Original Report: Diabetes

Residential Segregation and Diabetes Risk among Latinos

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Objective: To examine whether residence in ethnically segregated metropolitan areas is associated with increased diabetes risk for Latinos in the United States.

Methods: Population data from the 2005 Behavioral Risk Factor Surveillance System and the 2005 American Community Survey were used to determine whether higher levels of Latino-White segregation across metropolitan statistical areas (MSAs) in the United States is associated with increased diabetes risk among Latinos (N=7462).

Results: No significant relationship (P<.05) between levels of segregation and diabetes risk was observed.

Conclusion: The research literature examining the impact of residential segregation on health outcomes remains equivocal for Latinos. *Ethn Dis.* 2015;25(4):451-458; doi:10.18865/ed.25.4.451

Keywords: Segregation, Diabetes, Latinos

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Introduction

Residential segregation, or the minority composition and separation of neighborhoods within a metropolitan area,[1,2] may perpetuate health disparities between Latinos and Whites in the United States. Recent census data show that Latinos account for 16.9% of the nation's population and are the second most segregated minority group.[3,4] As the US Latino population grows, so too do concerns about the residential patterns of this minority group. National averages suggest that the overall segregation of Latinos over the last several decades has not changed. A review of 2010 Census data reveals that, on average, Latinos reside in metropolitan areas that are 46% Latino.[5] Using common indices of segregation,[6] several studies report increases in isolation for Latinos, particularly Mexicans, between 1990 and 2010.[3,7] An isolation index measures the extent to which different racial/ethnic groups are exposed to each other in the same neighborhood.[8] Furthermore, Latino immigrants are likely to locate in ethnic enclaves, often to ease the acculturation process.[6,9-11]

This spatial isolation and concentration of Latinos may have important implications for health outcomes. Specifically, segregation isolates minority groups such as African Americans and Latinos in economically disadvantaged neighborhoods.[12] These areas tend to be characterized by high crime, fewer educational and employment opportunities, discriminating housing practices, and poverty.[1,3,13,14] The ensuing low socioeconomic status of minorities living in these segregated areas creates racial/ethnic differences in access, quality, and utilization of health promoting resources such as healthy food or access to opportunities to engage in physical activity.[1,2,14] Consequently, health outcomes are poor among low-income minority populations. Much of the literature in this area, however, focuses on Black-White segregation.

The limited research that exists on Latino segregation and health outcomes reports mixed results. Some studies indicate positive associations between Latino-White segregation and risk for obesity,[15] physical inactivity,[16] body mass index (BMI),[17] and self-rated health.[18] However, many studies show that Latinos who live in segregated areas have lower mortality rates than non-Latino Whites.[19-21] This epidemiological contradiction, known as the Latino Paradox, explains the notion that Latinos have lower mortality rates than Whites,[22] albeit while experiencing greater barriers to health care and higher rates of chronic conditions like diabetes.[14,15,23] To this end, some studies introduce various control variables to isolate the effects of Latino status,[20,24,25] and find that the apparent mortality advantage suggested by the Latino Paradox does not exist for conditions like diabetes.[26]

Diabetes is the fifth leading cause of death among Latinos and is 66%

more likely to be diagnosed in Latinos than in Whites.[27,28] Risk for diabetes is often attributed to genetics, environmental factors, and modifiable lifestyle behaviors.[29,30] While these individual-level risk factors are important to our understanding of diabetes risk, population-level factors need to be explored further in order to develop policies to prevent diabetes onset. This is especially true for Latinos, as studies suggest that diabetes risk among Latinos is heavily influenced by population-level factors associated with segregation such as the availability of healthy food outlets and access to quality health care services in residential areas.[27,31] For these reasons, our study examined the association between segregation and risk of diabetes among Latinos from a population perspective. Specifically, we examined individual-level characteristics thought to predispose individuals to diabetes (eg, obesity and exercise), as well as residential characteristics (eg, segregation and population size). Given the state of current research, we hypothesized both individual and residential indicators interact to produce ethnic differences in diabetes risk.

