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Association of neighborhood segregation with 6-year incidence of metabolic syndrome in the Hispanic Community Health Study/ Study of Latinos

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Supplementary materials

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Abstract

Purpose: Examine the association between neighborhood segregation and 6-year incident metabolic syndrome (MetSyn) in the Hispanic Community Health Study/Study of Latinos.

Methods: Prospective cohort of adults residing in Miami, Chicago, the Bronx, and San Diego. The analytic sample included 6,710 participants who did not have MetSyn at baseline. The evenness and exposure dimensions of neighborhood segregation, based on the Gini and Isolation indices, respectively, were categorized into quintiles (Q). Racialized economic concentration was measured with the Index of Concentration at the Extremes (continuously and Q).

Results: Exposure, but not evenness, was associated with higher disease odds (Q1 (lower segregation) vs. Q4, OR = 1.53, 95% CI = 1.08-2.17; Q5, OR = 2.29, 95% CI = 1.49-3.52). Economic privilege (continuous OR = 0.87, 95% CI = 0.77-0.98), racialized privilege (continuous OR = 0.93, 95% CI = 0.82-1.04), and racialized economic privilege (i.e., higher SES non-Hispanic White, continuous OR = 0.86, 95% CI = 0.76-0.98) were associated with lower disease odds.

Conclusion: Hispanics/Latino adults residing in neighborhoods with high segregation had higher risk of incident MetSyn compared to those residing in neighborhoods with low segregation. Research is needed to identify the mechanisms that link segregation to poor metabolic health.

Keywords

Hispanic/Latino; Metabolic syndrome; Neighborhood segregation; Racialized economic concentration

Introduction

Approximately 36% of U.S. Hispanic/Latino adults have metabolic syndrome (MetSyn) [1]. Moderate to high rates of neighborhood segregation among Hispanic/Latino adults from non-Hispanic- White and Black adults are well documented [2–4]. Studies have linked racial/ethnic segregation to MetSyn related outcomes [5] and adverse metabolic profiles [6]. However, the literature on the association of neighborhood segregation with MetSyn components is mixed, particularly among Hispanic/Latino adults of diverse heritage [5,7–11].

The place stratification model centers structural discrimination — historical and current day discrimination in the housing and mortgage market and large scale public housing initiatives and prejudice — as the leading causes of segregation from non-Hispanic White spaces and residential immobility [12,13]. While scholars suggest that the neighborhood selection process may result from access to resources, individual preferences, and a person's changing life circumstance [14,15], historical labor processes, housing market discrimination, and high local immigration enforcement, [16–19] have played a more significant role in perpetuating the isolation of Hispanic/Latinos into substandard and segregated neighborhood environments [20].

Although segregated Hispanic/Latino or immigrant areas, commonly labeled as ethnic enclave, may promote positive outcomes by providing sociocultural resources and employment opportunities, market policies play a larger role in concentrating poverty by

limiting socioeconomic mobility and residential integration [20–24]. Additionally, Hispanic/Latino upward mobility does not always lead to the same residential attainments as Whites [25], and these inequities are exacerbated among some Hispanic subgroups (i.e., Puerto-Rican, Dominican) and adults who may be undocumented, leading to widened income inequality and health disparities [26–29]. Potential pathways linking segregated Hispanic/Latinos neighborhoods to metabolic health are environmental injustices, including high exposure to air pollutants and high land surface temperatures [30,31], poor neighborhood built conditions [32] and lower access to green spaces/vegetation [30], affordable quality healthy foods/food insecurity [33], physical activity amenities, medical resources, quality education, and housing [30,34–37]) compared to non-Hispanic Whites. These in turn, influence health related behaviors, social capital/integration and produce/exacerbate stressors [38–40].

Residential segregation does not affect all Hispanic/Latino subgroups in the same way [20,41]. Segregation has been conceptualized as having two overarching dimensions, *exposure,* and *evenness* [42–44]. Measures of evenness capture "the degree to which groups are evenly distributed in space" [37,38,45,46]. The exposure dimension captures "the probability for interaction between members of same vs. different racial groups in a given neighborhood" [38]. Although most studies of Hispanic/Latino segregation focus on the exposure dimension, the few studies that examine both dimensions show mixed results [38,47–52]. Given these considerations we examined both the exposure and evenness dimensions of segregation. While there is limited work examining the intersections of class and racial/ethnic segregation, these are interlocked to shape the distribution of the population across space. Thus, the proposed study investigated the interactive effects of class and racial/ethnic concentration. We examined associations between racial/ethnic and economic segregation and 6-year incidence of MetSyn among diverse Hispanic/Latino adults enrolled in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL).

