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Latino residential segregation and self-rated health among Latinos: Washington State Behavioral Risk Factor Surveillance System, 2012–2014

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Abstract

The relationship between Latino residential segregation and self-rated health (SRH) is unclear, but might be partially affected by social capital. We investigated the association between Latino residential segregation and SRH while also examining the roles of various social capital measures. Washington State Behavioral Risk Factor Surveillance System (2012–2014) and U.S. Census data were linked by zip code and zip code tabulation area. Multilevel logistic regression models were used to estimate odds of good or better SRH by Latino residential segregation, measured by the Gini coefficient, and controlling for sociodemographic, acculturation and social capital measures of neighborhood ties, collective socialization of children, and social control. The Latino residential segregation – SRH relationship was convex, or ‘U’-shaped, such that increases in segregation among Latinos residing in lower segregation areas was associated with lower SRH while increases in segregation among Latinos residing in higher segregation areas was associated with higher SRH. The social capital measures were independently associated with SRH but had little effect on the relationship between Latino residential segregation and SRH. A convex relationship between Latino residential segregation and SRH could explain mixed findings of previous studies. Although important for SRH, social capital measures of neighborhood ties, collective socialization of children, and social control might not account for the relationship between Latino residential segregation and SRH.

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Keywords

Latino residential segregation; self-rated general health; social capital; Behavioral Risk Factor Surveillance System

Introduction

U.S. residents of Latino ethnicity have lower self-rated general health (SRH) compared to U.S. residents of non-Latino ethnicity, even after adjustment for numerous factors (Anderson, Fullerton 2014, McGee et al. 1999, Shetterly et al. 1996). This is an important health disparity as SRH is a consistent predictor of mortality (DeSalvo et al. 2006, Idler, Benyamini 1997). A growing body of research has investigated whether residential ethnic composition – Latino density (percent of residents identifying as Latino) and Latino segregation (variation of where Latinos reside within an area) (Massey, Denton 1988, James, Taeuber 1985) – contributes to SRH disparities by ethnicity (Rios, Aiken & Zautra 2012, Anderson, Fullerton 2014, Nelson 2013, Patel et al. 2003, Shaw, Pickett 2011). Higher Latino density and segregation have been associated with adverse mental health (Rios, Aiken & Zautra 2012, Hong, Zhang & Walton 2014), health care access (Gaskin et al. 2012, Dinwiddie et al. 2013), food access (Powell et al. 2007), and physical activity facilities and outcomes (Osypuk et al. 2009) – factors that have been associated with worse SRH among Latinos (Anderson, Fullerton 2014, Nelson 2013, Patel et al. 2003). However, higher Latino density, but not segregation, has also been associated with better health behaviors and outcomes (Osypuk et al. 2009, Bécarea 2014).

Similarly, studies of SRH among Latinos are mixed with two indicating that SRH declines with higher Latino density (Rios, Aiken & Zautra 2012) or segregation (Anderson, Fullerton 2014) and one finding that SRH improves with higher Latino density (Patel et al. 2003). Additionally, studies have reported that gender or ethnic subgroup moderate the relationship between SRH and Latino density (Shaw, Pickett 2011) or segregation (Nelson 2013). Notably, Nelson (2013) found that higher Cuban segregation was associated with better SRH among U.S. Cubans. Greater understanding of these mixed findings can be reached through conceptualization of Latino residential composition and the mechanisms potentially affecting the relationship between Latino residential segregation and SRH.

Latino Residential Composition

Residential segregation is defined as, “... the degree to which two or more groups live separately from one another ... “ (Massey, Denton 1988). A recent review of racial-ethnic residential segregation differentiates between “formal versus proxy measures” (White, Borrell 2011). The “formal” construct has five dimensions, *evenness*, *exposure*, *concentration*, *centralization*, *clustering*, that are conceptually distinct and each with multiple measures (Massey, Denton 1988, White, Borrell 2011). White and Borrell (2011) report that evenness and isolation are overwhelmingly the most commonly studied dimensions. *Evenness* measures the over(under)-representativeness of Latinos in an area (James, Taeuber 1985). *Exposure* reportedly measures the physical contact or ‘experience of segregation’ between groups – somehow without personal accounts – and is a weighted

average of Latino density (Massey, Denton 1988). Although some have recommended exposure measures (Acevedo-Garcia et al. 2003, Lee 2009), James and Taeuber (1985) use the above definition of ‘segregation’ synonymously with evenness measures and explicitly distinguishes them from measures of exposure. Exposure measures fail a criterion of an ideal segregation metric in that two areas with identically distributed Latino populations will have different segregation values if the areas have different overall Latino densities (James, Taeuber 1985).

