Published in final edited form as:

Ethn Health. 2013 June ; 18(3): 227–243. doi:10.1080/13557858.2012.713092.

Racial discrimination, racial/ethnic segregation and health behaviors in the CARDIA Study

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Abstract

Objective—Racial discrimination has been associated with unhealthy behaviors, but the mechanisms responsible for these associations are not understood and may be related to residential racial segregation. We investigated associations between self-reported racial discrimination and health behaviors before and after controlling for individual- and neighborhood-level characteristics; and potential effect modification of these associations by segregation.

Design—We used data from the longitudinal Coronary Artery Risk Development in Young Adults study (CARDIA) for 1,169 African-Americans and 1,322 whites. To assess racial discrimination, we used a 4 category variable to capture the extent and persistence of self-reported discrimination between years 7 (1992–93) and 15 (2000–2001). We assessed smoking status, alcohol consumption, and physical activity at year 20 (2005–2006). Segregation was examined as the racial/ethnic composition of the Census tract level.

Results—Discrimination was more common in African-Americans (89.1%) than in whites (40.0%). Living in areas with high percentage of blacks was associated with less reports of discrimination in African-Americans but more reports in whites. After adjustment for selected characteristics including individual and neighborhood-level socioeconomic conditions and segregation, we found significant positive associations of discrimination with smoking and alcohol consumption in African-Americans and with smoking in whites. African-Americans experiencing moderate or high discrimination were more physically active than those reporting no discrimination. Whites reporting some discrimination were also more physically active than those reporting no discrimination. We observed no interactions between discrimination and segregation measures in African-Americans or whites for any of the three health behaviors.

Conclusions—Racial discrimination may impact individuals' adoption of healthy and unhealthy behaviors independent of racial/ethnic segregation. These behaviors may help individuals buffer or reduce the stress of discrimination.

Keywords

United States; discrimination; segregation; health behaviors; race/ethnicity; neighborhood characteristics

Introduction

Racial discrimination is pervasive and differentially distributed across race/ethnicity in the U.S., (Borrell et al., 2007; Borrell et al., 2006; Krieger, 1999; D. R. Williams et al., 2003) with at least 75% of blacks reporting experience of discrimination (Borrell et al., 2007; Borrell et al., 2006). Self-reported racial discrimination is associated with poorer self-rated physical and mental health (Borrell et al., 2006; Gee, 2002; Krieger, 1999; Paradies, 2006; Pascoe & Smart Richman, 2009; D.R. Williams & Mohammed, 2009; D. R. Williams et al., 2003) and with adverse cardiovascular outcomes (Brondolo et al., 2011; Krieger, 1999; Krieger & Sidney, 1996; Lewis et al., 2006; Troxel et al., 2003; D. R. Williams et al., 2003; Wyatt et al., 2003). Most evidence on the association between racial discrimination and health status pertains to blacks (Krieger, 1999; Paradies, 2006; D.R. Williams & Mohammed, 2009; D. R. Williams et al., 2003).

While the mechanisms by which racial discrimination (hereafter discrimination) affects health are poorly understood, discrimination may affect health through behavioral risk factors (Cohen et al., 1995; Pascoe & Smart Richman, 2009; D.R. Williams & Mohammed, 2009). Thus, one may adopt unhealthy behaviors such as smoking and drinking to buffer or reduce the chronic stress of discrimination (Jackson & Knight, 2006). Consistent with this hypothesis, discrimination has been linked to greater alcohol and tobacco use in adults (Bennett et al., 2005; Borrell et al., 2007; Chae et al., 2008a; Chae et al., 2008b; Gee et al., 2007; Krieger et al., 2005; Kwate et al., 2003; H. Landrine & Klonoff, 1996; H. Landrine & Klonoff, 2000; H. Landrine et al., 2006; Martin et al., 2003; Taylor & Jackson, 1990; Whitbeck et al., 2004; Yen et al., 1999a, b).

In addition to the health consequences of individuals' experiences of discrimination, discrimination may affect health through institutional level discrimination. For instance, institutional discrimination may contribute to racial/ethnic residential segregation (hereafter, segregation), possibly a fundamental cause of health disparities (D. R. Williams & Collins, 2001). Segregation may affect individual health through differential physical, social and economic environments by race/ethnicity (Acevedo-Garcia et al., 2003; Kramer & Hogue, 2009; D. R. Williams & Collins, 2001). For example, highly segregated, predominantly minority neighborhoods in the U.S. often harbor a built environment deleterious to health through a climate of violence, lack of safe areas for physical activity, targeting and marketing of tobacco and alcohol, preponderance of fast food restaurants, and limited access to healthy food (Kramer & Hogue, 2009; White & Borrell, 2010; D. R. Williams & Collins, 2001). These environmental features may affect the distribution of individual risk factors or exposure to stressful situations (Kramer & Hogue, 2009; D. R. Williams & Collins, 2001). Indeed, studies have found that greater segregation is associated with smoking during pregnancy (Bell et al., 2007), physical inactivity (Lopez, 2006), weight gain (Chang, 2006) and injection drug use (Cooper et al., 2007).