Methods

Source population and analytic sample

Details of the HCHS/SOL have been described [53,54]. Briefly, it is an ongoing, multi-center, community-based cohort study, conducted at four field centers (Miami, FL; San Diego, CA; Chicago, IL; and the Bronx County, NY), that aims to characterize the prevalence and incidence of health status and disease burden (e.g., cardiovascular disease , diabetes, and pulmonary disease) of U.S. Hispanics/Latinos and describe protective and risk factors over time (Sorlie et al., 2010) [54]. Participants were non-institutionalized Hispanic/Latinos aged 18–74 at enrollment (2008–2011; $N = 16,415$) and 6 years later (follow-up; 2014–2017; $N = 11,623$). Additional details of the study design are provided in the supplementary document.

Geocoded baseline addresses were linked to census tracts and linked to the 2010 Census and American Community Survey data retrieved from IPUMS [55] and the Neighborhood Change Database produced by Geolytics [56]. Missingness was less than 5%, a level that should minimally impact results [57]. The analytical sample excluded participants without geocoded baseline addresses ($n = 316$), residing outside of the HCHS/SOL target areas (n

= 70). Following, participants that did not have a follow-up visit (n = 4,659) in 2014–2017, met criteria for MetSyn at baseline (n = 6,150), and whose MetSyn status could not be determined (n = 21) where excluded. Additionally, participants with incomplete data on variables of interest were excluded (n = 147), yielding an analytic sample of 6,710.

Exposure of interest: Racial and economic residential segregation

Evenness—We measured the evenness dimension of segregation with the Gini coefficient of Hispanic/Latino population density, which captures the "unevenness" of the distribution of Hispanic/Latino residents across census blocks compared to the variability of Hispanic/Latino of the census tract [58] and can range from zero to one, with higher values indicating greater segregation.

Exposure—We measured the exposure dimension of Hispanic/Latino segregation with the isolation index, which estimates the probability that Hispanic/Latino residents come into contact with other Hispanic/Latino residents within a census tract [59]. The isolation index can range from zero to one, with higher scores representing greater probability of interacting with a Hispanic/Latino resident (i.e., greater residential isolation from other ethnic groups).

Extreme racialized and/or economic concentration of privilege—Extreme racialized and/or economic concentration of privilege was measured using the Index of Concentration at the Extremes (ICE) [60,61]. Three different types of ICE indices were calculated, utilizing income data alone, race/ethnicity data alone, and combined (income and race/ethnicity data) [61]. The ICE indices can range from −1 (low privilege) to 1 (most privilege).

Patterns of neighborhood segregation for the HCHS/SOL sample have been published [62]. Additional details of segregation measures are provided in supplementary material.

Primary outcome of interest: Metabolic syndrome—Defined according to the National Cholesterol Education Program Adult Treatment Panel-III as having at least three of the following: waist circumference ≥102 cm for males or ≥88 cm for females; systolic BP ≥130 mm Hg and/or diastolic BP ≥85 mm Hg, and/or report of current hypertensive medication use; high-density lipoprotein (**HDL**)cholesterol <50 mg/dL for females, <40 mg/dL for males; serum triglycerides levels ≥150 mg/dL; and fasting blood glucose concentrations ≥100 mg/dL, and/or report of antidiabetic medication use [63]. Cases for incident MetSyn were identified as participants who did not meet criteria for MetSyn at baseline and developed MetSyn by 6-year follow-up.

Covariates

Individual-level covariates—Covariates at baseline included sex, employment status (any employment, other), health insurance status (uninsured, public, private), and marital status (married/partnered, otherwise), age, and education ("≤ high school diploma," "> high school diploma"), income (less than $10,000, $10,001–$20,000, $40,001–$75,000, more than $75,000), self-identified Hispanic/Latino heritage ("Cuban," "Dominican," "Mexican," "Puerto Rican," "Central American/South American," more than one heritage/other"), study

site (Bronx, Chicago, Miami, San Diego), proxies of acculturation (language of interview (English, Spanish), nativity, and years in the United States). Nativity was combined with years in the United States to create the following categories: (U.S. born, foreign born (including U.S. territories) and >10 years residing in the United States, foreign born (including U.S. territories) and residing in the United States ≤10 years).