Methods

Data Sources and Sample

The 2005 Behavioral Risk Factor Surveillance System (BRFSS), supported by the Centers for Disease Control and Prevention, served as our primary data source. The BRFSS is an annual US-based telephone survey, measuring health outcomes and risk factors of the non-institutionalized population.[32] The BRFSS also includes geographically referenced data for Metropolitan Statistical Areas (MSAs) with samples of 500 or more individuals to permit the assignment of segregation indices for analysis. The US Bureau of the Census defines an MSA as an area that contains a city or urbanized area with 50,000 or more inhabitants.[33]

The 2005 American Community Survey (ACS), which is conducted by the US Census Bureau, was also used in our research. On a monthly basis, the ACS surveys households in areas of the US with at least 65,000 people regarding socioeconomic characteristics such as race and income. The 2005 wave yielded a response rate of 97.3% with a working sample of 1,924,527 respondents.[34] The ACS was merged with the BRFSS in order to derive socioeconomic characteristics of MSAs for participants included in our sample. In addition, segregation data from the Racial Residential Project at the University of Michigan was used to assign levels of segregation to respective metropolitan areas.[35] The BRFSS is administered by local governments in the 50 states, the District of Columbia, Guam and Puerto Rico, and the 2005 wave includes 356,112 respondents aged >17 years, with a median state-level response rate of 51.1%.[36] After excluding non-Hispanic respondents and those living outside of MSAs or in Guam or Puerto Rico, 25,539 respondents remained. Of those, 7,462 responded to all BRFSS questions used in this study and comprise our working sample. (Figure 1)

A study of non-response bias comparing data from the year 2000 BRFSS and Decennial Census revealed that racial/ethnic minorities, women, and younger people were less likely to respond to the BRFSS.[37] Any over-representation of White, non-Hispanic respondents cannot influence the results here because the sample is limited to Latinos; women are in fact over-represented in our working sample (Table 1) and controlling for sex should counter any resulting biases. While the under-representation of

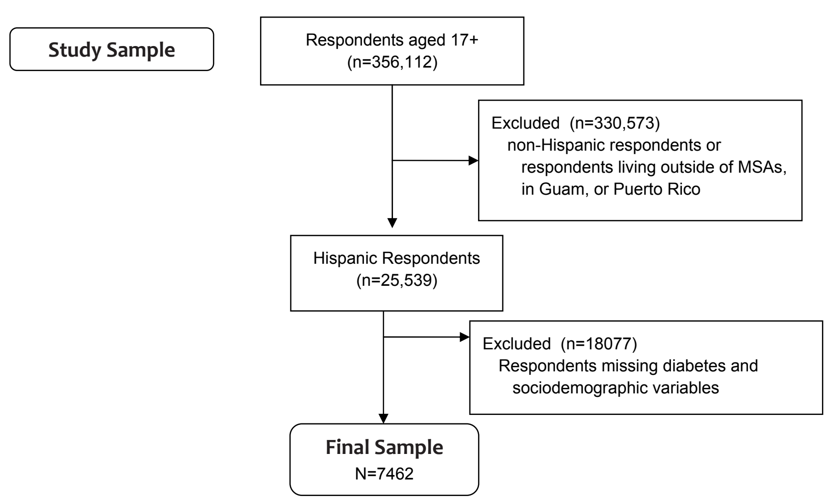

Figure 1. Participant inclusion/exclusion criteria, Behavioral Risk Factor Surveillance Survey, 2005

young people favors finding diabetes in our sample given it is not a young person's disease, that source of response bias should not bias the coefficients. The ACS was used to generate MSA-level data, so does not cause any further missing values.

Outcome Measure

Diabetes risk was measured using a question from the BRFSS that asks respondents, "*Have you ever been told by a doctor that you have diabetes?*" (Respondents were not asked to differentiate between diabetes type, eg, type 1 vs type 2).