Segregation might also reduce exposure to interpersonal discrimination by diminishing contact between minority and majority racial/ethnic groups. For instance, African-Americans residing in racially mixed neighborhoods in Detroit were more likely to report discrimination than those residing in predominantly African-American neighborhoods (Welch et al., 2001). Similarly, African-American women in Connecticut neighborhoods

with lower percentages of blacks were more likely to report experiencing discrimination than those residing in more predominantly black neighborhoods (Dailey et al., 2010). Finally, the Black's Women Health Study recently found that perceptions of everyday and lifetime discrimination increased as the proportion of blacks in the census tracts decreased (Hunt et al., 2007). Thus, segregation could modify the effect of discrimination on health.

Because of the multiple ways in which segregation and discrimination may interact, the relationship between discrimination, segregation, and health is likely complex, but elucidating it may contribute to our understanding of the effects of discrimination on health. However, no U.S. study has examined whether the effect of discrimination on health outcomes depends on level of segregation of an individual's neighborhood. In fact, reviews on segregation and health reveal the examination of the interaction between discrimination and segregation on health outcomes as an important but understudied area (Acevedo-Garcia et al., 2003; White & Borrell, 2010).

The longitudinal Coronary Artery Risk Development in Young Adults study (CARDIA) offers the opportunity to investigate whether there is an association between self-reported discrimination and health behaviors before and after controlling for individual- and neighborhood-level characteristics and whether these associations varies by neighborhood racial/ethnic segregation.

Methods

Study Design

CARDIA recruited 5,115 persons aged 18 to 30 years at baseline (1985–1986), by random digit dialing in 3 cities (Birmingham, AL; Chicago Ill; and Minneapolis, MN) and randomly from the membership roster of a large health plan (Oakland, CA) (Cutter et al., 1991; Friedman et al., 1988), with an overall response rate of 55%. Recruitment was stratified to obtain nearly equal numbers of African-Americans and whites, men and women, persons <25 and ≥25 years old, and persons with ≤high school education and >high school education at each of the four centers. Participants were re-examined every 2–5 years with retention rates for years 7 (1992–1993), 15 (2000–2001) and 20 (2005–2006) of 80%, 72% and 69%, respectively, for a sample of 3,549 at Year 20. African-Americans exhibited lower retention rates (74%, 65% and 62% for years 7, 15 and 20) than whites (85%, 78% and 76% for years 7, 15 and 20). Records were excluded from the analyses if data on discrimination at years 7 and 15 (n=213) or health behaviors at year 20 (n=482) were missing; addresses could not be geocoded or segregation information was missing (n=335); and marital status or income data were missing (n=28) for an analytical sample of 2,491 (1,169 African-Americans and 1,322 whites) distributed across 1,418 census tracts (median 1 participant per census tract at year 15, range 1–20).

Main Independent Variable

At years 7 and 15, participants were asked about their experiences of discrimination due to race or color, gender, and socioeconomic position or social class (Krieger & Sidney, 1996; Krieger et al., 1998). We focus on race or color only. During the year 7 examination, participants were asked whether they had ever experienced discrimination, been prevented from doing something, or been hassled or made to feel inferior because of their race or color in seven domains (Yes/No): at school, getting a job, at work, getting housing, getting medical care, on the street or in a public setting, and from the police or in the courts. At year 15, the phrase 'been prevented from doing something' was dropped from the discrimination question and the domain 'from the police or in the courts' was replaced with 'at home.' Consistent with prior work that found little difference in the prevalence of and number of

domains of discrimination in years 7 and 15 for African-Americans and whites (Borrell et al., 2007), we used a 4 category variable to capture the extent and persistence of discrimination at years 7 and 15: reporting discrimination in 3 domains at both years (high); reporting discrimination in 3 domains at one year only (moderate); reporting discrimination in <3 domains in one or both years (limited); and reporting no discrimination exposure (none).

Dependent Variables

Smoking status (never, former, and current smoker), alcohol consumption, and physical activity were ascertained at year 20. Participants were asked, “Did you drink any alcoholic beverages in the past year? Yes/No” and three follow-up questions regarding how many drinks of wine, beer, and liquor usually consumed per week. Alcohol consumption was also dichotomized as binge drinking, defined as 5 drinks for men and 4 drinks for women in any 24 hours.

