N = 1530) had incident MetSyn. In models adjusted for sociodemographic, health insurance status, and neighborhood characteristics, gentrification (IRR, 1.00, 95%CI, 0.96–1.03) and income inequality change (IRR, 1.00, 95%CI, 0.99–1.00) were not associated with MetSyn at visit 2. There was no association between cross-sectional income inequality (2005–2009) and MetSyn at visit 2 (IRR, 0.97, 95%CI, 0.82–1.15).

Conclusion: Neighborhood gentrification and income inequality change were not associated with incidence of MetSyn over 6 years among Hispanic/Latino adults. This study demonstrated that income-based residential changes alone may not be sufficient to explain neighborhood influences on health outcomes among this population.

Keywords

Neighborhood gentrification; Income inequality; Metabolic syndrome; Hispanic/Latino

1. Introduction

Metabolic syndrome varies by socio-demographic characteristics, with younger (18–29 years), older (50–69 years; >70 women) Hispanic/Latino having higher prevalence of compared to other groups. Metabolic syndrome (MetSyn) is defined as the presence of at least three cardiometabolic risk factors (larger waist circumference, hypertriglyceridemia, low high-density lipoprotein cholesterol, hypertension, and hyperglycemia) (Alberti et al., 2009). MetSyn is associated with deleterious health outcomes, including obesity-related cancers, cardiovascular function and disease, diabetes mellitus, and all-cause mortality (Braun et al., 2011; O'Neill and O'Driscoll, 2015; Tune et al., 2017; Ford et al., 2008; Ford, 2005), which exerts a significant financial burden in the U.S. (Virani et al., 2020; Mariotto et al., 2020; Khushalani et al., 2022) Data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) showed a MetSyn prevalence of 35% in 2008–2011 (Heiss et al., 2014), which varied by Hispanic/Latino heritage and was highest in persons of Puerto Rican heritage (37%) (Heiss et al., 2014).

Substantial research in predominantly African American and White adult cohorts has linked neighborhood characteristics (e.g., neighborhood socioeconomic characteristics, built/physical environment features, air pollution, racial and ethnic diversity, and perceptions of neighborhood conditions) with higher MetSyn prevalence (Chichlowska et al., 2008; Diez Roux et al., 2002; Keita et al., 2014; Li et al., 2019) and adverse metabolic profiles (Keita et al., 2014). To date, most ecological studies have focused on static neighborhood conditions, yet neighborhoods are complex and dynamic, undergoing change in socioeconomic composition, physical attributes, and resources over time (Drewnowski et al., 2020; Schnake-Mahl et al., 2020; Yen et al., 2009). Gentrification-the dynamic process by which a neighborhood's demographic social, and cultural characteristics change is different from other forms of neighborhood renewal (e.g., redevelopment), because gentrification entails rising rents, property values and amenities (Schnake-Mahl et al., 2020), and ultimately destabilizes long-standing communities. Many metropolitan cities in the U.S. are experiencing rapid gentrification (DeVerteuil, 2018; Hwang, 2015). For example, in 2010, approximately half of U.S. cities experienced some level of gentrification (Ding et al., 2016), with immigrant and racially and ethnically heterogeneous communities experiencing higher risk for gentrification compared to non-immigrant and racially and ethnically homogenous areas (DeVerteuil, 2018; Hwang, 2015).

Situated within a critical race theory perspective, which centers racism as the core functioning of America, gentrification processes align with the place-based stratification model, as they are predicated on racism (Valdes et al., 2002; Delgado and Stefancic, 2017; Ford and Airhihenbuwa, 2010; Lees et al., 2008). The segregation of communities and disadvantaged neighborhood conditions occurring from disinvestment create pathways for gentrification to occur through declines in property value and subsequent unequitable neighborhood development and investment (Chapple, 2016). While empirical evidence is mixed about whether gentrification directly displaces long-standing residents (Ding et al., 2016), researchers theorize that gentrification processes that result from urban-renewal re-cluster people of color into similar adjacent neighborhoods, in turn, heighten re-segregation and racial-class conflicts that include competition for scarce resources (Smith, 1996; Betancur, 2002; Wyly and Hammel, 2004). Contextual factors operating to produce gentrification (and exogenous of gentrification) may produce divergent processes and outcomes that are dependent on the racial/ethnic composition of the neighborhoods. Neighborhood contexts are driven by underlying political, social, and economic conditions that produce racial and ethnic segregation across communities of color, particularly Hispanic/Latinos (Schnake-Mahl et al., 2020).

Gentrification is linked to health outcomes through multiple pathways that result from changes to the physical/built and social environment (Bhavsar et al., 2020). Of particular relevance to this study, we draw from Bhavsar and colleagues' (2020) conceptual model of gentrification and health (Bhavsar et al., 2020). This model focuses on ways in which changes to the physical/built and social environment influence health through biological responses, changes in health behaviors and/or changes in healthcare utilization. Gentrification may produce long term poor mental and physical health outcomes by limiting access to affordable housing and healthy foods, altering social networks, feelings of safety, and community cohesion and increasing potential experiences with interpersonal racial and ethnic discrimination (Newman and Holupka, 2014; Mehdipanah et al., 2018; Kirkland, 2008). Scholars link gentrification with declines in social capital, defined as "*collective value of all social networks and the inclinations that arise from these networks to do things for each other (norms of reciprocity)*" (Bhavsar et al., 2020). Declines in social capital within gentrifying neighborhoods are related to decreases in neighborhood trust, social cohesion, and/or social networks (Betancur, 2011; Versey, 2018; Versey et al., 2019; Burns et al., 2012; Lyons et al., 2017) and higher risk of interpersonal racial and ethnic discrimination. The negative effects of co-ethnic density on cardiometabolic health may be related to the detrimental effects of racial-turnover resulting from gentrification (Li et al., 2017a). Additionally, intrinsically linked to changes in social capital are loss of place attachment, decreased residential security and helplessness from forced removal, which in turn lead to chronic psychosocial stress and adverse mental and physical health outcomes (Bhavsar et al., 2020; Newman and Holupka, 2014; Mehdipanah et al., 2018). On the other hand, changes to the physical environment include limited or increased access to affordable healthy food, green space, quality housing and changes in exposure to environmental pollutants (Bhavsar et al., 2020). Although gentrification may promote healthy lifestyles by increasing access to community resources such as parks and recreational areas (Schnake-Mahl et al., 2020; Mullenbach and Baker, 2020; Byrne, 2002), studies have shown that within gentrifying neighborhoods, increased green space exposure is primarily beneficial to affluent residents (Cole et al., 2019).

