Systemic racism is evidenced in the neighborhood environment via land use practices like residential racial segregation (Williams & Collins, 2001b). Residential segregation is the "degree to which two or more groups live separately from one another, in different parts of the urban environment" (Massey & Denton, 1988, p. 282). Segregation is multidimensional, understandable and measurable according to five distinct aspects of spatial variation: centralization, clustering, concentration, evenness, and exposure (Massey & Denton, 1988). According to Williams (1999), residential segregation is the "single most important [land use] policy" that "continues to have pervasive adverse effects on the socioeconomic circumstances and the health of African Americans." While it is commonly measured with an index of evenness or differential distribution such as dissimilarity; consensus has grown that indices of exposure reflecting degree of potential contact or interaction between minority and majority group members, like isolation, are more appropriate as they better approximate the experience of the average resident (Massey & Denton, 1988). At the societal level systemic racism is evidenced as practices like residential racial segregation, which has been shown to be strongly linked to health disparities (Williams & Collins, 2001a).

Alcohol Environment as Indicator of Segregation

One aspect of the neighborhood environment that has been linked to health outcomes that disproportionately affect poor and minority populations is the alcohol environment (LaVeist & Wallace, 2000; Scribner, Cohen, Kaplan, & Allen, 1999). In particular, the risk is associated with alcohol outlets that sell liquor of off premise consumption (e.g., liquor stores, conveniences stores) (Scribner et al., 1999). LaVeist and Wallace (2000) have demonstrated that the over concentration of off-sale alcohol outlets is associated with black neighborhoods despite lower levels of alcohol consumption by black people. Their findings suggest that due to segregation black and white neighborhoods with similar compositional socioeconomic characteristics (e.g., 40% households in poverty) may look very different contextually with regard to land uses like alcohol outlet density (LaVeist & Wallace, 2000).

Overconcentration of alcohol outlets at the neighborhood level has been linked to a variety of health outcomes. Several mechanisms have been proposed to explain how the alcohol environment contributes to these outcomes. The most straightforward mechanism is the role of increased alcohol availability increasing alcohol consumption. Ironically, this mechanism has been the most difficult to document (Scribner, 2013). However, a study by Halonen and colleagues (2013) convincingly demonstrated an association between off-sale alcohol outlet density and consumption even after controlling for the potential of drinkers selecting neighborhoods with high outlet density. Alternatively, numerous studies have demonstrated geographic associations between both on- and off- sale alcohol outlet density and outcomes like assaultive violence, drunk driving, homicide, domestic violence, and sexually transmitted diseases (Carol B. Cunradi, 2010; Freisthler, Needell, & Gruenewald, 2005; Gruenewald, Ponicki, & Holder, 1993; Livingston, Chikritzhs, & Room, 2007; Scribner, MacKinnon, & Dwyer, 1994, 1995). These studies tend to implicate the role of the alcohol outlets in the neighborhood as a problem land use causing social disorganization affecting routine activities (Cohen & Felson, 1979; Sampson, Raudenbush, & Earls, 1997). In any case, overconcentration of alcohol outlets in minority neighborhoods has been implicated in health disparities affecting minority populations in general and black populations in particular (LaVeist & Wallace, 2000; Livingston, 2012; Williams & Jackson, 2005).

In this study, we investigate whether social inequities in the neighborhood environment, in this case alcohol outlet density, are linked to residential segregation. Specifically we seek to determine whether the overconcentration of alcohol outlets is more likely in black neighborhoods within segregated communities. With this framework, we extend LaVeist and Wallace's (2000) analysis of alcohol outlets and racial concentration by examining the relationship between outlet density and residential segregation in Louisiana (LA) and Alabama (AL), focusing on neighborhoods embedded in counties/parishes. We hypothesize that segregated neighborhoods with high concentrations of Black residents are associated with higher concentrations of alcohol outlets, and thus increased contextual risk for negative health outcomes.

Data

We obtained alcohol outlet data for 2014, including address and type of license, from the Alabama Alcoholic Beverage Control Board (Alabama Alcoholic Beverage Control Board, n.d.) and the Louisiana Office of Alcohol and Tobacco Control (Louisiana Office of Alcohol and Tobacco Control, n.d.). Population estimates and socioeconomic indicators for 2010 census tracts were obtained from the United States (US) Census Bureau's American Community Survey (ACS) (US Census Bureau, n.d.).Total population and population by race were included in the dataset to facilitate the construction of the indicators of residential segregation and population living below the poverty line. The study included all counties (parishes) in Alabama (n=64) and Louisiana (n=67).