At each exam, physical activity was assessed with the CARDIA Physical Activity History Questionnaire in each of 13 vigorous (8)- and moderate (5)-intensity activities over the previous year including sports, exercise, home maintenance and occupational activities. This questionnaire showed test-retest reliability ranging between 0.77 and 0.84 (Jacobs et al., 1989). An intensity score was developed by summing the scores for all activities expressed in exercise units to represent the usual level of activity over the past 12 months (Jacobs et al., 1989). Consistent with a previous study (Parker et al., 2007), we used the mean total intensity score because of its high correlation with the moderate (0.74) and vigorous (0.94) scores. Because the total intensity score was non-normally distributed and consistent with a recent study (Hankinson et al., 2010), we used the following categories: lower activity (scores <340 exercise units for men and <192 exercise units for women), moderate activity (scores 340–607 exercise units for men and 192–397 exercise units for women), and higher activity (scores 608 exercise units for men and 398 exercise units for women).

Individual-level covariates

Age and sex were ascertained at baseline and updated at year 2. Marital status, income and education were obtained at year 15. We dichotomized marital status into married (married or living with someone in a marriage-like relationship) and non-married (widowed, divorced, separated, never married, or other). Educational attainment was recoded as <high school; high school (high school diploma or general equivalence diploma (GED)); some college; and college graduate or higher. Annual family income was categorized as \$34,999, \$35,000–\$49,999, \$50,000–\$74,999 and >\$75,000.

Coping mechanisms with unfair treatment at year 15 was categorized as those who both talk to others about it and try to do something when they feel they have been treated unfairly (active coping); do either one or the other (mixed); and those that do neither (passive) (Stancil et al., 2000).

Neighborhood-level covariates

Neighborhood variables were derived from the 2000 U.S. Census based on CARDIA participants' address information for year 15. Defining the level at which segregation should be defined is complex. Some studies have used Metropolitan Statistical Areas (MSA)-level measures of segregation to capture the extent of residential segregation within an MSA (Acevedo-Garcia & Osypuk, 2008; Kramer et al., 2010; Kramer & Hogue, 2009; White & Borrell, 2010). MSA level measure have the advantage of capturing macro-level processes that affect all MSA residents but do not capture heterogeneity of exposures within MSA linked to small scale variations across neighborhoods. Because CARDIA participants were

recruited from 4 cities and most had remained in those cities throughout the follow-up period, we had limited variability in MSA-level measures of segregation. For this reason, and due to our interest in investigating smaller scale processes linked to variations across neighborhoods we utilized race/ethnic composition of the census tract of residence as a proxy for segregation of the participant's neighborhood of residence. Census tracts, a U.S. Census subdivision with an average 4,000 residents, comprised multiple block groups ("U.S. Census Bureau. Census 2000 Tabulation Geography Tallies. 2001,"). We investigated racial/ethnic composition defined as the percent of African-Americans or blacks living in a given Census tract. Although this is not a measure of segregation because it does not make reference to the overall race/ethnic composition of the larger area, it is often correlated with segregation and may represent geographic clustering of racial/ethnic groups. After examining the distribution of the % blacks in the Census tract, we categorized this variable using distribution tertile across the entire CARDIA cohort. These identical tertile categories were used for the analyses of both African-Americans and whites.

Consistent with previous analysis using the 1990 U.S. Census (Borrell et al., 2004; Diez-Roux et al., 2001a; Diez-Roux et al., 2001b), a neighborhood socioeconomic (SE) score was developed using multiple 2000 U.S. Census variables. Briefly, using factor analysis, six variables representing dimensions of wealth/income (log of the median household income for 1999, log of the median value of owner occupied housing units, and proportion of households receiving interest, dividend or net rental income), education (proportion of adults aged 25 years or older with at least a high school diploma and with at least a completed college education), and occupation (proportion of employed persons aged 16 years or older in executive, managerial, or professional specialty occupations) loaded on a factor with an Eigenvalue of 4.9 explaining 81% of the variance and were combined to develop the score. Each variable was transformed into a Z-score by subtracting its value from the mean of all Census tracts in the CARDIA study sample (or grand mean for that variable) and dividing by the standard deviation for all Census tracts in the sample (or standard deviation of the grand mean). The score for each Census tract was calculated as the sum of the Z-scores for the six variables. The score ranged from -11.83 to 14.33, with higher values reflecting neighborhood SE advantage. The neighborhood SE score was categorized into tertiles.