Recent systematic reviews have reported mixed findings regarding the association of gentrification with various health outcomes such as self-reported health, hypertension, and mortality among diverse racial and ethnic residents (Schnake-Mahl et al., 2020; Bhavsar et al., 2020; Mehdipanah et al., 2018; Smith and Thorpe, 2020; Tulier et al., 2019). Additionally, the effects of gentrification on health may differ for “gentrifiers” who usually tend to self-identify as white and have higher incomes compared to long-time residents (Kirkland, 2008; Tulier et al., 2019). Furthermore, gentrification-related processes may exacerbate economic inequality and polarization (Chapple, 2016; Christafore and Leguizamon, 2019). Christafore and Leguizamon et al. found that income inequality was higher within neighborhoods experiencing gentrification (Christafore and Leguizamon, 2019). Rising income inequality has been associated with a plethora of negative health outcomes and health disparities (e.g., survival gaps, obesity, heart disease, lung-cancer, lifestyle behaviors) (Pickett and Wilkinson, 2015; Bor et al., 2017). To date, most studies have been cross-sectional or were conducted at larger geographic levels (i.e., counties, cities) and few have captured the cardiometabolic health effects of changes in income inequality (Pickett and Wilkinson, 2015). To our knowledge, the association between neighborhood change processes (i.e., gentrification, change in income inequality) and objective measures of cardiometabolic health among diverse U.S. Hispanic/Latino populations remains unknown. Scholars have called for research that examines not only whether neighborhood processes are protective or detrimental to health, but also for whom (Viruell-Fuentes et al., 2012), and studies that consider the intersections of neighborhood change processes with class and age (Hochstenbach et al., 2018) (Xiao et al., 2018). Previous research suggests that associations between measures of neighborhood change and MetSyn might vary by age, acculturation, socio-economic status and heritage (Versey, 2018; Versey et al., 2019; Smith et al., 2017; Burns et al., 2012; Hochstenbach et al., 2018; Golant, 2008; Ahn et al., 2020; Bekteshi and Kang, 2020; Barry and Miller, 2005; Portes and Rumbaut, 2001; Portes and Truelove, 1987; Portes and Zhou, 1993; Betancur, 1996; Sangalang et al., 2019; Lee and Ferraro, 2007).

To address the aforementioned gaps in the literature, the current study examined the independent associations of neighborhood gentrification and income inequality with 6-year incidence of MetSyn in a large and diverse cohort of Hispanic/Latino adults. Effect modification of these associations (if any) by Hispanic/Latino heritage, acculturation, and select demographics was also explored. Difference across Hispanic/Latinos are likely due to diverse experience with racial/ethnic discrimination, acculturative stress, and availability of social capital and health resources (Barry and Miller, 2005; Portes and Rumbaut, 2001; Portes and Truelove, 1987; Portes and Zhou, 1993; Betancur, 1996).

2. Methods

2.1. The Hispanic Community Health Study/Study of Latinos sample (HCHS/SOL)

The HCHS/SOL is an ongoing prospective, community-based cohort study that aims to characterize the prevalence and incidence of cardiovascular disease burden among U.S.

Hispanic/Latino adults and describes protective and risk factors over time (Sorlie et al., 2010). A total of 16,415 non-institutionalized Hispanic/Latino adults (aged 18–74 at baseline) were enrolled at baseline (Visit 1; 2008–2011) and 11,623 adults attended a follow-up visit approximately six years later (Visit 2; 2014–2017). Details of the sampling design and cohort selection have been published elsewhere (Sorlie et al., 2010) (Lavange et al., 2010). Participants self-identified as Cuban (n = 2,348), Puerto Rican (n = 2728), Dominican (n = 1,473), Mexican (n = 6,472), Central American, (n = 1,732), and South American (n = 1,702). The study protocol was approved by each site's Institutional Review Board and all participants provided written consent. The research was conducted in accordance with the ethical principles of the Declaration of Helsinki. Participants with missing home addresses (n = 316) and those residing outside of San Diego County, The Bronx County, Miami Dade County and Chicago City (n = 70) were excluded from the analytic sample. From participants that attended the baseline visit 16,029 had geocoded addresses and resided within Miami Dade County, San Diego County, Bronx Counties and Chicago City. Out of these, 11,370 participants participated in the 2014–2017 follow-up visit and 6857 did not meet criteria for MetSyn at baseline, among those whose MetSyn status could be determined. Among participants with the aforementioned inclusion criteria only participants with complete data for individual-level variables were included in analytic sample (n = 6,647).

2.2. Data collection and measures

Details on data collection processes and instruments have been previously published (Sorlie et al., 2010). Briefly, at both baseline (visit 1) and visit 2, HCHS/SOL participants completed fasting clinical exams and surveys of demographics, health factors and medication use. Anthropometric measures included objectively measured height, weight, and waist and hip circumference. Oscillometric automated sphygmomanometer was used to average three seated systolic and diastolic blood pressure measurements after a 5-min rest in the seating position; the average of the three measures was used.

2.3. Neighborhood exposures

Baseline home addresses for participants were geocoded and linked to 2010 U.S. Census Tract-level neighborhood indicators from the National Neighborhood Change Database produced by Geolytics (Geolytics. Neighborhood change database, 2014) and IPUMS National Historical Geographic Information System (Manson et al., 2019). The National Neighborhood Change Database adjusts for tract boundary changes between decennial censuses.

An index of *gentrification* was constructed based on the approach by Huynh and Maroko (2014) and Linton et al. (2017) (Huynh and Maroko, 2014; Linton et al., 2017). This measure comprises a sum of z scores of changes in the percent of resident adults aged 25+ with college or more education, the number of residents living below the federal poverty line, and median household income (MHI). This exposure was calculated using data from the U.S. 2000 decennial census and the 5-year 2006-10 American Community Survey (ACS) (Geolytics. Neighborhood change database, 2014). Higher values represent greater gentrification marked by an increase in the area-level population of residents with a college education, median household income, and decreasing poverty.

A Gini coefficient of income distribution was drawn from the IPUMS National Historical Geographic Information System based on the ACS 2005-09 and the ACS 2012–16 (Manson et al., 2019). Shrider et al. provide a description of this measure (Shrider et al., 2021). The Gini coefficient of income distribution reflects how similar household income is across households within the census tract. It can range from 0 (prefect equality) to 10 (perfect inequality) (Iceland et al., 2002). A percent change in neighborhood *income inequality* was calculated as fallows: $[(GINI_{2012\text{-}16} - GINI_{2005\text{-}09})/GINI_{2005\text{-}09})]*100$. Negative value for the income inequality change scores indicate an improvement in income inequality, zero no change, and positive values a worsening in income inequality. Based on prior studies, a cross-sectional measure of neighborhood income inequality was also examined (Cubbin et al., 2020).