Neighborhood-level covariates—The 2006–2010 neighborhood immigrant composition (i.e., percent foreign-born residents) and socioeconomic status were included as confounders. Neighborhood socioeconomic status was operationalized using the neighborhood deprivation index based on the approach by Messer et al. [64].

Statistical analysis—We calculated design based F-tests for weighted means and standard errors of continuous variables and Chi-squared tests for proportions of categorical variables, to summarize differences in covariates by MetSyn status. In a series of stepwise logistic regression models, we estimated odds ratio (OR) and 95% confidence intervals (CI) for incident MetSyn. Model 1 included individual-level covariates. Given that other neighborhood risk factors may be confounders, a second model for the two dimensions of segregation (analyzed together and separately) and for ICE for race/ethnicity also controlled for neighborhood deprivation index. The second model that investigated the evenness dimension separately and ICE for income added neighborhood immigrant composition. Finally, separate cross-level interaction terms between exposure variables of interest, proxies of acculturation and Hispanic/Latino heritage were included in fully adjusted models.

We conducted sensitivity analyses to examine non-linear trend associations. To do so, we generated quintiles (Q) for each dimension of segregation (Q1, least segregation or least racial/ethnic privilege or economic privilege for ICE). Linear trends between neighborhood exposures and outcomes were based on 0.10-unit change. Within- and between- neighborhood variance was not examined since the HCHS/SOL sampling weights account for clustered sampling and stratification, there were very few participants in some census tracts and the number of participants varied widely by tract. All analyses were deemed significant at $P < .05$, statistical tests were two tailed, and accounted for complex survey sampling and weights. We conducted all analyses using STATA 16.1 [65].

Results

Overall, the mean age among the population was 37.54 years (Standard Error = 13.34) and 49% were males (Table 1). Most Hispanic/Latino adults were born outside of the United States 50 states (68%) and preferred Spanish (73%). When comparing Hispanic/Latino adults by MetSyn status, we found significant differences by age ($P \leq .001$), education ($P = .008$), language of interview ($P \leq .001$), and years in the United States ($P \leq .001$). We found overall moderate levels[1] of segregation: evenness (95% CI: 0.39 ± 0.05, exposure (95% CI: 0.77 ± 0.01), ICE for income (95% CI: −0.29 ± 0.01), ICE for race/ethnicity (95% CI: −0.65 ± 0.01), and ICE combined (95% CI: −0.27 ± 0.01) (Table 2).

[1]Determined based on cut-points described in prior literature, very low (≤0.3; reference group), low (>0.3 and ≤0.4), moderate (>0.4 and ≤0.60) and high segregation (above 0.60) [3,46,92,93].

Neighborhood segregation and metabolic syndrome

In multivariable models shown in Table 3, the exposure dimension of segregation was associated with a 57% (Q1 vs. Q4, OR = 1.53, 95% CI = 1.08–2.17) and 129% (Q1 vs. Q5, OR = 2.29, 95% CI = 1.49–3.52) higher odds of incident MetSyn. The evenness dimension of segregation was not associated with incident MetSyn (Q1 (low segregation) vs. Q2, OR = 1.06, 95% CI = 0.77–1.47; Q3, OR = 1.28, 95% CI = 0.91–1.80; Q4, OR = 0.91, 95% CI = 0.66–1.24; Q5, OR = 1.18, 95% CI = 0.86, 1.63). No effect modifications on the association between segregation and incident MetSyn were found: years in the United States (evenness $P = .389$; exposure $P = .098$); language of interview (evenness $P = .884$; exposure $P = .329$); Hispanic/Latino heritage (evenness $P = .616$; exposure $P = .804$); age (evenness $P = .544$, exposure $P = .133$); sex (evenness $P = .235$, exposure $P = .106$); education (evenness $P = .731$, exposure $P = .643$); or study site (evenness $P = .238$, exposure $P = .163$).

