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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[⋆]

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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: $[(GINI_{2012-16} - GINI_{2005-09})/GINI_{2005-09}]*100$. 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.

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.

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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)	

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.