2.4. Metabolic syndrome outcome

MetSyn was operationalized according to criteria established by The National Cholesterol Education Program (NCEP) Adult Treatment Panel-III (ATP-III), which include presence of at least three of the following: (1) a waist circumference (WC) ≥102 cm for males or ≥88 cm for females; (2) systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥85 mmhg, and/or report of current hypertensive medication use; (3) HDL cholesterol <50 mg/dl for females or <40 mg/dl for males; (4) serum triglyceride levels ≥150 mg/dl; (5) fasting blood glucose concentrations ≥100 mg/dl, and/or report of antidiabetic medication use (Alberti et al., 2009; Grundy et al., 2004). At baseline, the criteria for MetSyn included both objective and self-report medication use; while at visit 2, only self-report of medications was used. Incident cases were defined as participants who did not meet criteria for MetSyn at baseline but met criteria when assessed at visit 2.

2.5. Covariates

The following participant characteristics, measured at baseline, were selected as covariates due to their influence on metabolic health, sex (female, male) (Heiss et al., 2014), Hispanic/Latino heritage (Mexican, Cuban, Dominican, Puerto Rican, more than one or other heritage) (Heiss et al., 2014), socio-economic status (employment status (any employment, none), education (≤high school diploma, >high school diploma), income (less than $10,000; $10,001-$20,000; $20,001-$40, 000; $40,001-$75,000)) (McCurley et al., 2017) and marital status [(partnered/married/living as married/living with a partner), other (single, separated, divorced, or widowed)] (Troxel et al., 2005) (Hosseinpour-Niazi et al., 2014), age at baseline (continuous) (Heiss et al., 2014) and acculturation related variables (i.e., place of birth combined with years in the U.S. [U.S. born (50 states), foreign or U.S. territory born and >10 years residing in the U.S., and foreign/territory born and <10 years residing in the U.S.], interview language preference [English, Spanish]) (Liu et al., 2021). We also controlled for health insurance (uninsured, public, private) as a proxy for access to preventive services (Velasco-Mondragon et al., 2016; Lines et al., 2014; Vargas Bustamante et al., 2010). Due to the contextual nature of gentrification (Schnake-Mahl et al., 2020) we controlled for study site.

Neighborhood level percent foreign-born residents (Li et al., 2017b) and neighborhood deprivation (Gallo et al., 2022) have been previously linked to metabolic health and included as confounders calculated using data from the 5-year ACS 2006–2010 census tracts. The neighborhood deprivation index was constructed to measure census tract-level socioeconomic deprivation concentration according to Messer et al. (2006). Principal components analysis was used to extract a single factor representing the shared variance from the following variables: percent of residents with less than a high school diploma, percent of residents with household incomes below 100% of the federal poverty level, percent of residents who are unemployed, and median household income. Greater values on the neighborhood deprivation index indicate higher neighborhood deprivation.

2.6. Statistical analysis

Preliminary analysis examined missing data among participants that did not have MetSyn at baseline (n = 6,857, incidence sample). Rates of missing data for individual level variables indicating an acceptable level of missingness (i.e., <5%). Only complete cases for individual-level variables were included, yielding an analytical sample of 6,647.

F-tests and χ^2-tests for continuous and categorical variables, respectively, were used to examine covariate differences by MetSyn status. The associations between neighborhood measures (i.e., neighborhood gentrification and income inequality change) and MetSyn were examined using Poisson regression models to calculate Incident Rate Ratios (IRR) and 95% confidence intervals (CI). Three separate models were examined for each exposure. The first model adjusted for individual-level covariates. The second model of gentrification further adjusted for neighborhood immigrant composition (deprivation was not included given the overlap in variables comprising the constructs). In the second model of neighborhood income inequality, we additionally adjusted for neighborhood immigrant composition and neighborhood deprivation index. Finally, in fully adjusted models, we conducted exploratory analysis to examine potential effect modifiers of our primary associations by sex, age (18–44 years of age, >45 years of age), education (≤high school diploma, >high school diploma), acculturation proxies [language preference (Spanish, English), nativity (U.S. born (50 states/DC), foreign or U.S. territory born and >10 years residing in the U.S., and foreign/territory born and <10 years residing in the U.S.), and heritage (Mexican, Cuban, Dominican, Puerto Rican, more than or other heritage)]. We conducted all analyses using STATA 16.1 (StataCorp, 2019), accounting for complex survey sampling design (stratification, clustering, and sampling weights) and follow-up attrition (Lavange et al., 2010). Significance for primary aims was $p < 0.05$. Exploratory analyses used a Bonferroni corrected alpha level for statistical significance.

3. Results

3.1. Descriptive statistics

Table 1 provides descriptive weighted means ± standard errors (SE) for individual characteristics. Overall, 23% (n = 1530) of individuals developed MetSyn by visit 2. Relative to Hispanic/Latino adults without MetSyn, adults who developed MetSyn were more likely to be older (42.72 ± 0.58 vs. 36.38 ± 0.29 years, $p < 0.001$), have ≤ high school education (64% vs. 57%, p=<0.001), preferred Spanish as their interview language (80% vs. 71%, p < 0.001), report and an income of $20,001-$40,000 (33% vs. 31%, p = 0.003) and were foreign/U.S. territory born and residing in the U.S. ≥ 10 years (52% vs 43%, p < 0.001). No differences by MetSyn were observed for sex (p = 0.866), employment status (p = 0.222), Hispanic/Latino heritage (p = 0.870), marital status (p = 0.608), and health insurance status (p = 0.270).

Table 2 provides descriptive weighted means ± standard errors (SE) for neighborhood characteristics. Differences in gentrification were observed by metabolic syndrome status only in Chicago. Relative to Hispanic/Latino adults without MetSyn, adults who developed MetSyn were more likely to have lower levels of gentrification (−0.47 ± 0.25 vs. −0.86 ± 0.30, p = 0.008). In stratified analysis by study site, no differences for income inequality change and cross-sectional income inequality were observed by MetSyn status (see Table 3).

3.2. Associations of neighborhood measures with metabolic syndrome

In independent multivariate models, gentrification (IRR, 1.00, 95% CI, 0.96–1.03) and income inequality change (IRR, 1.00, 95% CI, 0.99–1.00) were not associated with MetSyn at visit 2 (Table 2). There was no association between cross-sectional income inequality (2005–2009) and MetSyn at visit 2 (IRR, 0.97, 95% CI, 0.82–1.15).