Latino density is a “proxy” to formal segregation measures but is described, more appropriately, as a construct that differs in the social, economic, and political processes captured by measures of racial-ethnic segregation (White, Borrell 2011). Latino density, is strongly correlated with area-level socioeconomic deprivation, quality and disorder, such that the independent effects and contributing mechanisms of each are difficult to disentangle (Bécares 2014, Hong, Zhang & Walton 2014, Sampson, Raudenbush & Earls 1997). Evenness measures, however, are less correlated with socioeconomic deprivation, especially among measures of Latino segregation (Denton 1994, Holliday, Dwyer 2009, Jargowsky 1997, Vélez, Martin & Mendez 2009). The effects of Latino density and Latino segregation are thought to effect SRH through similar mechanisms yet the effects of Latino segregation are more easily separated from potential confounders than are those of Latino density, such that ‘formal’ segregation measures more clearly describe effects on SRH (White, Borrell 2011). Notably, these mechanisms detailed below are entirely from studies of Latino density as no known study among Latinos has investigated mechanistic effects of Latino segregation measures under the theories of discrimination or social capital.

Self-rated Health, Discrimination and Social Capital

Increased discrimination is associated with lower SRH among Latinos (Bécares 2014, Molina, Alegría & Mahalingam 2013). Similarly, increased social capital – informational, emotional and social support, common norms and values and social and economic resources – is consistently associated with higher SRH (Bécares 2014, Chen, Yang 2014, Hong, Zhang & Walton 2014, Rios, Aiken & Zautra 2012).

Latino Segregation, Discrimination and Social Capital

Historical and current U.S. housing practices that discriminate by ethnic and socioeconomic status constrain housing options and geographically cluster the residential spaces of Latinos and those of lower income (Massey, Gross & Shibuya 1994, Pager, Shepherd 2008, Portes, Sensenbrenner 1993, Supreme Court of the United States 2015), including Latinos in Washington State (Seattle Office for Civil Rights 2015). In this way institutional discrimination causes Latino segregation by disallowing residence within majority non-Latino White areas.

In contrast to institutional discrimination and housing choice limitation, non-Latino Whites’ prejudices affect residential preferences resulting in resistance to integration (Bobo, Zubrinsky 1996, Clark 1992). Latinos residing in areas with lower same-ethnicity density report higher interpersonal discrimination (Ortiz, Telles 2012, Bécares 2014), suggesting that anticipated interpersonal discrimination might lead Latinos to choose areas of residence

where discrimination occurs less frequently. Therefore, non-Latino White prejudices might maintain extant Latino segregation or anticipated interpersonal discrimination against Latinos might intensify Latino segregation due to Latino individuals' movement to more Latino-dense areas.

The social capital theory of Latino segregation posits that Latino Americans choose to live in closer proximity to more easily exchange social capital (Alba, Nee 1997, Muntaner, Lynch & Smith 2000, Portes, Sensenbrenner 1993, Viruell-Fuentes et al. 2013). Empirical evidence of the relationship between Latino density and measures of social capital are mixed; some studies report lower neighborhood social cohesion with higher Latino density (Osypuk et al. 2009, Rios, Aiken & Zautra 2012), while others report that increased Latino density is associated with increased social ties (Almeida et al. 2009) and increased neighborhood social cohesion (Bécares 2014, Hong, Zhang & Walton 2014).

In response to the unclear and mixed findings, this study assessed the associations between Latino residential segregation, social capital and SRH among Latinos of Washington State. Nearly one in eight Washingtonians are Latino (U.S. Census Bureau 2011). The Eastern, rural regions of the State exhibit some of the highest ethnic segregation while the urban counties (dotted outline) have some of the lowest (Figure 1). Using a Statewide representative sample of Latinos, we hypothesized that: 1) SRH will decrease with increased Latino residential segregation, and 2) that controlling for measures of social capital will attenuate the relationship between Latino residential segregation and SRH.

Methods

Individual-level data are from the Washington State Behavioral Risk Factor and Surveillance System (BRFSS) 2012–2014 survey data. The BRFSS is the largest, continuously conducted, telephone health survey in the world (Centers for Disease Control and Prevention (CDC) 2012). Random digit dialing is used to contact potential respondents who use land lines or cell phones.

Individual-level Measures

Self-rated Health—Self-reported general health status was assessed by asking ‘*Would you say that in general your health is: Excellent, Very good, Good, Fair or Poor*’. Following previous lit, we dichotomized responses into ‘good’, ‘very good’ or ‘excellent’ (hereafter, ‘good SRH’) versus ‘fair’ or ‘poor’ (Anderson, Fullerton 2014, Chen, Yang 2014).