Statistical Analysis

Because self-reported discrimination has been found to be far less frequent in whites (37.9%) than in African-Americans (89.5%) in CARDIA (Borrell et al., 2007) and may be a qualitatively different phenomenon with different health implications, we analyzed African-Americans and whites separately. Descriptive statistics were calculated by categories of levels of discrimination. Statistical significance of differences among discrimination categories were assessed via chi-square statistics and ANOVA as appropriate. Two-sided *p* values of <0.05 were considered statistically significant.

Logistic regression estimated the association of discrimination at years 7 and 15 with any alcohol consumption and binge drinking at year 20; multinomial logistic regression estimated the association of discrimination with smoking and physical activity at Year 20 before and after adjusting for selected individual and neighborhood characteristics. Population-average models were fitted through Generalized Estimating Equations to account for the correlation between outcomes of individuals within the same neighborhoods (Diggle et al., 2003; Hubbard et al., 2010; Zeger et al., 1988). To determine whether the association of discrimination with each outcome differs according to racial/ethnic composition, an interaction term between discrimination and racial/ethnic composition was tested for each outcome in the final model. The neighborhood SE score was highly correlated with % black ($r=-0.63$). However, results did not vary substantially when these variables were included separately or together so both variables were retained in final models. Descriptive statistics

were performed with SAS ("The SAS Institute Inc. SAS Software® 9.2 2009,") while the rest of the analyses used SUDAAN ("Research Triangle Institute. SUDAAN Language Manual, Release 10.0. 2008 ").

Results

Almost 90% of African-Americans reported experiencing discrimination with 33.6% experiencing high discrimination (Table 1). Discrimination was more common among African-Americans with higher education, higher income and among those who resided in neighborhoods that had lower percent of blacks and were more socioeconomically advantaged (all p-values <0.05).

Whites (40%) were less likely than African-Americans (89.2%) to experience discrimination with only 1.4% reporting high discrimination (Table 2). In contrast to African-Americans, discrimination was more common among whites reporting less education, lower income and living in neighborhoods with a higher percentage of blacks and socioeconomic disadvantaged (all p-values <0.05). Consistent with previous research (Sampson & Wilson, 1995), the neighborhood SE score distribution for African-Americans was markedly lower than for whites. African-Americans reporting any discrimination were more likely to report drinking in the past year and be highly physically active (p-values <0.01, Table 3). In addition, while not statistically significant, African-Americans reporting any discrimination were more likely to report current smoking. Whites reporting high discrimination were more likely to currently smoke than those reporting no discrimination (p<0.01). There was no association of discrimination with alcohol use or physical activity for whites.

For African-Americans, while there was no statistically significant association between discrimination and current smoking at year 20 in the unadjusted model, after adjustment for age, gender, marital status, coping mechanisms, education and income (Model 2), African-Americans experiencing high and moderate discrimination versus no discrimination had 1.75 (95% CI: 1.05–2.91) and 2.20 (95% CI: 1.32–3.65) greater odds of current smoking (Table 4). African-Americans experiencing high discrimination versus no discrimination had 2.50 (95% CI: 1.23–5.07) greater odds of reporting former smoking before adjustment; after adjustment, these estimates were 2.38 (95% CI: 1.11–5.12) and 3.36 (95% CI: 1.59–7.09) for moderate and high discrimination, respectively (Model 2). Further adjustment for neighborhood SE conditions and racial/ethnic composition did not appreciably change these estimates.

African-Americans experiencing moderate and high discrimination versus no discrimination had greater odds of reporting any alcohol use in the past year, estimates that remained unchanged by any adjustments (Models 1 through 3a). There was no association between discrimination and binge drinking (data not shown). The odds of being in the highest versus the lowest physical activity tertile were at least two times higher in African-Americans experiencing moderate and high discrimination versus no discrimination, associations that remained statistically significant after adjustment (Models 1 to 3a).

Whites reporting high discrimination versus no discrimination had 5.79 (95% CI: 1.99–16.84) greater odds of current smoking (data not shown), an association nearly unchanged after adjustments. Whites reporting limited discrimination had 37% (OR: 1.37; 95% CI: 1.03–1.81) greater odds of being in the highest compared to the lowest physical activity tertile versus no discrimination. This association remained unchanged after adjustment.

We re-examined alcohol consumption specified as heavy (> 2 drinks/day for men and more > one drink/day for women), mild to moderate (any but not heavy) and no alcohol consumption. The results were qualitatively similar to when we used any alcohol versus

none, unadjusted or adjusted (data not shown). We observed no association between discrimination and alcohol consumption among whites regardless of the definition and adjustment used.