Index of concentration at the extremes (ICE) and metabolic syndrome

Multivariable models for ICE for race/ethnicity, income and combined are shown in Table 3. For models of ICE for income, a 1-unit increase (i.e., increasing economic privilege) was associated with a 13% lower odds of incident MetSyn (OR = 0.87, 95% CI = 0.77–0.98). For models of ICE for race/ethnicity, a 1-unit increase (i.e., increasing racialized privilege) was associated with an 7% lower odds of incident MetSyn (OR = 0.93, 95% CI = 0.82–1.04). For models of ICE combined, 1-unit increase (i.e., increasing racialized economic privilege) was associated with a 14% lower odds of incident MetSyn (OR = 0.86, 95% CI = 0.76–0.98).

No effect modification on the association between ICE indices and incident MetSyn was found by years in the United States (ICE income $P = .301$; ICE race/ethnicity $P = .384$; ICE combined $P = .297$); language preference (ICE income $P = .845$; ICE race/ethnicity $P = .807$; ICE combined $P = .764$); Hispanic/Latino heritage (ICE income $P = .635$; ICE race/ethnicity $P = .687$; ICE combined $P = .988$); age (ICE income $P = .104$; ICE race/ethnicity $P = .125$; ICE combined $P = .059$); sex (ICE income $P = .217$; ICE race/ethnicity $P = .380$; ICE combined $P = .160$); education (ICE income $P = .463$; ICE race/ethnicity $P = .871$; ICE combined $P = .364$); or study site (ICE income $P = .313$; ICE race/ethnicity $P = .153$; ICE combined $P = .511$).

Discussion

Evenness and exposure dimensions of segregation and metabolic syndrome

The evenness dimension of segregation, measured by the isolation index, has the least clear theoretical and empirical association with health because it has lower impacts on neighborhood quality and socioeconomic indicators compared to the exposure dimension [66]. We found Hispanic/Latino residents of isolated neighborhoods (i.e., more segregation in the exposure dimension) had higher odds of incident MetSyn. These results support prior research indicating that isolation is associated with worse health outcomes (i.e., obesity, cardiometabolic risk) [11,67,68], but counter prior work that found that isolation was not associated with other MetSyn-related health outcomes such as total allostatic load [5].

Our findings are also suggestive that evenness segregation may not influence health unless it is accompanied by isolation (i.e., hypersegregation) [38,66,69]. Individuals experienced moderate levels of segregation on the evenness dimension and were not *hypersegregated* across the two dimensions, identified as those that scored >0.55 on each of the segregation dimensions [3,8,70,71] (results not shown). Kramer and Hogue [38] suggest that the evenness dimension aligns with the protective effects of segregated Hispanic/Latino neighborhoods, only if it is conditioned on isolation (i.e., exposure dimension). In our study, evenness segregation was not associated with MetSyn incidence after adjusting for exposure segregation. Some attributes of residence in isolated Hispanic/Latino communities — protection from discrimination, family networks, culturally sensitive healthcare services and linguistically appropriate medical services, social networks that share information regarding the location of affordable medical services—may counter some of the adverse effects of unevenness [72].

Lastly, it is also plausible that the evenness dimensions of segregation may matter at different levels of the spatial scale. For example, previous studies showed a relationship between the evenness dimension of segregation and self-rated health at the zip code level and city level [37,73], while another study did not observe an association between evenness and self-rated health at the census tract level [58]. Our findings extend this conclusion using an objective measure of health. Significant variations in segregation by geographic levels indicate that it is vital for future work to examine evenness at multiple geographic scales and elucidate at which level evenness may matter more using objective measures of health [49]. The large body of literature on segregation and health has failed to incorporate the evenness dimension at the local level despite important theoretical considerations of examining the effects of this dimension at the community level [49,74].

Exposure dimension of segregation and metabolic syndrome

Social or environmental exposures may lead to high prevalence of chronic health conditions and mortality [75]. Among Hispanic/Latinos, exposure segregation may lead to neighborhood and community characteristics and environmental injustices (e.g., residing near environmentally hazardous facilities, exposure to air and water pollution, crowded housing, crime) that perpetuate structural inequities in health outcomes. It is important to note that individual level factors that are tied to structural marginalization and segregation (e.g., fatigue and limited time due to the structure of low-income work), environmental (e.g., safety, lack of resources) and financial factors (e.g., cost) are strong barriers to engagement in healthful behaviors (i.e., physical activity, diet quality) among Hispanic/Latinos [76].