Social Capital—Respondents were asked to rate statements or questions related to community social capital on five-level Likert scales: ‘*How often do you and people in your community do favors for each other?*’ (very often to never), ‘*You can count on adults in your community to watch out that children are safe and don’t get into trouble*’ (very likely to very unlikely) and ‘*Your community members can be counted on to intervene if children are skipping school and hanging out in your community*’ (strongly agree to strongly disagree). These items are from three multi-item constructs used in the Project on Human Development in Chicago Neighborhoods: neighborhood ties, collective socialization of children, and social control (Earls et al. 2007, Franzini et al. 2005). Together, these questions

had poor reliability (Cronbach's alpha = 0.56), and were analyzed separately as categorical variables.

Potential Confounders—Age was provided in integer years and analyzed in continuous form. Ethnicity was limited to those identifying as 'Latino or Hispanic'. Marital status was categorized as 'Married/unmarried couple' and 'Divorced, widowed, separated or never married'. Educational attainment was categorized 'Less than a high school diploma', 'High school diploma', 'Some college' or 'Graduate of four-year college or more'. Employment status was categorized as 'Employed', 'Out of work or unable to work' or 'Student, home maker or retired' for analysis. Income was not modelled due to high missingness (12.7%). Language of survey administration (Spanish or English) was used to measure acculturation (Osypuk et al. 2009, Molina, Simon 2014), an important confounder in studies of self-rated health (Viruell-Fuentes et al. 2011).

Chronic disease morbidity was characterized as a sum score of diagnosis with various chronic conditions – myocardial infarction; coronary heart disease; stroke; asthma; skin cancer; other cancers; chronic obstructive pulmonary disease, emphysema or chronic bronchitis; arthritis, gout, lupus or fibromyalgia; kidney disease; or diabetes (excluding pregnancy-related and pre-diabetes). Current tobacco smoking and non-occupation related physical activity within the previous 30 days were categorized as 'yes'/'no' following previous literature (Bratter, Gorman 2011, Anderson, Fullerton 2014).

Area-level Measures

We measured residential segregation using the Gini Index, a measure of evenness (James, Taeuber 1985, Massey, Denton 1988). The Gini index has been shown to have superior measurement properties compared to other segregation metrics (James, Taeuber 1985), operationalizes the residential segregation construct well under both the discrimination and social capital theories (Kandel, Massey 2002, Logan, Alba 1995, Muntaner, Lynch & Smith 2000, Portes, Sensenbrenner 1993, Wily, Hammel 2004), and is well-known in economics and public health literature (Gini 1912, Subramanian, Kawachi 2004). We calculated the Gini as

$$G = \frac{\sum_{i=1}^n \sum_{j=1}^n t_i t_j |p_i - p_j|}{2T^2 P(1-P)},$$

where n is the number of blocks in the zip code, t_i and t_j are the total populations of blocks i and j, p_i and p_j are the percent Latino of blocks i and j, T is the total population of the zip code, and P is the overall percent Latino of the zip code (SAS macro in Supplementary material). Calculations of total population and percent Latino are restricted to the Latino (minority) and non-Latino White (traditional majority) populations (Massey, Denton 1988). The Gini is defined as the average of the absolute differences between all block-specific pairs of percent Latino, weighted by their populations, and expressed as a proportion of the maximum weighted mean difference (the value obtained if Latinos were completely

segregated from non-Latino Whites in the zip code). The Gini index ranges from 0–100 with higher values indicating greater segregation.

Zip code-level percent of residents with household incomes below 100% of the federal poverty level (percent < 100% FPL) were from the U.S. Census American Community Survey, 2009–2013 (U.S. Census Bureau 2015). Latino residential composition data were from the 2010 US Census (U.S. Census Bureau 2011). Latino density was included as proxy for potential area-level confounders, as recommended (White, Borrell 2011). All three zip code-level variables were analyzed in centered and standardized forms.