Exposure Measures

Segregation

According to Massey and Denton,[12] there are five distinct but complimentary measures of minority residential segregation: evenness, exposure, centralization, clustering and concentration. Each measure taps into a slightly different construct of segregation, and all have been used to model diabetes care[38] and other health outcomes such as obesity.[11] From these measures, three distinct types of segregated environments are constructed. Hypersegregated areas correspond to MSAs that score .55 or higher on at least four of five segregation measures. Segregated areas score .55 or higher on one, two, or three of the five measures of segregation. Lastly, nonsegregated areas are those MSAs that did not score high on any of the segregation measures.

Covariates

Sociodemographic and health information served as controls in the analyses. At the individual level, so-

Table 1. Individual and metropolitan-level descriptive statistics

	Mean or %	SD
Diabetes diagnosis		
Yes	9.1%	
No	90.9%	
Individual SES		
Education level		
Less than high school[a]	27.3%	
High school graduate	3.3%	
Some college	23.5%	
Graduated college	18.9%	
Household income		
Less than $15,000[a]	18.7%	
$15,000 - $25,000	3.5%	
$25,000 - $35,000	15.4%	
$35,000 - $50,000	13.2%	
> $50,000	22.3%	
Employed	67.7%	
Individual Controls		
Body mass index		
Body mass index categories	27.8	5.9
Underweight	1.4%	
Normal weight[a]	31.6%	
Overweight	38.6%	
Obese	28.4%	
Smoker status		
Current smoker[a]	17.7%	
Former smoker	19.9%	
Never smoked	62.3%	
Physical activity (minutes of moderate activity)	53.3	73.5
Insured	69.1%	
Age	41.8	15.01
Sex		
Male[a]	39.6%	
Female	60.4%	
Marital status		
Never married, separated	38.6%	
Married, cohabitating[a]	61.4%	
Fruit/Vegetable Intake		
Less than 5 times per day[a]	77.9%	
5+ times per day	22.1%	
General health		
Excellent	17.3%	
Very good	23.9%	
Good	34.4%	
Fair	18.8%	
Poor[a]	5.7%	
Segregation measures[b]		
Nonsegregated[a]	4.0%	
Segregated	95.0%	
Hypersegregated	1.0%	
Area SES		
Total MSA population	.15	.18
Proportion in poverty	.14	.049
Hispanic population	701448.8	806196.5

N=7,462.
N for MSA = 198.
a. Indicates a category used as the base category for logistic regression.
b. Summary is at MSA level.
c. .55 cutoff, Wilkes' Index.

cioeconomic status was captured using measures of education, employment and income from the BRFSS. Education was divided into four categories: less than high school, high school graduate, some college and graduated college. Income was constructed based on total household income, excluding income from interest, dividends, and other investments. This measure included other income for each person such as disability assistance, social security, and public assistance, which are not necessarily from earnings, but is still contributed to the household. A series of dummy variables were used with the categories less than $15,000, $15,000 to $25,000, $25,000 to $35,000, $35,000 to $50,000, and more than $50,000. Employment status was dichotomized based on whether or not respondents indicated they worked full- or part-time during the previous year.

Self-reported health measures included body mass index (BMI), smoker status, levels of physical activity, fruit and vegetable intake and insurance status. BMI, as a proxy for adiposity, is based on height and weight that applies to both adult men and women. Four categories of BMI were created using the CDC's definition of BMI that correspond with underweight, normal weight, overweight and obese.[39] Physical activity was defined as the number of days per week respondents perform at least 10 minutes of exercise excluding work- related activities. Fruit/vegetable intake was assessed using self-report by asking whether the respondent ate five or more fruit and vegetable servings per day. Insurance status assessed whether or not the respondent had any kind of public or private health insurance. Smoker status was measured with a series of dummy variables characterize respondents as current smokers, former smokers or nonsmokers at time of interview.