In multivariable modeling, there was no evidence that discrimination interacted with racial/ethnic composition for smoking status, alcohol consumption or physical activity among African-Americans or whites (all p-values >0.20). These findings were consistent regardless of whether racial/ethnic composition was examined as continuous or categorical.

Discussion

As previously found in CARDIA (Borrell et al., 2007), African-Americans reported discrimination much more frequently than whites. African-Americans reporting highest levels of discrimination were more likely to smoke, use alcohol, and be physically active. Whites reporting high discrimination were more likely to smoke and those reporting limited discrimination were more physically active. All associations persisted after adjustment for individual and neighborhood level variables, including racial/ethnic composition. Importantly, the associations between discrimination and health behaviors were not modified by racial/ethnic composition, for either African-Americans or whites.

Previous studies have reported that self-reported discrimination is linked with tobacco and alcohol use in adults (Bennett et al., 2005; Borrell et al., 2007; Chae et al., 2008a; Chae et al., 2008b; Gee et al., 2007; Krieger et al., 2005; Kwate et al., 2003; H. Landrine & Klonoff, 2000; H. Landrine et al., 2006; Martin et al., 2003; Taylor & Jackson, 1990; Whitbeck et al., 2004; Yen et al., 1999a, b). While most studies have examined these associations among African-Americans (Bennett et al., 2005; Borrell et al., 2007; Kwate et al., 2003; H. Landrine & Klonoff, 2000; H. Landrine et al., 2006; Martin et al., 2003; Taylor & Jackson, 1990; Yen et al., 1999a, b), fewer studies have reported associations of discrimination with smoking (Borrell et al., 2007; H. Landrine et al., 2006) and alcohol use (Borrell et al., 2007) among whites. However, discrimination is consistently associated with smoking and alcohol consumption in both African-Americans and whites. For instance, Landrine et al. (2006) found that whites experiencing frequent discrimination were 76% more likely to smoke than those reporting low discrimination. In prior work with CARDIA, African-Americans experiencing discrimination were at least 87% more likely to be current smokers and to drink alcohol in the past year (Borrell et al., 2007). This finding was also observed in whites for smoking (Borrell et al., 2007).

Our current findings, consistent with previous reports on tobacco and alcohol, also expand our knowledge in two directions. First, we found no confounding or modifying effect of racial/ethnic composition on the association between discrimination and tobacco or alcohol consumption, suggesting that discrimination may operate regardless of racial/ethnic composition. Second, the assessment of discrimination at two times years apart, and the measurement of health behaviors 5 years after the last measurement of discrimination, lends credence to the long-lasting nature of the associations we found.

With regard to discrimination and physical activity, the evidence is limited. For instance, a recent study of 1,055 black and Hispanic adults residing in low-income housing found no association between discrimination and physical activity (Shelton et al., 2009). Shelton et al. (2009) found that 48% of adults reported ever experiencing discrimination and that those reporting discrimination also reported higher mean number of steps per day (5772.6) versus those never experiencing discrimination (5655.9). However, this association was not statistically significant after adjusting for age, gender, race/ethnicity, BMI and employment status. Our study found that African-Americans reporting high and moderate discrimination

reported higher levels of physical activity than those reporting no discrimination after controlling for individual and neighborhood characteristics including racial/ethnic composition. This finding was also observed for whites reporting limited discrimination.

We can only speculate on reasons for the positive associations between high levels of discrimination and physical activity. Discrimination may be considered as a stressor and one of the potential mechanisms to cope with it is to initiate or engage in behaviors to mitigate or reduce this stress (Jackson & Knight, 2006; D.R. Williams & Mohammed, 2009). Thus, the same way people engage in addictive behaviors such as smoking or excessive alcohol consumption to deal with discrimination, some individuals may be aware of the stress-relieving effects of exercise and channel stress into this positive health behavior. Interestingly, these findings were observed in both, African Americans and whites, suggesting that the correlated of reports of discrimination in various racial/ethnic groups need to be further examined.

Residential segregation has been linked to smoking (Bell et al., 2007) and to experience of discrimination in African-Americans (Dailey et al., 2010; Hunt et al., 2007; Welch et al., 2001). In these studies, African-Americans residing in neighborhoods with low percentages of blacks were more likely to smoke and report discrimination. However, while segregation and discrimination are common for African-Americans in the U.S. (Borrell et al., 2007; Borrell et al., 2006; Iceland et al., 2002), the interaction between discrimination and segregation on health outcomes has not been examined. We found no evidence of heterogeneity of the associations of discrimination with smoking, alcohol consumption, and physical activity according to racial/ethnic composition.