The exposure dimension of segregation measures the probability of interaction with other members of the same racial/ethnic group. High exposure to members of racial/ethnic groups that exhibit poor lifestyle behaviors (i.e., limited exposure to healthier groups) may lead to poor lifestyle behaviors [74]. Hispanic/Latinos are at high risk of sedentary behaviors [77,78] and barriers may include limited social supports and networks resulting from disrupted community cohesion, increased residential mobility, and stress resulting from gentrification-related Hispanic/Latino resegregation. That is, the consequences of poverty and environmental conditions within isolated Hispanic/Latino communities may undercut

the positive effects of socio-cultural capital, social networks, and cohesion in the long-term. Researchers theorize that gentrification processes within segregated environments re-cluster people of color into similar adjacent neighborhoods and, in turn, heighten re-segregation and racial-class conflicts that include competition for scarce resources [79–81]. As a result, over time, gentrification-led displacement of residents in segregated areas leads to a decline in social capital stemming from decreased neighborhood trust, social cohesion, and/or social networks [82–86]. In turn, social support for healthy behaviors may be disrupted, widening health disparities [87].

Extreme racialized and/or economic concentration of privilege

Racialized economic concentration has been linked to health inequities [88,89]. Our study showed that higher census tract-level measures of extreme residential concentrations of economic and racial privilege were associated with reduced odds of incident MetSyn. Findings align with prior similar studies that examined ICE and focused on BMI [88] and hypertension [89] and which included Hispanic/Latino participants in their samples. Similar to prior studies [73,90,91], associations suggest health benefits of residing in areas with concentrated racialized privilege (i.e., more non-Hispanic Whites) as captured by the ICE for race/ethnicity index.

Strengths and limitations

Among the strengths of our study are the use of probability sampling and the largest prospective cohort study of diverse Hispanic/Latino heritage, which makes results more representative to Hispanic/Latinos in the United States cities of the Bronx, Chicago, Miami, and San Diego and compared to convenience samples [53]. We also used various measures of segregation and examined two valid dimensions of segregation— evenness and exposure and controlled for a wide range of confounders. There are several limitations worth noting. Although we examined neighborhood exposures at baseline and MetSyn at 6 years follow-up, allowing us to make strong inferences, no causal inferences can be drawn. The HCHS/SOL study currently only has geocoded baseline address; thus, we were not able to capture the duration of exposure overtime. We were unable to estimate incidence rate due to lack of data on time of diagnosis. Lastly, generalizability of findings to Hispanic/Latinos residing in other states and rural areas is limited.

Conclusion

Racial/ethnic residential segregation has profound health consequences, and the present study expands the evidence to diverse Hispanic/Latino adults. Although the risk of segregation on MetSyn was modest at the individual level, there may be strong long-term societal implications at the population level, particularly given the socioeconomic implications attributed to cardiovascular and obesity-related cancer risk and outcomes resulting from poor metabolic health. While the evidence points to the harmful effects of segregation, there is also evidence of the positive consequences resulting from access to socio-cultural capital within areas with high concentration of Hispanic/Latino residents. Public health policy and interventions may address the consequences of detrimental conditions within segregated neighborhoods on metabolic health by empowering and

harnessing community building, political representation, and advancement efforts, as well as increasing access to quality resources that promote health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability statement

Data are maintained by the Hispanic Health Community Study/Study of Latinos and are available upon submitting a proposal to be approved by the publications committee. For more information visit https://sites.cscc.unc.edu/hchs/. Data can also be accessed in Database of Genotype and Phenotype (dbGaP), NIH maintained database of datasets and was developed to archive and distribute the results of studies that have investigated the interaction of genotype and phenotype. https://www.ncbi.nlm.nih.gov/gap/