Demographic Controls

Age at time of survey was measured in complete years. The sex of the respondent also served as a control measure. Marital status was categorized as either currently in a relationship (ie, married, coupled with an unmarried partner) or currently not in a relationship (ie, never married, separated, divorced, widowed).

Area Controls

Metropolitan characteristics were used as control variables to examine the effect of segregation on diabetes for Latinos. These measures were linked to the MSA the respondent resided in during 2005. The first is population size, which is logged. The proportion of residents who are below the poverty line was also used as a control measure. To account for the racial composition of MSAs, the proportion of Whites in the MSA was included. These covariates were derived from the 2005 ACS estimates and were merged onto the BRFSS data file using 6-digit MSA codes that are present in both the ACS and the BRFSS.

Statistical Analysis

Multi-level linear models were constructed using the PROC GLIMMIX procedure in the SAS 9.1 statistical software program. A random intercept model with a random effect at the MSA level was used. Chi-square and t-tests were used to assess associations between ethnicity (Latino) and covariates used in the analysis.

Results

Table 1 shows the majority of individuals in the sample of Latinos (90.9%) reported that they had not been diagnosed with diabetes. The sample included 7,462 persons with an average age of 41.8 years. Of those sampled, 60.4% were female and 61.4% were currently in a relationship (married or cohabitating). While 67.7% of individuals were employed, other socioeconomic characteristics suggested that individuals from this sample came from slightly disadvantaged backgrounds. Less than half (42.4%) had any college experience, and only 22.3% earned a household income >$50,000. The percentage of households in poverty was 14% and the percentage of uninsured individuals was 30.9%. Descriptive statistics further show that nearly 95% of Latinos in the study lived in segregated communities. In terms of health behavior, the majority (77.9%) of respondents reported that they consumed <5 servings of fruits/vegetables daily. The average time spent engaging in physical activity per week was less than one hour (53.3 minutes per week), and approximately 67% were overweight or obese.

Comparative descriptive statistics and tests for differences across respondents reporting or not reporting diabetes are provided in Table 2, with *P* values from Chi-squared tests of association for categorical variables and from t-tests for continuous variables. The average body mass index (BMI) among individuals who reported having diabetes exceeds that for non-diabetic individuals. On average, the BMI for individuals with diabetes was 4.1 units higher than the

BMI for non-diabetics. Additionally, individuals reporting a diabetes diagnosis were more likely to be in fair or poor health. Of the 681 individuals in the sample diagnosed with diabetes, 34.65% were in fair health compared with 17.17% of the 6,781 individuals without diagnoses of diabetes. The percentage of people with poor health totaled 22.47% for diabetics and only 4.06% for non-diabetics respectively.

Results from these simple tests also showed statistically significant differences in several individual-level factors between those who self-reported diabetes diagnosis and those who did not. The individuals most likely to have diabetes included a higher proportion of people who formerly smoked, had less than a high school education, and made <$15,000 annually. Those with diabetes also tended to be older than those without diabetes. Compared with people without diabetes, people diagnosed with the disease were less likely to be employed, but more likely to be insured.

Table 3 summarizes the regression analysis. Specifically, being employed and having an annual income >$15,000 had a protective effect on the risk for diabetes for Latinos. Those who were unemployed were significantly more likely to be diagnosed with diabetes. Being a female also served as a protective factor. The results further suggest that the likelihood of being diagnosed with diabetes is significantly less for uninsured individuals compared with those with insurance, while obesity was associated with increased risk. Neither higher levels of physical activity or fruit and vegetable consumption were found to be significantly associated with reduced diabetes

Table 2. Comparative descriptive statistics for diabetes diagnosis, Behavioral Risk Factor Surveillance System, Hispanic participants, 2005