The relationship between Latino residential segregation and SRH was analyzed at the zip code level. Previous public health research has critiqued the use of zip code-level analyses for two main reasons: theoretical relevance (Sharkey, Faber 2014) and selection biases due to spatiotemporal mismatches between zip codes and zip code tabulation areas (ZCTA) (Krieger et al. 2002a, Krieger et al. 2002b, Grubestic, Matisziw 2006). Historical mortgage lending and insurance premium pricing discriminatory practices based on zip code-level racial-ethnic and income density theoretically motivates a zip code-level analysis (Hyman 2011, Aalbers 2013). Spatial mismatch issues have become mitigated as U.S. Census blocks determine ZCTA boundaries. In previous work, higher percentages of addresses unmatched to zip codes (9.4%) due to temporal changes in zip code designation were hypothesized to induce selection bias and drive unexpected associations involving area-level characteristics (Krieger et al. 2002a). The majority of invalid zip codes in this study were the result of respondents not knowing (3.9%) or refusing to provide zip codes (2.0%) as opposed to mismatches between US census ZCTAs and BRFSS zip codes (0.3%). We further explored the appropriateness of zip codes as a contextual level through statistical tests of the zip code random intercept variance parameter ($\sigma = 0$), calculation of intraclass correlation coefficients (ICC) (Hedeker 2003), and calculation of residual spatial autocorrelation indices (Waller, Gotway 2004, Chaix et al. 2005, Gelman, Hill 2007, Diez Roux, Mair 2010). For comparison to previous work, sensitivity analyses were conducted using county-level estimates (Bécares 2014).

Statistical Analysis—Frequencies or means of individual-level sample characteristics by good SRH will be calculated and tested using Wald chi-square tests for categorical variables and t-tests for continuous variables. Descriptive statistics and Pearson correlation coefficients of zip code-level factors were calculated.

Multilevel models of good SRH health by Latino segregation will be investigated while employing varying degrees of control for other factors. First, a model with only Latino segregation will be estimated. Commonly controlled factors of age, sex, marital status, employment status, educational attainment, survey year, survey language, smoking status, physical activity status, number of chronic conditions and zip code-level percent Latino and percent < 100% FPL will be included with Latino segregation in a second model. Lastly, the effects of additionally modeling community social capital measures will be investigated. Survey weights, scaled to the final analytic sample size, were used in all models to reduce biases associated with non-response and non-coverage (Zhang et al. 2014). All models included zip code-level random intercepts to account for clustering of individuals within zip

codes (Gelman, Hill 2007). Tests of multilevel model estimates were t-tests. Moran's I will be calculated for null and final models of SRH to test for zip code-level spatial autocorrelation – assessing the conditional independence assumption and the presence of zip code-level spatial confounders (Waller, Gotway 2004, Clayton, Bernardinelli & Montomoli 1993). Moran's I P-values will be obtained using random labelling Monte Carlo techniques (999 replicates) (Waller, Gotway 2004). Type-I error of all tests will be *a priori* set at 0.05.

Results

Among 1327 surveyed Latinos in Washington State, 74.1% report good SRH. Those Latinos who are younger, married, with higher than a high school education, not out of work, English speaking, reporting physical activity within the last 30 days, reporting fewer chronic conditions, reporting that community members more frequently do favors for one another, or agreeing that community members protect children from trouble are more likely to report good SRH (Table 1).

Zip code-level Latino residential composition and percent < 100% FPL vary greatly across Washington State. The average Gini index was 60.9 (SD=14.1, Range: 6.6–99.5), percent Latino was 13.6 (SD=16.7, Range: 0.8–90.3), and percent <100% FPL was 14.6 (SD=10.1, Range: 0.0–100.0). Zip code-level Gini index positively correlated with percent Latino ($r=0.148$, $p<0.01$), but not with percent < 100% FPL ($r=-0.008$, $p=0.87$) (Table 2).

Regardless of adjustment factors, the relationship between Latino segregation and odds of good SRH is estimated to be convex or 'U'-shaped: increases in Latino segregation among Latinos residing in lower Latino segregation zip codes is associated with decreased odds of good SRH, while increases in Latino segregation among Latinos in higher Latino segregation zip codes is associated with increased odds of good SRH (Table 3 and Figure 2). Among those residing in zip codes with a Gini index of 32.7, the odds of good SRH is 0.3 (95% CI: 0.12 – 0.75) for a one SD increase (14.1) in Latino segregation, adjusting for age, sex, marital status, employment status, education status, survey year, survey language, smoking status, physical activity status, chronic conditions, community members' favors, community members' child protection, community members' child truancy intervention, percent Latino and percent <100% FPL (Table 3, model 3). Among those residing in zip codes of Gini index of 75.0, the odds of good SRH is 4.65 (95% CI: 1.75 – 12.32) for a one SD increase in Latino segregation (Table 3, model 3). Although certain levels of the social capital measures are independently associated with good SRH, they do not attenuate the relationship between Latino residential segregation and good SRH (Table 3, models 2 and 3).