3.3. Effect modification

In fully adjusted models, no effect modification on the association between gentrification, income inequality change, and cross-sectional income inequality with incident MetSyn was found by place of birth combined with years in the U.S (gentrification $p = 0.901$; income inequality change $p = 0.573$; cross-sectional income inequality $p = 0.086$); language preference (gentrification $p = 0.983$; income inequality change $p = 0.286$; cross-sectional income inequality $p = 0.668$); Hispanic/Latino heritage (gentrification $p = 0.273$; income inequality change $p = 0.935$; cross-sectional income inequality $p = 0.378$); age (gentrification $p = 0.270$; income inequality change $p = 0.665$; cross-sectional income inequality p=0.727); sex (gentrification $p = 0.138$; income inequality change $p = 0.017$; cross-sectional income inequality $p = 0.392$); education (gentrification $p = 0.052$; income inequality change p=0.329; cross-sectional income inequality $p = 0.718$); or study site (gentrification $p = 0.066$; income inequality change $p = 0.722$; cross-sectional income inequality p=0.686).

4. Discussion

In the current study, gentrification and income inequality change were not associated with odds of incident MetSyn across six years, and no evidence of effect modification with individual level characteristics were found. We are the first to quantify the relationship between gentrification and an objective measure of health – incident MetSyn – among Hispanic/Latino adults. Our findings align with prior evidence that gentrification may not be associated with self-rated health among Hispanic/Latino adults (Gibbons and Barton, 2016) (Izenberg et al., 2018).

One plausible explanation for non-significant associations between the neighborhood gentrification index and metabolic health may be divergent characteristics of gentrification with varying health effects, masked by an overall index of gentrification. For example, gentrification can co-occur with positive changes driven by poverty de-concentration (Schnake-Mahl et al., 2020), and consequently neighborhood beautification, decreased crime rates, and increased health resources (Byrne, 2002). On the other hand, other characteristics of gentrification, such as displacement, decreased social networks, increased racial and ethnic interpersonal discrimination associated with racial turnover, decreased access to affordable quality housing, social capital, over-policing, and ethno-racial profiling among long-standing residents (Betancur, 2011) (Byrne, 2002) (Fullilove, 1996), may negatively influence health. Examining the relationship between characteristics of gentrification and health would inform and strengthen tailored neighborhood interventions within gentrifying neighborhoods. These specific processes of gentrification remain understudied. Lastly, the current study captured neighborhood economic trajectories with both absolute and relative measures. In line with prior work, findings show that both relative historical measures of economic context perform similarly compared to absolute measures in examinations of health effects of gentrification (Cubbin et al., 2020).

It is plausible that resiliency related processes within gentrifying Hispanic/Latino communities may be protecting from the theorized negative effects of gentrification. For example, over the past few decades, Puerto Rican and Mexican communities in Chicago have formed dense community fabrics, defenses, and diverse forms of resistance to confront multiple forms of gentrification (Betancur, 2011). In the short term, these may protect against negative health consequences. However, displacement and the depletion of energies and resources by anti-gentrification strategies and efforts may negatively impact the fabrics and well-being of Hispanic/Latino communities and health consequences may only evident over protracted time periods not captured in our study, an important area for future work (Betancur, 2011). It is important that policy makers foster diverse forms of resistance and resilience that Hispanic/Latino develop to defend, develop and uplift their communities, as well as protect direct political participation and engagement in anti-displacement efforts over the long term, as these are protective of the negative consequences of gentrification.

Among the strengths of our study are the use of probability sampling within pre-selected neighborhoods and one of the largest sample of diverse Hispanic/Latino adults, representative Hispanic/Latino residing in the cities of Miami, San Diego, Chicago and the Bronx compared to convenience samples (Lavange et al., 2010). Because this cohort study was specifically designed to understand disease processes among Hispanic/Latino adults, we were able to adjust for a wide range of covariates that are particularly important for Hispanic/Latino health outcomes. Although examining the exposures at baseline and MetSyn incidence in the second visit allowed us to make strong inferences, no causal inferences can be drawn for several reasons including the potential for bias from loss to follow-up, confounding, and selection bias. The cross-sectional nature of our geocodes limited our ability to capture gentrification across the life-course and disentangling effects related to duration of neighborhood residence. Specifically, the current study did not capture residential histories or residential mobility by visit 2. This study may have also been limited in power and variability in the level of gentrification to detect health effects given that the study included non-central urban cities (i.e., San Diego, Miami). Gentrification has been operationalized using several definitions and measures lack standardization (Williams, 2015). Findings may have been biased due to limitations of the Gini coefficient (Krieger et al., 2016). Within- and between-neighborhood variance was not examined since the HCHS/SOL sampling weights account for clustered sampling and stratification (Lavange et al., 2010). Additionally, there were very few participants in some census tracts and the number of participants varied widely by tract. Lastly, findings are representative of Hispanic/Latino adults residing in San Diego, Miami, The Bronx, and Chicago and generalizability of findings to populations residing in other states, rural areas, and other racial and ethnic groups is limited.

5. Conclusion

Neighborhood gentrification and income inequality change were not associated with incidence of MetSyn over 6 years among a diverse population of Hispanic/Latino adults. This study demonstrated that income-based residential changes alone may not be sufficient to explain neighborhood influences on health outcomes among this population.

Acknowledgements

The authors thank the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) participants, who generously contributed their time and provided the study data. The authors also thank the HCHS/SOL staff members for their dedication and expertise. A complete list of staff and investigators was published in the Annals of Epidemiology 2010; 20:642–649 and is also available on the study website (http://www.cscc.unc.edu/hchs).

Funding

This research was supported by NCI training grant: T32CA057699. The Hispanic Community Health Study/Study of Latinos is a collaborative study supported by contracts from the National Heart, Lung, and Blood Institute (NHLBI) to the University of North Carolina (HHSN268201300001I/N01-HC-65233), University of Miami (HHSN268201300004I/N01-HC-65234), Albert Einstein College of Medicine (HHSN268201300002I/N01-HC-65235), University of Illinois at Chicago (HHSN268201300003I/N01-HC-65236 Northwestern Univ), and San Diego State University (HHSN268201300005I/N01-HC-65237). The following Institutes/Centers/Offices have contributed to the HCHS/SOL through a transfer of funds to the NHLBI: National Institute on Minority Health and Health Disparities, National Institute on Deafness and Other Communication Disorders, National Institute of Dental and Craniofacial Research, National Institute of Diabetes and Digestive and Kidney Diseases, National Institute of Neurological Disorders and Stroke, NIH Institution-Office of Dietary Supplements.

Role of the funding source

The funder did not have any role in the design and execution of the analysis in this manuscript, data interpretation, manuscript writing, and nor in the decision to submit the paper for publication.

Data sharing statement

Data from HCHS/SOL can be accessed by submitting proposals for manuscripts through the HCHS/SOL website, http://www2.cscc.unc.edu/hchs/.

Data availability

Data will be made available on request.