	No self-report of diabetes diagnosis	**Self-reported diabetes diagnosis**	
Covariate	Mean (SD) or *n* (%)	Mean (SD) or *n* (%)	*P*[b]
Diabetes			
Diabetes diagnosis	6781 (9.87%)	681 (9.13%)	
Individual SES			
Educational level			<.001
Less than high school [a]	1803 (88.64%)	231 (11.36%)	
High school graduate	2049 (9.62%)	212 (9.38%)	
Some college	1608 (91.57%)	148 (8.43%)	
Graduated college	1321 (93.62%)	90 (6.38%)	
Household income			<.001
<$15,000 [a]	1189 (85.05%)	209 (14.95%)	
$15,000 to $25,000	2073 (91.20%)	200 (8.80%)	
$25,000 to $35,000	1063 (92.76%)	83 (7.24%)	
$35,000 to $50,000	908 (92.37%)	75 (7.63%)	
>$50,000	1548 (93.14%)	114 (6.86%)	
Employed			<.001
Yes	4750 (93.95%)	306 (6.05%)	
No	2031 (84.41%)	375 (15.59%)	
Individual Controls			
Body mass index	27.45 (5.61)	31.55 (7.47)	<.001
Body mass index categories			<.001
Underweight	99 (94.29%)	5 (5.71%)	
Normal weight [a]	2268 (96.26%)	88 (3.74%)	
Overweight	2659 (92.36%)	220 (7.64%)	
Obese	1755 (82.70%)	367 (17.30%)	
Smoker Status			<.001
Current smoker [a]	1216 (91.84%)	108 (8.16%)	
Former smoker	1271 (85.53%)	215 (14.47%)	
Never smoked	4294 (92.30%)	358 (7.70%)	
Physical activity (minutes of moderate activity)	53.76 (73.07)	49.08 (77.72)	.132
Insured			<.001
Yes	4619 (89.58%)	537 (1.42%)	
No	2162 (93.76%)	144 (6.24%)	
Age	4.53 (14.52)	54.83 (13.62)	<.001
Sex			.619
Male	2682 (9.67%)	276 (9.33%)	
Female	4099 (91.01%)	405 (8.99%)	
Marital status			.081
Never married, separated	2596 (9.14%)	284 (9.86%)	
Cohabiting, married [a]	4185 (91.34%)	397 (8.66%)	
Fruit and vegetable consumption			.877
Less than 5 times per day [a]	5285 (9.90%)	529 (9.10%)	
5 or more times per day	2596 (9.14%)	284 (9.86%)	
General Health			<.001
Excellent	1258 (97.67%)	30 (2.33%)	
Very good	1707 (95.79%)	75 (4.21%)	
Good	2377 (92.71%)	187 (7.29%)	
Fair	1164 (83.14%)	236 (16.86%)	
Poor[a]	275 (64.25%)	153 (35.75%)	

a. Indicates a category used as the base category for logistic regression.
b. *P*s are from Chi-square test of association for categorical variables and from t-test for continuous variables.

risk. Increasing age was associated with an increase in diabetes risk (P<.05).

At the MSA level, higher levels of segregation were not significantly associated with diabetes risk, even at the P<.05 level. Nor were larger populations, a higher concentration of poverty or a larger number of Latinos in the MSA significantly related to diabetes risk.

Discussion

Previous studies of Latinos have found that higher levels of segregation confer benefits against obesity,[11] and other health outcomes.[18,40] Our study, on the contrary, found no significant association between residential segregation among Latinos and diabetes risk. It is possible that, while measures of segregation in the United States typically reflect isolation from resources and other racial ethnic groups, this isolation may not influence Latinos in the same way as other minority groups. Specifically, immigrants comprise a large number of Latinos in the United States who may reap benefits from being in enclaves that reinforce ethnic identity and aid the assimilation process.[41,42] In conjunction with the findings reported here, a reasonable conclusion may be that, while residential segregation may be related to adverse health effects among some minority groups, such as African Americans, those adverse effects may be limited among Latinos in the United States.[43]

Among the significant findings, diabetes risk was positively related to unemployment and to health insurance coverage. Given that unemployment includes all respondents not employed, and that Medicare provides insurance to older respondents, it is possible that these findings are a statistical artifact of post-retirement age respondents being more likely to report diabetes. While this is possible, note that the findings hold in the regression results, which control directly for age, and that age is significantly and positively correlated with diabetes risk (Table 3). Instead, it seems likely that employed individuals enjoy greater resources and perhaps greater health in general, and that diabetes diagnoses are more likely among those with greater access to health care, as proxied by health insurance coverage.