Spatial autocorrelation tests of residuals calculated using two different neighborhood weighting matrices (adjacent zip codes representing small spatial scale, and zip codes 54 km away representing large spatial scale) indicates that significantly positive spatial autocorrelation of good SRH is present in null but not final models: null model Moran's I (p-value) = 0.06 (0.10) and 0.04 (0.03), final model Moran's I (p-value) = 0.01 (0.36) and -0.01 (0.44) for small and large spatial scales, respectively. These results, together with the statistically significant random intercept variance parameters and large ICCs in each model

(Table 3), indicate that zip code may be a suitable level at which to quantify variability of SRH among Latinos in Washington State. County-level estimates were no longer statistically significant in adjusted models (results now shown).

Discussion

This investigation of the Latino residential segregation – SRH relationship among Washington State Latinos found that the relationship is statistically significantly convex: among those in lower Latino segregation zip codes, increases in segregation is associated with decreases in SRH, while increases in segregation is associated with *increases* in SRH among residents of higher Latino segregation zip codes. Although increases in measures of social capital were generally associated with higher SRH, they had little effect on the Latino residential segregation – SRH relationship.

These results coincide with the seemingly conflicting bodies of literature indicating that SRH declines with higher Latino segregation (Anderson, Fullerton 2014, Nelson 2013) and others finding that SRH improves with higher Latino segregation (Nelson 2013). This is the first known study to assess the effects of social capital on the Latino segregation – SRH relationship, although several studies of Latino density have investigated this construct. Patel et al. (2003) found that social support had little effect on the relationship between Mexican American density and SRH. In contrast, Rios et al. (2012) reported that neighborhood social cohesion completely mediated the inverse relationship between Latino density and SRH. The authors also report a statistically significant second order effect of Latino density indicating that the decreases in neighborhood social cohesion associated with increases in Latino density were only present among residents of Latino-sparse areas. Complete mediation of the Latino density – SRH relationship by neighborhood social cohesion implies that this convex relationship was also present between Latino density and SRH, a finding similar to ours.

Studies investigating the effects of Latino density on psychologic and mental health outcomes have demonstrated the partial mediating role of social capital (Bécares 2014, Shell, Peek & Eschbach 2013, Hong, Zhang & Walton 2014). These studies represent each ‘side’ of the potential convex relationship between Latino segregation and health, suggesting that social capital might account for both the positive or negative effects on SRH that are associated with increases in Latino segregation. Similarly, discrimination partially accounted for both the inverse relationship (Shell, Peek & Eschbach 2013, Bécares 2014) and positive relationship between Latino density and mental health outcomes (Bécares 2014).

The measures of social capital had negligible effect on the Latino segregation – SRH relationship in this study for several potential reasons. First, the three items which were part of either neighborhood ties, collective socialization of children, or social control might not represent these multi-item constructs well enough. Most studies measuring these social capital constructs used more than one item (Chen, Yang 2014, Franzini et al. 2005), although there is an exception (Almeida et al. 2009). Second, these single items might have measured the constructs well, but these constructs truly might not affect the relationship between Latino segregation and SRH. This is the first known study to include these social capital

constructs in an investigation of Latino segregation and SRH, prohibiting comparisons to previous studies. However, increasing Latino density has been associated with more social ties (Almeida et al. 2009, Viruell-Fuentes et al. 2013), and increased neighborhood social ties have been associated with better mental health among Latinos (Mulvaney-Day, Alegria & Sribney 2007). The only other known U.S. study to examine associations between SRH and collective socialization of children or community's social control found that neither of these relationships were statistically significant (Franzini et al. 2005).

Recent studies have found that the relationships between Latino density, segregation, social capital, discrimination, or SRH depend on ethnic subgroup, generation status or preferred language (Bécares 2014, Nelson 2013, Viruell-Fuentes et al. 2013). The effects of Latino segregation on SRH in any given Latino population could, therefore, be dependent on cultural factors as well as the magnitude and persistence by which various forms of social capital and discrimination occur within any given area. For example, Latinos in areas of higher Latino segregation might experience lower discrimination which, together with increased levels of social capital, might result in an overall higher SRH. In contrast, the health-promoting effects of social capital might not be large enough to offset the detrimental effects of discrimination in areas characterized by lower Latino segregation. However, it is important to highlight the instances and duration of time for which changes in SRH would result from changes in Latino segregation using current empirical evidence situated in the theories of social capital and discrimination.