References

Ahn M, Kwon HJ, Kang J, 2020. Supporting aging-in-place well: findings from a cluster analysis of the reasons for aging-in-place and perceptions of well-being. J. Appl. Gerontol 39 (1), 3–15. 10.1177/0733464817748779 [published Online First: 20171225]. [PubMed: 29277156]

Alberti KGMM, Eckel RH, Grundy SM, et al. , 2009. Harmonizing the metabolic syndrome. Circulation 120 (16), 1640–1645. 10.1161/CIRCULATIONAHA.109.192644. [PubMed: 19805654]

Barry RC, Miller PW, 2005. Do enclaves matter in immigrant adjustment? City Community 4 (1), 5–35. 10.1111/j.1535-6841.2005.00101.x.

Bekteshi V, Kang S-w, 2020. Contextualizing acculturative stress among Latino immigrants in the United States: a systematic review. Ethn. Health 25 (6), 897–914. 10.1080/13557858.2018.1469733. [PubMed: 29792072]

Betancur JJ, 1996. The settlement experience of Latinos in Chicago: segregation, speculation, and the ecology model. Soc. Forces 74 (4), 1299–1324. 10.1093/sf/74.4.1299.

Betancur JJ, 2002. The politics of gentrification: the case of west town in Chicago. Urban Aff. Rev 37 (6), 780–814. 10.1177/107874037006002.

Betancur J., 2011. Gentrification and community fabric in Chicago. Urban Stud. 48 (2), 383–406. 10.1177/0042098009360680 [published Online First: 2011/02/01]. [PubMed: 21275200]

Bhavsar NA, Kumar M, Richman L, 2020. Defining gentrification for epidemiologic research: a systematic review. PLoS One 15 (5), e0233361. 10.1371/journal.pone.0233361 [published Online First: 2020/05/22]. [PubMed: 32437388]

Bor J, Cohen GH, Galea S, 2017. Population health in an era of rising income inequality: USA, 1980–2015. Lancet 389 (10077), 1475–1490. 10.1016/S0140-6736(17)30571-8. [PubMed: 28402829]

Braun S, Bitton-Worms K, LeRoith D, 2011. The link between the metabolic syndrome and cancer. Int. J. Biol. Sci 7 (7), 1003–1015. 10.7150/ijbs.7.1003 [published Online First: 2011/08/16]. [PubMed: 21912508]

Burns VF, Lavoie JP, Rose D, 2012. Revisiting the role of neighbourhood change in social exclusion and inclusion of older people. J Aging Res 2012, 148287. 10.1155/2012/148287 [published Online First: 2011/10/21]. [PubMed: 22013528]

Byrne JP, 2002. Two cheers for gentrification. Howard Law J. 46 (3), 405–432.

Chapple K., 2016. Income inequality and urban displacement: the new gentrification. New Labor Forum 26 (1), 84–93. 10.1177/1095796016682018.

Chichlowska KL, Rose KM, Diez-Roux AV, et al. , 2008. Individual and neighborhood socioeconomic status characteristics and prevalence of metabolic syndrome: the Atherosclerosis Risk in Communities (ARIC) Study. Psychosom. Med 70 (9), 986–992. 10.1097/PSY.0b013e318183a491 [published Online First: 2008/09/19]. [PubMed: 18799428]

Christafore D, Leguizamon S, 2019. Neighbourhood inequality spillover effects of gentrification. Pap. Reg. Sci 98 (3), 1469–1484. 10.1111/pirs.12405.

Cole HVS, Triguero-Mas M, Connolly JJT, et al. , 2019. Determining the health benefits of green space: does gentrification matter? Health Place 57, 1–11. 10.1016/j.healthplace.2019.02.001. [PubMed: 30844594]

Cubbin C, Kim Y, Vohra-Gupta S, et al. , 2020. Longitudinal measures of neighborhood poverty and income inequality are associated with adverse birth outcomes in Texas. Soc. Sci. Med 245, 112665 10.1016/j.socscimed.2019.112665. [PubMed: 31778899]

Delgado R, Stefancic J, 2017. Critical Race Theory: an Introduction, third ed. ed. New York University Press, New York, NY.

DeVerteuil G., 2018. Immigration and Gentrification. Handbook of Gentrification Studies. Edward Elgar Publishing, Cheltenham, UK, pp. 428–443.

Diez Roux AV, Jacobs DR, Kiefe CI, 2002. Neighborhood characteristics and components of the insulin resistance syndrome in young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) study. Diabetes Care 25 (11), 1976–1982. 10.2337/diacare.25.11.1976 [published Online First: 2002/10/29]. [PubMed: 12401742]

Ding L, Hwang J, Divringi E, 2016. Gentrification and residential mobility in Philadelphia. Reg. Sci. Urban Econ 61, 38–51. 10.1016/j.regsciurbeco.2016.09.004. [PubMed: 28579662]

Drewnowski A, Buszkiewicz J, Aggarwal A, et al. , 2020. Obesity and the built environment: a reappraisal. Obesity 28 (1), 22–30. 10.1002/oby.22672 [published Online First: 2019/11/28]. [PubMed: 31782242]

Ford ES, 2005. Risks for all-cause mortality, cardiovascular disease, and diabetes associated with the metabolic syndrome: a summary of the evidence. Diabetes Care 28 (7), 1769–1778. 10.2337/diacare.28.7.1769. [PubMed: 15983333]

Ford CL, Airhihenbuwa CO, 2010. Critical Race Theory, race equity, and public health: toward antiracism praxis. Suppl 1 Am. J. Publ. Health 100 (Suppl. 1), S30–S35. 10.2105/AJPH.2009.171058 [published Online First: 2010/02/10].

Ford ES, Li C, Sattar N, 2008. Metabolic syndrome and incident diabetes. Diabetes Care 31 (9), 1898. 10.2337/dc08-0423. [PubMed: 18591398]

Fullilove MT, 1996. Psychiatric implications of displacement: contributions from the psychology of place. Am. J. Psychiatr 153 (12), 1516–1523. 10.1176/ajp.153.12.1516 [published Online First: 1996/12/01]. [PubMed: 8942445]

Gallo LC, Savin KL, Jankowska MM, et al. , 2022. Neighborhood environment and metabolic risk in hispanics/latinos from the hispanic community health study/study of Latinos. Am. J. Prev. Med 63 (2), 195–203. 10.1016/j.amepre.2022.01.025 [published Online First: 20220329]. [PubMed: 35365395]

Geolytics. Neighborhood Change Database [NCDB] Tract Data from 1970-2010 [Online Demographic Data], 2014.

Gibbons J, Barton MS, 2016. The association of minority self-rated health with Black versus White gentrification. J. Urban Health 93 (6), 909–922. 10.1007/s11524-016-0087-0 [published Online First: 2016/10/21]. [PubMed: 27761683]

Golant SM, 2008. Commentary: irrational exuberance for the aging in place of vulnerable low-income older homeowners. J. Aging Soc. Pol 20 (4), 379–397. 10.1080/08959420802131437.