Our study has several limitations. The BRFSS is cross-sectional, so no causal inferences can be drawn. The data were collected over the telephone, which may omit populations, such as the poor, without access to a telephone. The key dependent variable, diabetes diagnosis, is self-reported and not based on any medical records or

Table 3. Standardized regression coefficients for hierarchical linear modeling of the effects of individual and metropolitan measures on diabetes diagnosis

	Hispanic
Individual-level measures	
Education (<high school)	
High school graduate	.005
Some college	.005
Graduated college	-.011
Annual household income (< $15,000)	
$15,000 - $25,000	-.04[c]
25,000 - $35,000	-.05[c]
$35,000 - $50,000	-.04[c]
> $50,000	-.05[c]
Employed (Yes)	
No	.04[c]
BMI (Normal weight)	
Underweight	.02
Overweight	.02[b]
Obese	.11[c]
Minutes of physical activity per week	-.00
Fruit/vegetable intake (< 5 times per day)	
5+ times per day	.003
Insurance (Yes)	
No	-.02[a]
Smoker status (current smoker)	
Former smoker	-.005
Never smoked	.022[a]
Age	.004[c]
Sex (Male)	
Female	-.014[a]
Marital status (currently in a relationship)	
Currently not in a relationship	-.003
Metropolitan-level measures	
Segregation (segregated)	-.008
Nonsegregated	.00
Hypersegregated	
Log population size	.002
% Households in poverty	-.007
% Hispanic in MSA	.01
N	7244

[a] P<.05.
[b] P<.01.
[c] P<.001.

> *Our study, on the contrary, found no significant association between residential segregation among Latinos and diabetes risk.*

physical examination. Also, the analysis was not able to divide the sample into individuals with type 1 or type 2 diabetes. There were a large number of uninsured in our sample, which may be related to the dependent measure because it could influence awareness of diabetes. While the focus on Latinos was intentional, the study was not able to make inter-ethnic comparisons within the Latino community, which might identify differences across Latinos with historical ties to Mexico, Puerto Rico, or other areas in Latin America and the Caribbean. Future research could expand on this work by making these distinctions and by including other races and ethnicities.

There are further limitations in terms of the spatial data. The geographic data were aggregated to the metropolitan level, but the research could have been more powerful if the spatial level was more localized, such as a community or neighborhood. While five separate measures of segregation were used, they had to be collapsed into a trichotomous variable to indicate if areas were segregated, hypersegregated or non-segregated. Because of this coding strategy, variation in segregation was compressed and, perhaps more troubling, there were few non-segregated areas identified in these data, limiting the variation available to statistically explain diabetes risk.

Conclusions

There are two important implications of this research. First, other research has indicated a strong deleterious segregation effect on health across many disadvantaged racial and ethnic groups. The fact that this research found no such relationship between segregation and health among Latinos suggests that there could be a self-segregation effect that may be protective or at least not harmful to health among this group. Second, given the high prevalence of diabetes among Latinos in the United States compared with Whites,[28] future studies could either consider more finely grained geographic data or alternative socio-environmental factors to explain that difference.[44,45]

Author Contributions

Research concept and design: Grigsby-Toussaint Jones, Bradford. Acquisition of data: Grigsby-Toussaint, Kubo. Data analysis and interpretation: Grigsby-Toussaint, Kubo. Manuscript draft: Grigsby-Toussaint, Jones, Bradford. Statistical expertise: Grigsby-Toussaint, Jones, Kubo. Acquisition of funding: Grigsby-Toussaint. Administrative: Grigsby-Toussaint, Jones, Bradford. Supervision: Grigsby-Toussaint.

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