According to the theories of social capital and discrimination there are three scenarios in which higher SRH is expected to correlate with higher Latino segregation and only one scenario in which lower SRH might occur with higher Latino segregation. Both representing longer-term relationships, Latinos might choose to maintain residence in segregated areas to avoid interpersonal discrimination or to share social capital. As SRH increases with decreases in discrimination and increases in social capital, higher Latino segregation should correlate with higher SRH in these two scenarios. Representing a shorter-term relationship, the desire to more easily exchange social capital will influence some Latino individuals to move to segregated areas. Latinos might move because they reside in integrated areas that confer low social capital, or they might have recently moved to segregated areas that confer high social capital. Regardless, the observation would be that higher (lower) Latino segregation is associated with higher (lower) social capital. Representing another short-term relationship, Latinos experiencing interpersonal housing discrimination during home-seeking activities would result in the observation that increased Latino segregation was associated with lower SRH. Together and if considered as a time-weighted cumulative risk, these scenarios generated under the theories of social capital and discrimination would predict higher SRH with increases in Latino segregation. However, mixed results of studies investigating the relationships between Latino residential segregation, social capital, discrimination and SRH might also suggest that social capital and interpersonal discrimination incompletely describe the relationship between Latino residential segregation and SRH.

As previously noted, the discriminatory housing practices that create (Massey, Gross & Shibuya 1994, Pager, Shepherd 2008, Portes, Sensenbrenner 1993, Seattle Office for Civil

Rights 2015, Supreme Court of the United States 2015) and the racial-ethnic prejudices that maintain racial-ethnic residential segregation (Bobo, Zubrinsky 1996, Clark 1992) also contribute to the colocation of environments characterized by reduced access to healthcare facilities (Dinwiddie et al. 2013, Gaskin et al. 2012), healthy food (Kwate 2008, Walker, Keane & Burke 2010), adequate physical activity resources (McNeill et al. 2006, Moore et al. 2008), and increased violent crime (Sampson, Raudenbush & Earls 1997). The co-creation of these health-deleterious environments – oftentimes associated with theories of social disorder and institutional resources (Sampson, Raudenbush 1999, Sampson, Morenoff & Gannon-Rowley 2002) – are expected to have effects on SRH that persist much longer than a short-term, interpersonal discriminatory effect on SRH experienced while home-seeking. Indeed, some of the best evidence in support of the social disorder theory are from the randomized-controlled Moving to Opportunity (MTO) study, in which movement to census tracts of lower poverty – and due to discrimination’s co-segregating effects, movement to lower areas of African American density – resulted in decreased crime victimization and improved psychological distress and mental health outcomes among female study participants (Kessler et al. 2014, Clampet-Lundquist, Massey 2008). This suggests that a more complete description of the relationships between Latino residential segregation, social capital, discrimination and SRH might be achieved by also considering the factors and processes acting within the theory of social disorder and institutional resources.

This study is limited by its cross-sectional design, limited geographic scope, inability to investigate the effects of Latino subgroup, nativity or discrimination and use of social capital metrics and geographic levels as convenience. The cross-sectional design and possibility of unmeasured confounders (i.e., cultural factors, income, etc.) prevent these associations from being interpreted causally. These results might not be generalizable to U.S. Latino residing outside of Washington State. Selective mobility by health status (i.e., neighborhood selection bias) could be responsible for the associations between Latino residential segregation and SRH (Sampson, Sharkey 2008). A leading theory explaining the relationship between Latino residential segregation and SRH involves interpersonal discrimination, unmeasured within these data. Similarly, ethnic subgroup or nativity status – measures unavailable in these data – might act as moderators (Bécares 2014, Nelson 2013, Viruell-Fuentes et al. 2013). However, we found that a previously identified factor of importance, language, negligibly effected the Latino residential segregation and SRH relationship (Viruell-Fuentes et al. 2011). Although other studies have measured social capital using various constructs, the social capital measures we used were significantly associated with SRH indicating construct validity. Use of zip codes could be a limitation. However, the low percentage of mismatch (0.3%) or invalid/missing (5.9%), high intra-zip code correlation coefficients and statistically significant random intercept variance parameters indicate that zip codes may be suitable boundaries that adequately captured the geographic variability of SRH reported by Latinos in Washington State. County-level estimates were not statistically significant, possibly because counties are too large to adequately capture these relationships.

The methodologic techniques used characterize this study’s strengths. Multilevel regression techniques more accurately estimated standard errors of modeled associations and yielded more stable zip code-level estimates of SRH by ‘shrinking’ estimates of zip codes with

sparse samples towards the Statewide SRH mean (Gelman, Hill 2007). Employing BRFSS weights reduced non-coverage and non-response biases and produced findings generalizable to all Washingtonian Latino residents. Lastly, testing of spatial autocorrelation strengthened the results by verifying model assumptions and providing evidence that zip codes are valid levels at which to test associations with SRH (Clayton, Bernardinelli & Montomoli 1993, Waller, Gotway 2004).