Consistent with previous studies (Borrell et al., 2007; Borrell et al., 2006; Krieger et al., 1998; Ren et al., 1999; Yen et al., 1999a, b), we found that African-Americans reporting high levels of discrimination had higher education and income than those experiencing less or no discrimination. For whites, the opposite was true. We also found that African-Americans reporting high discrimination were more likely to reside in neighborhoods in the highest tertile of socioeconomic score whereas whites reporting discrimination reside in neighborhoods in the lowest tertile. African-Americans with high socioeconomic position (SEP) may be more likely to interact and/or live in environment exposing them to more discrimination or they may be more aware of discrimination. For whites, the opposite may be true, their low SEP may expose whites to environments in which they are the minority, and, thus, are more likely to feel discriminated.

Among the strengths of our study are its community-based nature, the focus on young to middle-aged adults, the information on discrimination, and the availability of longitudinal and geocoded data. The differential attrition by race may have affected our results by under or overestimating our associations if the exposure and/or outcomes were associated with the retention. In addition, the exclusion of CARDIA participants as the result of missing data may have affected our results. However, we compared selected characteristics for participants included and those excluded in African Americans and whites. We found no difference in age, sex, smoking, alcohol, physical activity, coping, discrimination, racial/ethnic composition and neighborhood SE between those excluded and those included in the analyses for African Americans (all $p>0.10$). Excluded Whites were more likely to report moderate discrimination than those included in the analyses ($p=0.005$) but no differences were observed for the other factors.

While our data were collected in 1992–1993, 2000–2001, and 2005–2006, we used the 2000 U.S. Census linked to participants' addresses in 2000–2001 to define segregation and neighborhood SE. However, we conducted preliminary analyses on 1990 and 2000 U.S.

Census data linked to participant addresses for years 7 (1992–1993), 15 (2000–2001) and 20 (2005–2006) and consistent with previous studies (Diez-Roux et al., 2004; Diez-Roux et al., 2001b; Haan et al., 1989), our analyses showed that when people moved they do so to similar neighborhoods. Thus, the characteristics of the neighborhoods remained relatively stable.

An important limitation pertains to the measure of segregation that we used. The most common measures of segregation such as the indices of dissimilarity and isolation refer to MSA, a unit constructed to define counties clustered around a central city defined by its economic integration (Acevedo-Garcia & Osypuk, 2008; Kramer et al., 2010). However, because CARDIA recruited from 4 cities and most participants have remained in those cities, we did not have the power to use MSA as the macro-unit to define segregation. Thus, we were limited to the use of racial/ethnic composition as a proxy for segregation at the Census tract level. However, Wong argues that although the use of Census tracts to define local segregation requires conceptual debates and empirical evidence, local segregation defined at the tract level may be more relevant to individuals as it reflects their daily experiences more accurately than global segregation or segregation defined at the MSA level (Wong, 2008). Thus, it is possible that racial/ethnic composition may capture neighborhood dynamics affecting and/or shaping individual's behaviors.

In summary, self-reported discrimination was associated with deleterious alcohol and tobacco behaviors several years later, regardless of neighborhood characteristics such as racial/ethnic segregation. Surprisingly, discrimination was related to increase physical activity, regardless of possible explanatory factors at the individual or the neighborhood levels. Future studies should explore the complex associations between race/ethnicity, socioeconomic position, neighborhood racial/ethnic composition, and health to provide insights into evidence-based approaches to reduce racial disparities.

Acknowledgments

The CARDIA Study was supported by National Heart, Lung, and Blood Institute contracts N01-HC-48047, N01-HC-48048, N01-HC-48049, N01-HC-48050, and N01-HC-95095. The authors thank the staff of the CARDIA Study for their important contributions.

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Key Message

This study shows that African Americans reported racial discrimination much more frequently than whites in the CARDIA study. High discrimination associated with current/former smoking, any alcohol use and high levels of physical activity in African Americans. Whites reporting high discrimination were more likely to report current smoking and high levels of physical activity. Associations persisted after adjustment for individual- and neighborhood-level variables. Associations were not modified by **racial/ethnic composition**, for African Americans or whites.