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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* = 6857	No metabolic syndrome, *n* = 5274	Metabolic syndrome, *n* = 1571	*P*-value
Age, mean (± SE)	37.54 (0.27)	36.37 (0.29)	42.66 (0.57)	<.001
Sex, *n* (%)				.581
Female	4173 (51)	3186 (51)	987 (50)	
Male	2672 (49)	2088 (49)	584 (50)	
Education, *n* (%)				.001
≤High school or less	4100 (58)	3105 (56)	995 (65)	
>High school	2727 (42)	2155 (44)	572 (35)	
Income *n* (%)				.004
< $10,000	852 (13)	(632) (12)	217 (7)	
$10,001–$20,000	1965 (31)	1496 (31)	468 (33)	
$20,001–$40,000	2259 (34)	1749 (35)	507 (33)	
$40,001–$75,000	918 (15)	740 (16)	176 (13)	
> $75,000	321 (6)	260 (6)	61 (4)	
Employment status, *n* (%)				.237
Employed	55 (3869)	2198 (56)	690 (53)	
Unemployed | retired	2888 (45)	3006 (44)	863 (47)	
Language preference, *n* (%)				<.001
Spanish	5495 (73)	4163 (71)	1332 (81)	
English	1350 (27)	1111 (29)	239 (19)	
Years in the United States combined with nativity, *n* (%)				<.001
U.S. born	1184 (25)	965 (26)	219 (19)	
Years in the United States ≥10	3912 (45)	2927 (43)	985 (51)	
Years in the United States <10	1724 (31)	1360 (31)	364 (29)	
Hispanic/Latino heritage, *n* (%)				.756
Dominican	659 (11)	524 (11)	135 (10)	
Central or South American	1272 (13)	984 (13)	288 (13)	
Cuban	904 (19)	697 (19)	207 (20)	
Mexican	2851 (38)	2159 (37)	692 (39)	

Participant characteristics	Total, *N* = 6857	No metabolic syndrome, *n* = 5274	Metabolic syndrome, *n* = 1571	*P*-value
Puerto Rican	946 (14)	741 (15)	205 (14)	
Other/ >1 background group	198 (5)	157 (5)	41 (5)	
Marital status, *n* (%)				.404
Married	3644 (47)	2806 (47)	838 (49)	
Other	3182 (53)	2453 (53)	729 (51)	
Health insurance, *n* (%)				.239
Private	1560 (21)	1222 (21)	338 (18)	
Public	1368 (22)	1026 (22)	342 (23)	
Uninsured	3828 (57)	2957 (57)	871 (59)	

Note. SE = standard error. 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. A total of 12 participants were missing on metabolic syndrome data at visit 2. Statistical tests are two-sided.

Table 2

Patterns of segregation by metabolic syndrome status, $N = 6857$

	Full sample *N* = 6857	**Full sample range**	**No metabolic syndrome, *n* = 5274**	**Metabolic syndrome, *n* = 1571**
	Mean (standard error)		Mean (standard error)	Mean (standard error)
Formal measures of segregation				
Evenness	0.39 (0.00)	0–0.80	0.39 (0.00)	0.39 (0.01)
Exposure	0.77 (0.007)	0.09–0.99	0.76 (0.01)	0.79 (0.01)
Racialized economic concentration				
ICE for race/ethnicity	−0.65 (0.01)	−1 to 0.58	−0.64 (0.01)	−0.67 (0.01)
ICE at the extremes for income	−0.29 (0.01)	−3.14 to 4.01	−0.29 (0.01)	−0.31 (0.01)
ICE for race/ethnicity and income	−0.27 (0.01)	−3.91 to 6.43	−0.27 (0.01)	−0.29 (0.01)

Note. The evenness dimension of segregation was measured using the GINI coefficient for race/ethnicity. The exposure dimension of segregation was measured using the Isolation index. All analysis was weighted for complex survey design and non-response in the full sample.

Table 3

Stepwise logistic regression model estimating for the association between segregation measures and metabolic syndrome