Conclusion

The relationship between Latino residential segregation and SRH relationship might be ‘U’-shaped, such that increases in segregation among Latinos residing in lower segregation areas might result in lower SRH while increases in segregation among Latinos residing in higher segregation areas might result in higher SRH. Future longitudinal studies should measure not only SRH, racial-ethnic discrimination (Williams et al. 1997), various forms of social capital (i.e., social ties, social cohesion, social control, community and governmental trust, efficacy, civic engagement) (Kawachi, Subramanian & Kim 2008, Norris et al. 2008), and Latino residential segregation, but also possible biasing factors (acculturation, ethnic subgroup, demographic, socioeconomic, residential address, health-related behaviors and outcomes) at multiple time points. This information will help to better estimate and understand the mechanisms contributing to the association between Latino residential segregation and SRH disparities by ethnicity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Examined Latino residential segregation, social capital and self-rated health (SRH)
- The Latino residential segregation – SRH relationship is ‘U’-shaped
- Increases in social capital are associated with increases in SRH
- Measures of social capital do not affect the segregation – SRH relationship

Figure 1.
Zip code Latino residential segregation (Gini index), 2010

Figure 2. Odds of excellent, very good, or good health by levels of Latino residential segregation estimated from the fully adjusted model (N=1327).

Table 1

Washington State Behavioral Risk Factor Surveillance System 2012–2014, Latino sample characteristics by self-rated health status (N=1327)¹

Variable	Excellent, Very Good, Good N/Mean (%/SE)	Fair or Poor N/Mean (%/SE)	p-value ²
Age (year)	39.7 (0.54)	43.6 (0.94)	<0.001
Sex			0.900
Male	560 (74.3)	197 (25.7)	
Female	426 (73.9)	144 (26.1)	
Race			0.004
White	512 (80.1)	127 (19.9)	
African American	10 (83)	2 (17)	
Other/multi-race	372 (71)	156 (29)	
Don't Know	72 (60)	50 (40)	
Refused	20 (78.3)	6 (21.7)	
Marital status			0.045
Married/unmarried couple	387 (77.5)	138 (22.5)	
Divorced/widowed/separated/never married	590 (71.1)	202 (28.9)	
Education			<0.001
< High school	230 (59.1)	198 (40.9)	
High school	235 (94.2)	18 (5.8)	
Some college/technical school	275 (81.2)	84 (18.8)	
Graduate of college/technical school	246 (85.4)	41 (14.6)	
Employment status			0.002
Employed	643 (76.6)	178 (23.4)	
Out of work/unable to work	111 (59.8)	84 (40.2)	
Student/homemaker/retired	223 (75.7)	78 (24.3)	
Survey language			<0.001
English	716 (83.4)	150 (16.6)	
Spanish	270 (59.5)	191 (40.5)	
Smoking status			0.146
Not current	893 (75)	289 (25)	
Current	93 (67.8)	52 (32.2)	
Previous 30 day physical activity status			0.003
Yes	764 (77.2)	207 (22.8)	
No	222 (66.6)	134 (33.4)	
Number of chronic conditions	0.58 (0.04)	0.84 (0.07)	<0.001
Survey year			0.941
2012	448 (74.8)	154 (25.2)	
2013	277 (73.8)	104 (26.2)	
2014	261 (73.6)	83 (26.4)	
Community favors frequency			0.034
Very often	225 (79)	61 (21)	

Variable	Excellent, Very Good, Good N/Mean (%/SE)	Fair or Poor N/Mean (%/SE)	p-value ²
Often	203 (80.1)	54 (19.9)	0.003
Sometimes	290 (68.4)	128 (31.6)	
Rarely	161 (70.9)	56 (29.1)	
Never	107 (77.1)	42 (22.9)	
Community intervenes on child truancy			0.004
Very likely	286 (68.6)	121 (31.4)	
Somewhat likely	291 (80)	76 (20)	
Neither likely or unlikely	75 (84.4)	15 (15.6)	
Somewhat unlikely	124 (79.6)	38 (20.4)	0.004
Very unlikely	210 (68.8)	91 (31.2)	
Community protects child safety			
Strongly agree	485 (69.7)	198 (30.3)	
Slightly agree	307 (81.6)	73 (18.4)	0.004
Neither agree nor disagree	73 (75.1)	24 (24.9)	
Slightly disagree	75 (81.7)	19 (18.3)	
Strongly disagree	46 (64.9)	27 (35.1)	

¹ N is the sample count, percentages are survey weighted

² p-values are from survey weighted Wald Chi-square tests

Table 2

Correlation between zip code-level Latino residential composition and economic distress measures (n=367)

	Latino residential segregation	Percent Latino
Percent < 100% Federal Poverty Level	-0.008	0.414 ***
Latino residential segregation		0.148 **

p<0.001,**
p<0.01,*
p<0.05

Table 3

Model estimated odds of excellent, very good, or good health by Latino segregation (N=1327).