Grundy SM, Brewer HB Jr., Cleeman JI, et al. , 2004. Definition of metabolic syndrome: report of the national heart, lung, and blood Institute/American heart association conference on scientific issues related to definition. Circulation 109 (3), 433–438. 10.1161/01.Cir.0000111245.75752.C6. [PubMed: 14744958]

Heiss G, Snyder ML, Teng Y, et al. , 2014. Prevalence of metabolic syndrome among hispanics/latinos of diverse background: the hispanic community health study/study of Latinos. Diabetes Care 37 (8), 2391–2399. 10.2337/dc13-2505. [PubMed: 25061141]

Hochstenbach C, Boterman W, 2018. Age, life course and generations in gentrification processes. In: Lees L, Phillips M (Eds.), Handbook of Gentrification Studies. Edward Elgar Publishing, Chetenham, UK, pp. 170–185.

Hosseinpour-Niazi S, Mirmiran P, Hosseinpanah F, et al. , 2014. Association of marital status and marital transition with metabolic syndrome: tehran lipid and glucose study. Int. J. Endocrinol. Metabol 12 (4), e18980 10.5812/ijem.18980 [published Online First: 20141001].

Huynh M, Maroko AR, 2014. Gentrification and preterm birth in New York City, 2008–2010. J. Urban Health 91 (1), 211–220. 10.1007/s11524-013-9823-x [published Online First: 2013/09/12]. [PubMed: 24022181]

Hwang J, 2015. Gentrification in changing cities: immigration, new diversity, and racial inequality in neighborhood renewal. Ann. Am. Acad. Polit. Soc. Sci 660 (1), 319–340. 10.1177/0002716215579823.

Iceland J, Weinberg DH, Steinmetz E, 2002. Racial and Ethnic Residential Segregation in the United States: 1980-2000. US Census Bureau, Series CENSR-3, Washington, DC.

Izenberg JM, Mujahid MS, Yen IH, 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. 10.1016/j.healthplace.2018.06.002 [published Online First: 2018/06/26]. [PubMed: 29957396]

Keita AD, Judd SE, Howard VJ, et al. , 2014. Associations of neighborhood area level deprivation with the metabolic syndrome and inflammation among middle- and older- age adults. BMC Publ. Health 14, 1319. 10.1186/1471-2458-14-1319 [published Online First: 2014/12/30].

Khushalani JS, Cudhea FP, Ekwueme DU, et al. , 2022. Estimated economic burden of cancer associated with suboptimal diet in the United States. Cancer Causes Control 33 (1), 73–80. 10.1007/s10552-021-01503-4. [PubMed: 34652592]

Kirkland E., 2008. What's race got to do with it? Looking for the racial dimensions of gentrification. West. J. Black Stud 32 (2), 18–30.

Krieger N, Waterman PD, Spasojevic J, et al. , 2016. Public health monitoring of privilege and deprivation with the index of concentration at the extremes. Am. J. Publ. Health 106 (2), 256–263. 10.2105/ajph.2015.302955.

Lavange LM, Kalsbeek WD, Sorlie PD, et al. , 2010. Sample design and cohort selection in the hispanic community health study/study of Latinos. Ann. Epidemiol 20 (8), 642–649. 10.1016/j.annepidem.2010.05.006 [published Online First: 2010/07/09]. [PubMed: 20609344]

Lee M-A, Ferraro KF, 2007. Neighborhood residential segregation and physical health among Hispanic Americans: good, bad, or benign? J. Health Soc. Behav 48 (2), 131–148. 10.1177/002214650704800203. [PubMed: 17583270]

Lees L, Slater T, Wyly E, 2008. Gentrification. Routledge/Taylor & Francis Group, New York.

Li K, Wen M, Henry KA, 2017a. Ethnic density, immigrant enclaves, and Latino health risks: a propensity score matching approach. Soc. Sci. Med 189, 44–52. 10.1016/j.socscimed.2017.07.019. [PubMed: 28780439]

Li K, Wen M, Henry KA, 2017b. Ethnic density, immigrant enclaves, and Latino health risks: a propensity score matching approach. Soc. Sci. Med 189, 44–52. 10.1016/j.socscimed.2017.07.019 [published Online First: 20170725]. [PubMed: 28780439]

Li K, Wen M, Fan JX, 2019. Neighborhood racial diversity and metabolic syndrome: 2003–2008 national health and nutrition examination survey. J. Immigr. Minority Health 21 (1), 151–160. 10.1007/s10903-018-0728-3.

Lines LM, Urato M, Halpern MT, et al., 2014. RTI Press Research Report Series. Insurance Coverage and Preventive Care Among Adults. RTI Press © 2014 Research Triangle Institute, Research Triangle Park (NC). All rights reserved.

Linton SL, Cooper HLF, Kelley ME, et al. , 2017. Cross-sectional association between ZIP code-level gentrification and homelessness among a large community-based sample of people who inject drugs in 19 US cities. BMJ Open 7 (6), e013823. 10.1136/bmjopen-2016-013823.

Liu J, Fulda KG, Tao MH, 2021. Association between acculturation and metabolic syndrome in Hispanic adults mediated by fruits intake. Publ. Health Nutr 24 (18), 6472–6476. 10.1017/s1368980021003530 [published Online First: 20210816].

Lyons T, Krüsi A, Pierre L, et al. , 2017. The impact of construction and gentrification on an outdoor trans sex work environment: violence, displacement and policing. Sexualities 20 (8), 881–903. 10.1177/1363460716676990 [published Online First: 2018/01/31]. [PubMed: 29379380]

Manson S, Schroeder J, Van Riper D, Ruggles S, 2019. IPUMS National Historical Geographic Information System: Version 14.0 0 [Database]. IPUMS.

Mariotto AB, Enewold L, Zhao J, et al. , 2020. Medical care costs associated with cancer survivorship in the United States. Cancer Epidemiol. Biomarkers Prev 29 (7), 1304–1312. 10.1158/1055-9965.Epi-19-1534 [published Online First: 20200610]. [PubMed: 32522832]

McCurley JL, Penedo F, Roesch SC, et al. , 2017. Psychosocial factors in the relationship between socioeconomic status and cardiometabolic risk: the HCHS/SOL sociocultural ancillary study. Ann. Behav. Med 51 (4), 477–488. 10.1007/s12160-016-9871-z. [PubMed: 28130624]

Mehdipanah R, Marra G, Melis G, et al. , 2018. Urban renewal, gentrification and health equity: a realist perspective. Eur. J. Publ. Health 28 (2), 243–248. 10.1093/eurpub/ckx202 [published Online First: 2017/11/18].