Table 1

Distribution of selected sociodemographic characteristics at year 15, by self-reported discrimination at years 7 and 15 among African-Americans: The CARDIA study, 1992–2001

Characteristics at Year 15	Discrimination Experience at Years 7 and 15 [†]				P-Value [*]
	None (n=138)	Limited (n=311)	Moderate (n=327)	High (n=393)	
Individual-level					
Discrimination Experience (%)	11.8	26.6	28.0	33.6	
Age in Years: Mean (SD)	39.2 (3.8)	39.6 (3.8)	39.3 (3.7)	39.8 (3.7)	0.18
Gender (%)					
Male	9.3	24.4	30.5	35.9	0.05
Female	13.4	28.0	26.4	32.2	
Married (%)					
Married	9.7	27.1	27.8	35.3	0.12
Non-married	14.0	26.0	28.1	31.8	
Education (%)					
Incomplete high school	27.8	18.1	31.9	22.2	<0.0001
Complete high school or GED	17.3	30.7	25.8	26.1	
1–3 years of college	10.7	28.6	27.7	33.0	
Complete College and higher	5.5	22.3	29.3	42.9	
Income (%)					
\$34,999	16.5	28.1	28.8	26.5	<0.0001
\$35,000-\$49,999	10.7	28.0	25.3	36.0	
\$50,000-\$74,999	9.9	28.2	31.3	30.6	
\$75,000	7.1	21.6	25.6	45.7	
Unfair treatment coping mechanisms					
Active	11.4	25.5	28.8	34.4	0.50
Mixed	11.2	29.3	26.1	33.3	
Passive	17.3	29.3	26.7	26.7	
Neighborhood-level					
% of Blacks mean (SD) [‡]	0.58 (0.35)	0.49 (0.34)	0.47 (0.34)	0.44 (0.33)	0.0003
Low	6.0	23.0	30.0	41.0	0.10

Characteristics at Year 15	Discrimination Experience at Years 7 and 15 [†]					P-Value *
	None (n=138)	Limited (n=311)	Moderate (n=327)	High (n=393)		
Middle	9.5	26.6	29.3	34.7		
High	13.9	27.1	27.0	32.0		
Neighborhood SEP Score mean (SD)	-3.96 (4.45)	-2.62 (4.72)	-2.18 (4.75)	-1.67 (4.74)		<0.0001
Low	14.8	28.7	28.8	27.7		0.0001
Middle	9.8	24.7	25.0	40.4		
High	6.5	24.0	31.0	38.5		

* P-values for Chi-Square and ANOVA tests.

[†] Categories for discrimination experience represent discrimination in 7 domains in years 7 and 15.

[‡] Mean (SD) and tertile are presented for each measure.

Table 2

Distribution of selected sociodemographic characteristics at year 15, by self-reported discrimination at years 7 and 15 among Whites: The CARDIA study, 1992–2001

Characteristics at Year 15	Discrimination Experience at Years 7 and 15 [†]				P-Value [*]
	None (n=795)	Limited (n=452)	Moderate (n=57)	High (n=18)	
Individual-level					
Discrimination Experience (%)	60.1	34.2	4.3	1.4	
Age in Years: Mean (SD)	40.8 (3.2)	40.4 (3.5)	39.9 (3.5)	40.4 (3.6)	0.10
Gender (%)					
Male	61.0	33.3	4.4	1.3	0.90
Female	59.3	35.0	4.2	1.4	
Married (%)					
Married	61.9	33.3	3.8	0.9	0.03
Non-married	56.1	36.1	5.4	2.4	
Education (%)					
Incomplete high school	36.4	45.4	18.2	0	0.03
Complete high school or GED	62.2	30.5	5.3	2.0	
1–3 years of college	58.4	34.5	5.1	2.0	
Complete College and higher	60.9	34.5	3.5	1.1	
Income (%)					
\$34,999	44.3	43.2	8.5	4.0	<0.0001
\$35,000-\$49,999	61.0	33.5	3.3	2.2	
\$50,000-\$74,999	61.6	33.9	3.9	0.6	
\$75,000	63.5	32.1	3.6	0.8	
Unfair treatment coping mechanisms					
Active	60.6	34.6	3.3	1.5	0.09
Mixed	59.4	32.0	7.8	0.8	
Passive	57.0	36.0	5.8	1.2	
Neighborhood-level					
% of Blacks mean (SD) [‡]	0.09 (0.14)	0.10 (0.14)	0.16 (0.21)	0.14 (0.21)	0.004
Low	63.0	32.8	2.7	1.4	0.03

Characteristics at Year 15	Discrimination Experience at Years 7 and 15 [†]				P-Value [*]
	None (n=795)	Limited (n=452)	Moderate (n=57)	High (n=18)	
Middle	56.8	36.2	6.0	1.0	
High	57.1	33.6	6.7	2.5	
Neighborhood SEP Score mean (SD)	3.18 (4.50)	2.87 (4.46)	1.83 (4.39)	2.50 (4.72)	0.13
Low	58.2	32.6	7.1	2.1	0.29
Middle	58.6	35.9	4.8	0.7	
High	61.4	33.5	3.5	1.6	

^{*} P-values for Chi-Square and ANOVA tests.