Segregation

For this study, we examined residential segregation by using an index of isolation, a measure of exposure common in investigations of the relationship between neighborhood conditions and individual health (Kiarri N. Kershaw, Albrecht, & Carnethon, 2013; Kiarri N. Kershaw et al., 2011). This construct represents the extent to which minority residents, in this case Black residents, live near members of their same minority group. Black isolation for a county was calculated as the weighted average of each tract's black resident proportion,

$$Isolation_j = \sum_{i=1}^{n_j} \left[\frac{b_{ij}}{B_j}\right] * b_{ij} \qquad (1)$$

where B_j is the proportion of black residents in county j and b_{ij} is proportion of black residents in census tract $i = 1, \dots, n_j$ in county j. Scores take a value between 0 and 1 and can be interpreted as the average share of black neighbors for black residents in a county. For analysis, county level black isolation was classified into three categories: low (≤0.3), medium (>0.3 and ≤0.6) and high (>0.6) (Kiarri N. Kershaw et al., 2013).

Analysis

Alcohol Outlet density was modeled using multilevel models with census tracts nested within counties or parishes. Mixed effects generalized linear models were used with off-sale outlet count as a negative binomial response and the natural log of population (given in thousands) as a model offset. We included a random intercept at the county level to account for the correlation of tracts within a county. All models were fit using the Glimmix procedure in SAS version 9.4. Model fit was assessed using the Pearson Chi-square goodness of fit statistic and Chi-square goodness of fit tests. All models included main effects for state to account for differences in alcohol licensing. Our initial model (Model 1) accounted for differences in outlet density by county-level alcohol control policy (wet versus damp). In model 2, we assessed the effects of county- level black isolation. Model 3 introduced a tract-level measure of racial composition to determine if outlets were differentially distributed into neighborhoods with a greater share of black residents within counties. We also included an interaction between tract racial composition and county policy to assess if the association was consistent across wet and damp counties. Finally, in Model 4, we included tract-level poverty to estimate the degree to which differences in alcohol outlet density by racial/ethnic composition may be explained by gradients of poverty.

Results

Multilevel state, county/parish and tract characteristics are reported in Table 1. Alabama had a slightly larger total population and slightly lower percentage of black residents (26.4% for AL and 32.1% for LA). In terms of alcohol outlets, Alabama had greater outlet density per capita overall than Louisiana as well as a greater share of damp counties (35.8% for AL and 25.0% for LA). On average, Louisiana parishes had higher black isolation than Alabama counties.

Table 1. Multilevel state, county/parish and tract characteristics, overall and by State.

Item	All	Alabama	Louisiana
State			
Population, N	9,418,727	4,817,678	4,601,049
Race, %			
White	66.02	69.08	62.82
Black	29.17	26.36	32.12
Other	4.81	4.50	5.06
Off-sale Outlets, N	9,881	5,241	4,640
Counties/Parishes			
N	131	67	64
Policy, %			
Wet	69.47	64.18	75.00
Damp	30.53	35.82	25.00
Black Isolation[1], %			
Low	31.30	46.27	15.63
Medium	32.82	23.88	42.19
High	35.88	29.85	42.19
Tracts			
N	2,304	1,176	1,128
	------------ median (min , max) ------------		
Percent Black	23.01 (0,100)	19.94 (0,100)	27.21 (0,100)
Percent Below Poverty Line	19.19 (0,100)	18.98 (0,79.11)	19.48 (0,100)
Outlet Density[2]	0.97 (0,12.88)	1.03 (0,8.41)	0.91 (0,12.88)

[1] Black Isolation was categorized as Low (≤0.3), Medium (>0.3 and ≤0.6) and High (>0.6).
[2] Off-sale outlet density is given as number of off-sale outlets per 1,000 residents.

A summary of tract characteristics by level of county segregation (black isolation level: high, medium or low) is presented as Table 2. A higher level of black isolation was associated with higher percentages of black residents and higher rates of poverty within tracts. The median percentage of black residents increased from 7.6% to 42.7% going from low to high black isolation counties. The median percentage of residents living below the poverty line increased from 15.8% to 21.7%. The greatest alcohol outlet densities were observed in tracts within counties characterized by medium and high black isolation, which had a median off-sale outlet density of 1.01 and 1.00 outlets per 1,000 residents, respectively. Counties characterized by low black isolation had the largest proportion of tracts with dry or damp county alcohol policy (43.4%).