Fixed effects	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Intercept	1.112 ***	1.027 *	0.331
Zip code-level ^I			
Latino segregation (Gini index)	0.81 (0.62–1.05)	1.23 (0.90–1.67)	1.18 (0.87–1.62)
Latino segregation * Latino segregation	1.43 (1.09– 1.86) **	1.62 (1.20–2.18) **	1.58 (1.17–2.12) **
1 SD Gini increase from Gini=32.7 (mean –2 SD)	0.28 (0.12– 0.65) **	0.29 (0.11–0.73) **	0.30 (0.12–0.75) **
1 SD Gini increase from Gini=46.8 (mean –1 SD)	0.57 (0.39– 0.83) **	0.76 (0.50–1.14)	0.75 (0.50–1.13)
1 SD Gini increase from Gini=60.9 (mean)	1.16 (0.80–1.68)	1.98 (1.25–2.97) **	1.87 (1.19–2.93) **
1 SD Gini increase from Gini=75.0 (mean +1 SD)	2.35 (1.02–5.46) *	5.20 (1.95–13.89) **	4.65 (1.75–12.32) **
Percent Latino		0.90 (0.73–1.11)	0.89 (0.72–1.1)
Percent < 100% federal poverty level		0.90 (0.67–1.22)	0.93 (0.69–1.25)
Individual-level			
Age (year)		0.98 (0.96–0.99) ***	0.97 (0.96–0.99) ***
Sex			
Male		1.00	1.00
Female		1.08 (0.77–1.50)	1.08 (0.77–1.52)
Marital status			
Divorced/widowed/separated/never married		1.00	1.00
Married/unmarried couple		1.05 (0.74–1.48)	0.98 (0.69–1.4)
Education			
< High school		1.00	1.00
High school		1.90 (1.23–2.93) **	1.99 (1.28–3.11) **
Some college/technical school		2.89 (1.70–4.93) ***	3.12 (1.8–5.43) ***
Graduate of college/technical school		10.26 (4.06– 25.94) ***	10.78 (4.18– 27.77) ***
Employment status			
Employed		1.00	1.00
Out of work/unable to work		1.57 (1.01–2.46)	1.53 (0.97–2.41)
Student/homemaker/retired		1.59 (0.93–2.72)	1.57 (0.91–2.7)
Survey language			
Spanish		1.00	1.00
English		2.51 (1.67–3.78) ***	2.41 (1.57–3.7) ***
Survey year			
2012		1.00	1.00
2013		0.95 (0.65–1.40)	1.02 (0.69–1.51)
2014		0.91 (0.62–1.34)	1.00 (0.67–1.49)
Smoking status			

Fixed effects	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Not current		1.00	1.00
Current		0.73 (0.45–1.18)	0.73 (0.45–1.19)
Previous 30 day physical activity status			
Yes		1.00	1.00
No		0.99 (0.70–1.40)	0.98 (0.69–1.39)
Number of chronic conditions		0.45 (0.36–0.55) ***	0.43 (0.35–0.53) ***
Community favors frequency			
Never			1.00
Very often			1.4 (0.75–2.62)
Often			1.36 (0.71–2.6)
Sometimes			0.67 (0.38–1.15)
Rarely			0.71 (0.39–1.29)
Community intervenes on child truancy			
Very unlikely			1.00
Somewhat unlikely			1.74 (0.95–3.18)
Neither likely or unlikely			1.81 (0.75–4.34)
Somewhat likely			1.62 (1.03–2.55) *
Very likely			1.47 (0.93–2.31)
Community protects child safety			
Strongly disagree			1.00
Strongly agree			2.82 (1.45–5.47) **
Slightly agree			3.02 (1.52–6) **
Neither agree nor disagree			1.94 (0.86–4.39)
Slightly disagree			2.12 (0.87–5.17)
Random effects			
Zip code variance	0.827 ***	0.640 **	0.612 **
ICC ²	0.201	0.163	0.157
AIC	1450.9	1220.0	1206.5

¹ Variables were mean-centered and standardized (mean=0, standard deviation=1)

² ICC = Intraclass correlation calculated by dividing zip code variance by (zip code variance + $\pi^2/3$)

p<0.001,

**
p<0.01,

*
p<0.05