[†] Categories for discrimination experience represent discrimination in 7 domains in both Years 7 and 15.

[‡] Mean (SD) and tertile are presented for each measure.

Table 3

Prevalence of smoking status, alcohol consumption and physical activity at year 20, according to self-reported discrimination at years 7 and 15: The CARDIA study, 1992–2006

Discrimination Experience for Years 7 and 15 [†]					
Characteristics at Year 20	None	Limited	Moderate	High	P-Value*
African-Americans					
Smoking Status (%)					0.08
Current	23.9	19.9	25.7	25.5	
Former	7.2	12.9	11.9	15.5	
Never	68.8	67.2	62.4	59.0	
Alcohol Consumption					
Any alcohol in the past year (%)	58.0	66.9	70.0	75.3	0.001
Binge drinking (%) [‡]	18.8	16.1	22.0	21.9	0.19
Physical Activity					
Low	67.4	53.4	55.3	47.8	<0.0001
Moderate	22.5	30.5	24.2	25.5	
High	10.1	16.1	20.5	26.7	
Whites					
Smoking Status (%)					0.009
Current	11.4	14.8	12.3	38.9	
Former	22.4	25.2	28.1	22.2	
Never	66.2	60.0	59.6	38.9	
Alcohol Consumption					
Any alcohol in the past year (%)	86.5	86.3	82.5	83.3	0.83
Binge drinking (%) [‡]	26.7	27.2	28.1	22.2	0.96
Physical Activity					
Low	41.7	38.3	40.3	38.9	0.38
Moderate	33.0	30.1	28.1	33.3	
High	25.3	31.6	31.6	27.8	

^{*} P-Values for Chi-square and ANOVA tests.

[†]Categories for racial discrimination experience represent discrimination in 7 domains in both Years 7 and 15.

[‡]Binge drinking was defined at 5+ drinks in any occasion for men and 4+ drinks in any occasion for women.

Odds Ratios (OR) and their 95% confidence intervals (CI)* for smoking status, alcohol consumption and physical activity levels, respectively, at year 20 for self-reported discrimination experience at years 7 and 15 among African-Americans: The CARDIA Study, 1992–2006

Table 4

Dependent Variable Covariates added	Crude ----	Model 1 Individual level†	Model 2: Model 1 + neighborhood SE	Model 2 + racial/ethnic composition	Model 3a: Model 2 + racial/ethnic composition
Smoking status (Reference: Never)					
Current					
Discrimination at Years 7 and 15					
None	1.00	1.00		1.00	
Limited	0.83	0.51–1.35	1.13	0.67–1.92	1.16
Moderate	1.20	0.75–1.91	1.75	1.05–2.92	1.78
High	1.24	0.79–1.97	2.20	1.34–3.73	2.26
Former					
None	1.00	1.00		1.00	
Limited	1.82	0.87–3.78	2.15	1.01–4.60	2.09
Moderate	1.81	0.87–3.79	2.38	1.11–5.12	2.28
High	2.50	1.23–5.07	3.36	1.59–7.09	3.17
Alcohol consumption in the past year					
Any alcohol (Ref: No use)					
None	1.00	1.00		1.00	
Limited	1.44	0.95–2.18	1.48	0.97–2.26	1.46
Moderate	1.69	1.12–2.55	1.73	1.13–2.64	1.68
High	2.19	1.45–3.29	2.27	1.48–3.48	2.15
Physical activity (Ref: Low activity)					
High					
None	1.00	1.00		1.00	
Limited	2.03	1.07–3.83	2.04	1.05–3.96	1.94
Moderate	2.44	1.31–4.53	2.34	1.22–4.48	2.24
High	3.64	1.99–6.66	3.38	1.78–6.42	3.12
Moderate					
None	1.00	1.00		1.00	
Limited	1.73	1.07–2.80	1.62	0.99–2.63	1.62
					0.97–2.60

Dependent Variable Covariates added	Crude ----	Model 1 Individual level [†]	Model 2: Model 1 + neighborhood SE	Model 3a: Model 2 + racial/ethnic composition
Moderate	1.31 0.81–2.13	1.18 0.72–1.94	1.18 0.72–1.94	1.16 0.71–1.91
High	1.60 0.99–2.56	1.43 0.88–2.34	1.42 0.87–2.33	1.41 0.86–2.30

^{*} ORs for smoking and physical activity are from multinomial logistic regression models while the ORs for alcohol use are obtained from logistic regression.

[†] Adjusted estimates for individual level covariates include age, gender, marital status, coping mechanisms, education and income.