Table 2. Census tract characteristics by levels of Black Isolation

Item	All	County Black Isolation[1]		
		Low	Medium	High
N	2,329	525	596	1,208
Damp County Policy, %	16.70	43.43	10.91	7.95
		------------ median (min , max) ------------		
Percent Black	23.01 (0,100)	7.63 (0,94.83)	21.82 (0,95.57)	42.69 (0,100)
Percent Below Poverty Line	19.19 (0,100)	15.76 (0,53.26)	18.60 (0,79.11)	21.73 (0.51,100)
Outlet Density[2]	0.97 (0,12.88)	0.86 (0,8.41)	1.01 (0,12.88)	1.00 (0,8.11)

1 Black Isolation was categorized as Low (≤0.3), Medium (>0.3 and ≤0.6) and High (>0.6).
2 Off-sale outlet density is given as number of off-sale outlets per 1,000 residents.

Table 3 provides the results from multilevel generalized linear models of off-sale outlet density. Results are reported as adjusted rate ratios (RR) with corresponding 95% confidence intervals (CI). Off-sale outlet density was 70% greater in wet counties compared to damp counties (RR=1.70, 95%CI (1.52,1.90); Model 1). Controlling for county policy, Model 2 showed a significant relationship between county black isolation and off-sale outlet density, with census tracts in counties characterized by medium or high black isolation having greater outlet density as compared to tracts in counties characterized by low black isolation (RR=1.17, 95%CI (1.05,1.32) and RR=1.16, 95%CI (1.03,1.30) for medium and high black isolation, respectively).

How does the overall racial composition of the census tract affect off-sale outlet distribution – do highly segregated but mostly white tracts have a high outlet density or is outlet density higher for highly segregated and mostly black tracts? Model 3 examined this question by including county-standardized tract percent black, a measure of relative tract racial composition. It was observed that within a county, tracts with a greater share of black residents had significantly higher off-sale outlet density, though the magnitude of the effect differed for wet and damp counties. While a single standard deviation increase in percentage of black residents in a census tract was associated with a 12% increase in outlet density in wet counties(RR=1.12, 95%CI (1.09,1.15)), in damp counties that increase was 44% (RR=1.44, 95%CI (1.34,1.54)).

As poorer neighborhood conditions and alcohol outlet density are known to be associated with low-income and high poverty neighborhoods, we included a county standardized percent of residents living below the poverty line to examine the degree to which tract-level poverty accounts for differences associated with segregation and racial composition (Model 4). Controlling for poverty, tract racial composition remained significantly associated with off-sale outlet density in damp counties. In these counties, a single standard deviation increase in percentage of black residents in a census tract was associated with a 45% increase in off-sale outlet density (RR=1.45, 95%CI (1.34,1.57))..

Table 3. Estimated rate ratios (RR) and 95% confidence intervals (CI) from multilevel generalized linear models of off-sale outlets per 1,000 residents.

Item	Model 1	Model 2	Model 3	Model 4
County Black Isolation[1]				
Low (ref)		1.00	1.00	1.00
Medium		1.17 (1.05 , 1.32)	1.17 (1.04 , 1.32)	1.17 (1.03 , 1.32)
High		1.16 (1.03 , 1.30)	1.17 (1.04 , 1.32)	1.17 (1.04 , 1.33)
Tract Percent Black[2]				
Wet			1.12 (1.09 , 1.15)	1.00 (0.97 , 1.04)
Damp			1.44 (1.34 , 1.54)	1.45 (1.34 , 1.57)
Tract Poverty[2]				
Wet				1.30 (1.24 , 1.38)
Damp				0.96 (0.81 , 1.14)
County Policy				
Damp (ref)	1.00	1.00	1.00	1.00
Wet	1.70 (1.52 , 1.90)	1.61 (1.44 , 1.81)	1.77 (1.58 , 2.00)	1.74 (1.54 , 1.96)
State				
Louisiana (ref)	1.00	1.00	1.00	1.00
Alabama	1.08 (0.99 , 1.17)	1.12 (1.03 , 1.22)	1.12 (1.03 , 1.23)	1.13 (1.02 , 1.24)
Model fit				
N	2,304	2,304	2,304	2,302
Pearson χ^2/ DF	1.11	1.11	1.13	1.11
-2LL	11,163	11,160	10,970	10,854

1 Black Isolation was categorized as Low (≤0.3), Medium (>0.3 and ≤0.6) and High (>0.6).
2 Rate ratios were estimated separately for wet and damp counties using main effects and interaction terms from the model. Rates are given for a one standard deviation increase in the county-standardized tract measure.

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