Messer LC, Laraia BA, Kaufman JS, et al. , 2006. The development of a standardized neighborhood deprivation index. J. Urban Health 83 (6), 1041–1062. 10.1007/s11524-006-9094-x [published Online First: 2006/10/13]. [PubMed: 17031568]

Mullenbach LE, Baker BL, 2020. Environmental justice, gentrification, and leisure: a systematic review and opportunities for the future. Leisure Sci. 42 (5–6), 430–447. 10.1080/01490400.2018.1458261.

Newman SJ, Holupka CS, 2014. Housing affordability and investments in children. J. Hous. Econ 24, 89–100. 10.1016/j.jhe.2013.11.006.

O'Neill S, O'Driscoll L, 2015. Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies. Obes. Rev 16 (1), 1–12. 10.1111/obr.12229 [published Online First: 2014/11/20].

Pickett KE, Wilkinson RG, 2015. Income inequality and health: a causal review. Soc. Sci. Med 128, 316–326. 10.1016/j.socscimed.2014.12.031. [PubMed: 25577953]

Portes A, Rumbaut RG, 2001. Not Everyone Is Chosen: Segmented Assimilation and its Determinants. Legacies: the Story of the Immigrant Second Generation. University of California Press, Russell Sage Foundation, Berkeley, CA, pp. 44–69.

Portes A, Truelove C, 1987. Making sense of diversity: recent research on hispanic minorities in the United States. Annu. Rev. Sociol 13 (1), 359–385. 10.1146/annurev.so.13.080187.002043.

Portes A, Zhou M, 1993. The new second generation: segmented assimilation and its variants. Ann. Am. Acad. Polit. Soc. Sci 530 (1), 74–96. 10.1177/0002716293530001006.

Sangalang CC, Becerra D, Mitchell FM, et al. , 2019. Trauma, post-migration stress, and mental health: a comparative analysis of refugees and immigrants in the United States. J. Immigr. Minority Health 21 (5), 909–919. 10.1007/s10903-018-0826-2.

Schnake-Mahl AS, Jahn JL, Subramanian SV, et al. , 2020. Gentrification, neighborhood change, and population health: a systematic review. J. Urban Health 97 (1), 1–25. 10.1007/s11524-019-00400-1. [PubMed: 31938975]

Shrider EA, Kollar M, Chen F, et al., 2021. Income and Poverty in the United States: 2020. Current Population Reports. U.S. Census Bureau, Washington, DC, pp. 60–273.

Smith N., 1996. The New Urban Frontier: Gentrification and the Revanchist City. Routledge, London.

Smith GS, Thorpe RJ Jr., 2020. Gentrification: a priority for environmental justice and health equity research. Ethn. Dis 30 (3), 509–512. 10.18865/ed.30.3.509 [published Online First: 2020/08/04]. [PubMed: 32742156]

Smith RJ, Lehning AJ, Kim K, 2017. Aging in place in gentrifying neighborhoods: implications for physical and mental health. Gerontol. 58 (1), 26–35. 10.1093/geront/gnx105.

Sorlie PD, Avilés-Santa LM, Wassertheil-Smoller S, et al. , 2010. Design and implementation of the hispanic community health study/study of Latinos. Ann. Epidemiol 20 (8), 629–641. 10.1016/j.annepidem.2010.03.015 [published Online First: 2010/07/09]. [PubMed: 20609343]

StataCorp, 2019. Stata Statistical Software: Release, vol. 16. StataCorp LLC, College Station, TX.

Troxel WM, Matthews KA, Gallo LC, et al. , 2005. Marital quality and occurrence of the metabolic syndrome in women. Arch. Intern. Med 165 (9), 1022–1027. 10.1001/archinte.165.9.1022. [PubMed: 15883241]

Tulier ME, Reid C, Mujahid MS, et al. , 2019. Clear action requires clear thinking": a systematic review of gentrification and health research in the United States. Health Place 59, 102173. 10.1016/j.healthplace.2019.102173 [published Online First: 2019/07/30]. [PubMed: 31357049]

Tune JD, Goodwill AG, Sassoon DJ, et al. , 2017. Cardiovascular consequences of metabolic syndrome. Transl. Res.: J. Lab. Clin. Med 183, 57–70. 10.1016/j.trsl.2017.01.001 [published Online First: 2017/01/09].

Valdes Francisco, McCristal Culp Jerome, Harris Angela P., Crossroads 2002. Directions and A New Critical Race Theory. Temple University Press.

Vargas Bustamante A, Chen J, Rodriguez HP, et al. , 2010. Use of preventive care services among Latino subgroups. Am. J. Prev. Med 38 (6), 610–619. 10.1016/j.amepre.2010.01.029. [PubMed: 20494237]

Velasco-Mondragon E, Jimenez A, Palladino-Davis AG, et al. , 2016. Hispanic health in the USA: a scoping review of the literature. Publ. Health Rev 37 (1), 31. 10.1186/s40985-016-0043-2.

Versey HS, 2018. A tale of two Harlems: gentrification, social capital, and implications for aging in place. Soc. Sci. Med 214, 1–11. 10.1016/j.socscimed.2018.07.024 [published Online First: 2018/08/21]. [PubMed: 30125754]

Versey HS, Murad S, Willems P, et al. , 2019. Beyond housing: perceptions of indirect displacement, displacement risk, and aging precarity as challenges to aging in place in gentrifying cities. Int. J. Environ. Res. Publ. Health 16 (23). 10.3390/ijerph16234633 [published Online First: 2019/11/27].

Virani SS, Alonso A, Benjamin EJ, et al. , 2020. Heart disease and Stroke statistics. Circulation 141 (9), e139–e596. 10.1161/CIR.0000000000000757. [PubMed: 31992061]

Viruell-Fuentes EA, Miranda PY, Abdulrahim S, 2012. More than culture: structural racism, intersectionality theory, and immigrant health. Soc. Sci. Med 75 (12), 2099–2106. 10.1016/j.socscimed.2011.12.037. [PubMed: 22386617]

Williams KN, 2015. Toward a universal operationalization of gentrification. Sociation Today 13 (2).

Wyly EK, Hammel DJ, 2004. Gentrification, segregation, and discrimination in the American urban System. Environ. Plann.: Econ. Space 36 (7), 1215–1241. 10.1068/a3610.

Xiao Q, Berrigan D, Powell-Wiley TM, et al. , 2018. Ten-year change in neighborhood socioeconomic deprivation and rates of total, cardiovascular disease, and cancer mortality in older US adults. Am. J. Epidemiol 187 (12), 2642–2650. 10.1093/aje/kwy181. [PubMed: 30137194]

Yen IH, Michael YL, Perdue L, 2009. Neighborhood environment in studies of health of older adults: a systematic review. Am. J. Prev. Med 37 (5), 455–463. 10.1016/j.amepre.2009.06.022 [published Online First: 2009/10/21]. [PubMed: 19840702]

Table 1

Participant characteristics by metabolic syndrome status at visit 2 for adults in the Hispanic Health Community Study/Study of Latinos.