	Model 1	**Model 2**
	With individual-level characteristics	+ Neighborhood-level characteristics
	Odds ratio [95% confidence interval]	
Formal measures of segregation		
Evenness		
Q1, high evenness		
Q2	1.13 [0.81–1.59]	1.11 [0.79–1.55]
Q3	1.27 [0.90–1.79]	1.24 [0.88–1.74]
Q4,	1.02 [0.73–1.43]	0.98 [0.71–1.36]
Q5: low evenness	1.30 [0.96–1.78]	1.22 [0.89–1.69]
P for trend	.211	.438
continuous (0.10-unit change)	1.02 [0.93–1.12]	1.00 [0.91–1.10]
Exposure		
Q1, low isolation		
Q2	1.33 [0.94–1.90]	1.31 [0.92–1.87]
Q3	1.26 [0.92–1.73]	1.22 [0.88–1.67]
Q4,	1.54 [1.09–2.17]	1.46[1.03–2.07]
Q5: high isolation	2.13 [1.39–3.26]	2.00 [1.30–3.07]
continuous (0.10-unit change)	1.11 [1.02–1.21]	1.09 [1.00–1.19]
P for trend	.003	.008
Evenness, after controlling for exposure		
Q1: high evenness		
Q2	1.07 [0.78–1.47]	1.06 [0.77–1.47]
Q3	1.29 [0.92–1.80]	1.28 [0.91–1.80]
Q4,	0.91 [0.66–1.26]	0.91 [0.66–1.25]
Q5: low evenness	1.19 [0.88–1.62]	1.18 [0.86–1.63]
Continuous (0.10-unit change)	0.99 [0.90–1.09]	0.99 [0.90–1.09]
P for trend	.538	.616
Exposure, after controlling for evenness		

	Model 1	Model 2
Q1: high exposure		
Q2	1.34 [0.95–1.89]	1.34 [0.95–1.89]
Q3	1.29 [0.95–1.76]	1.28 [0.94–1.75]
Q4,	1.55 [1.10–2.18]	1.53* [1.08–2.17]
Q5: low exposure	2.33 [1.52–3.57]	2.29 [1.49–3.52]
P for trend	.006	.011
Continuous (0.10-unit change	1.11 [1.02–1.21]	1.11 [1.02–1.21]
Proxy measures of segregation		
ICE for income		
Q1, highest extreme concentration of disprivilege		
Q2	0.99 [0.75–1.31]	0.99 [0.75–1.31]
Q3	0.93 [0.69–1.26]	0.95 [0.7–1.29]
Q4	0.92 [0.62–1.35]	0.96 [0.65–1.41]
Q5: highest extreme concentration of privilege	0.82 [0.57–1.18]	0.87 [0.61–1.25]
P for trend	.292	.481
Continuous	0.87 [0.77–0.98]	0.88 [0.78–1.00]
ICE for race/ethnicity		
Q1, highest extreme concentration of disprivilege		
Q2	0.74 [0.53–1.03]	0.75 [0.54–1.04]
Q3	0.66 [0.42–1.02]	0.68 [0.44–1.05]
Q4	0.65 [0.44–0.97]	0.68 [0.45–1.01]
Q5: highest extreme concentration of privilege	0.58 [0.38–0.89]	0.64 [0.42–0.98]
P for trend	.050	.154
Continuous	0.89 [0.79–1.00]	0.93 [0.82–1.04]
ICE combined		
Q1, highest extreme concentration of disprivilege		
Q2	0.76 [0.55–1.05]	
Q3	0.87 [0.63–1.21]	
Q4	0.81 [0.55–1.18]	
Q5: highest extreme concentration of privilege	0.70 [0.47–1.04]	
P for trend	.091	

	Model 1	Model 2
Continuous	0.86 [0.76–0.98]	

ICE = Index of Concentration at the Extremes.

Note. The evenness dimension of segregation was measured using the GINI coefficient for race/ethnicity. The exposure dimension of segregation was measured using the Isolation index. The ICE for income was measured as a continuous variable. All model two, three, and effects modification analysis controlled for sex, education (≤high school or less, >high school), employment status (employed, other), language preference (English, Spanish), years in the United States combined with nativity (U.S. born, years U.S. ≥ 10, years U.S. <10), Hispanic/Latino heritage (Dominican, 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, $40,001–$75,000, more than $75,000). Neighborhood deprivation was included in model 2 of evenness and exposure (separate and together) and of ICE for race/ethnicity. Neighborhood racial/ethnic composition was included in model 2 and interaction models for evenness and ICE for income. Interaction models were tested separately fully adjusted for individual and neighborhood level variables. Exploratory interactions *P*-values used a Bonferroni adjusted $P < .001$ based on an alpha of 0.1 for 70 tests. Segregation dimensions and ICE Models $N = 6710$; interaction models: $N = 6706$. Exposure variables were analyzed as continuous in models of interactions.