Participant Characteristics	Total, N = 6647	No Metabolic Syndrome, n = 5117	Metabolic Syndrome, n = 1530	*p*-value
Age, mean (±SE)	37.57 (0.27)	36.38 (0.29)	42.72 (0.58)	<0.001
Sex n (%)				0.866
Female	4041 (51)	3076 (51)	965(50)	
Male	2606 (49)	2041(49)	565(50)	
Education, %				<0.001
≤ High school	4005 (58)	3035 (57)	970 (64)	
Some college or technical school	884 (12)	6,72 (12)	212 (12)	
≥ College or more	1758 (30)	1410 (31)	348 (24)	
Employment status, %				0.222
Employed	3815 (55)	2964 (56)	851 (53)	
Unemployed I not retired	2832 (45)	2153 (44)	679 (47)	
Language preference, %				<.001
Spanish	5336 (73)	4038 (71)	1298 (80)	
English	1311 (27)	1079 (29)	232 (20)	
Years in the US combined with nativity, %				<0.001
US born	1152 (25)	939 (26)	213 (20)	
Years in the US ≥10	3818 (44)	2855 (43)	963 (52)	
Years in the US <10	1677 (31)	1323 (31)	354 (29)	
Hispanic/Latino heritage, %				0.870
Dominican	622 (10)	492 (11)	130 (9)	
Central or South American	1236 (13)	952 (13)	284 (13)	
Cuban	877 (19)	676 (19)	201 (20)	
Mexican	2802 (38)	2124 (38)	678 (39)	
Puerto Rican	920 (14)	724 (15)	196 (14)	
Other/>1 Background group	190 (5)	149 (5)	41 (5)	
Marital status, %				0.608
Married	3567 (47)	2367 (47)	713 (48)	
Other	3080 (53)	2750 (53)	817 (52)	
Health insurance, %				0.270
Private	1535 (21)	1203 (21)	332 (18)	
Public	1351 (22)	1015 (22)	336 (23)	
Uninsured	3761 (57)	2899 (57)	862 (59)	
Income				0.003
Less than $10,000	824 (13)	613 (12)	211 (18)	
$10,001-$20,000	1915 (31)	1456 (31)	459 (33)	
$20,001-$40,000	2195 (34)	1702 (35)	493 (32)	
$40,001-$75,000	897 (15)	726 (16)	171 (13)	

Author Manuscript

Author Manuscript

Author Manuscript

Participant Characteristics	Total, N = 6647	No Metabolic Syndrome, n = 5117	Metabolic Syndrome, n = 1530	*p*-value
More than $75,000	314 (6)	254 (6)	60 (4)	

Note. Metabolic syndrome at visit 2 was defined as those who met criteria for the syndrome at visit 2 and did not have the syndrome at visit 1. All analysis was weighted for complex survey design and non-response in the full sample (except for sample size). SE = Standard Error.

Table 2

Patterns of gentrification and income inequality by metabolic syndrome status and study site (n = 6647).

	Gentrification			*p*-value	Income Inequality Change			*p*-value	Income Inequality 2005–2009			*p*-value
	Total	No Metabolic Syndrome	Metabolic Syndrome		Total	No Metabolic Syndrome	Metabolic Syndrome		Total	No Metabolic Syndrome	Metabolic Syndrome	
	Mean (± Standard Error)											
Full Sample, n = 6647	0.21 (.10)	0.22 (0.11)	0.15 (0.12)	0.467	4.69 (0.59)	4.86 (0.59)	3.96 (0.75)	0.115	4.23 (.03)	4.23 (0.03)	4.24 (0.03)	0.770
San Diego, CA, n = 1706	0.28 (0.27)	0.28 (0.30)	0.26 (0.19)	0.923	4.97 (1.38)	5.25 (1.46)	3.53 (1.42)	0.169	3.82 (.06)	3.81 (0.06)	3.88 (0.05)	0.205
Miami, FL, n = 1599	0.07 (0.19)	0.04 (0.19)	0.18 (0.21)	0.195	3.40 (0.98)	3.43 (0.95)	3.29 (1.36)	0.868	4.37 (0.04)	4.38 (0.04)	4.35 (0.05)	0.417
Chicago, IL, n = 1892	−0.55 (0.26)	−0.47 (0.25)	−0.86 (0.30)	0.008	5.47 (1.47)	5.83 (1.49)	4.13 (1.62)	0.088	4.00 (0.04)	3.99 (0.04)	3.98 (0.05)	0.635
The Bronx, NY, n = 1450	0.74 (0.11)	0.73 (0.10)	0.79 (0.21)	0.742	5.28 (0.94)	5.33 (0.90)	5.02 (1.56)	0.799	4.61 (0.03)	4.61 (0.03)	4.61 (0.05)	0.982

Note. All analysis was weighted for complex survey design and non-response in the full sample (except for sample size). Income inequality percent change means represent absolute values. Income inequality change was calculated with a percent change of the 2005–2009 and the 2012–2016 Gini coefficient of income distribution. Higher gentrification values indicate greater gentrification marked by increases in residents with a college education and median household income and decreases in poverty.

Table 3

Stepwise Poisson regression models estimating for the association between gentrification and income inequality measures with metabolic syndrome (n = 6647).

	Model 1, With Individual-level characteristics	Model 1+ Neighborhood-level characteristics
	Incident Rate Ratios [95% Confidence Interval]	
Gentrification Index	0.99 [0.96–1.02]	1.00 [0.96–1.03]
Neighborhood immigrant composition		1.06 [0.98–1.14]
Income Inequality Change	1.00 [0.99–1.00]	1.00 [0.99–1.00]
Neighborhood deprivation		1.06 [0.98–1.15]
Neighborhood immigrant composition		1.04 [0.97–1.12]
Income Inequality 2005–2009	1.01 [0.86–1.19]	0.97 [0.82–1.15]
Neighborhood deprivation		1.08 [0.99–1.17]
Neighborhood immigrant composition		1.04 [0.97–1.12]

Note. Model one and two controlled for sex, education (high school or less, more than high school), employment status (employed, other), language preference (English, Spanish), years in the US combined with nativity (US born, years US ≥ 10, years US < 10), Hispanic/Latino heritage (Dominican, Central or South American, Cuban, Mexican, Puerto Rican, other/>1 background group), marital status (married, other), health insurance (private, public, uninsured) and income (less than $10,000; $10,001-$20,000; $20,001-$40,000; $40,001-$75,000; more than $75,000). Model two added neighborhood characteristics. Higher gentrification values indicate greater gentrification marked by increases in residents with a college education and median household income and decreases in poverty. Income inequality change was calculated with a percent change of the 2005–2009 and the 2012–2016 Gini coefficient of income distribution.