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ABSTRACT

This study examines the role that residential neighborhoods may play in racial/ethnic and socioeconomic disparities in systolic (SBP) and diastolic (DBP) blood pressure, hypertension, and awareness, treatment, and control of hypertension. Between May 2001 and March 2003 we collected data, including direct assessments of SBP and DBP, on a probability sample of 3105 participants aged 18 and over living in 343 Chicago neighborhoods. We found that blacks and people with lower levels of education have significantly higher levels of SBP and higher rates of hypertension than their respective comparison groups (i.e., whites and people with 16 or more years of education), but that these disparities diminish and become statistically insignificant after adjusting for neighborhood context. Levels of SBP and DBP and the rate of hypertension were lower in more affluent/gentrified neighborhoods (i.e., places with a high level of residential turnover and with greater shares of people in their 20s and 30s and/or have 16 or more years of education and are in professional or managerial occupations), net of controls for a wide range individual- and neighborhood-level controls. Among people with hypertension, blacks were more likely than whites to be aware of their condition, but this difference was also explained by neighborhood factors: people living in more disadvantaged neighborhoods and neighborhoods with greater proportions of blacks were more likely to be aware of their hypertension. Among those being treated for hypertension, blacks were less likely than whites to have their condition under control, and controls for neighborhood context failed to explain this disparity. In sum, residential neighborhoods potentially play a large role in accounting for social disparities in high blood pressure and hypertension prevalence and, in a different way, awareness, but not in treatment for and control of hypertension.

INTRODUCTION

Understanding and reducing socioeconomic and racial-ethnic disparities in health is arguably the most significant challenge facing U.S. public health research and policy. Despite abundant research on these social disparities in health, important questions remain regarding the reasons for the observed differences, which do not appear to be fully "explained" by the traditional individual-level risk factors included in most analyses (House, Morenoff, Raudenbush, Kaplan, Diez Roux, & Linder, In Preparation; Lynch, Kaplan, Cohen, Tuomilehto, & Salonen, 1996; Marmot, Smith, Stansfeld, Patel, North, & al., 1991). Reasons for social disparities in the individual-level risk factors themselves are also not well understood. Given the spatial segregation of the population of the U.S. and other nations by socioeconomic position and race-ethnicity, the social contexts in which people live are increasingly recognized as additional potential determinants of health and factors contributing to health disparities, over and above the effects of individual and household risk factors. Research is beginning to document such effects of social context, though their nature and magnitude is variable and disputed and their role in understanding and explaining racial-ethnic and socioeconomic disparities in health is even less clear (Diez-Roux, 2000; Ellen, Mijanovich, & Dillman, 2001; Haan, Kaplan, & Camacho, 1987; Morenoff & Lynch, 2004b; Pickett & Pearl, 2001; Robert, 1999).

In this paper we consider the extent to which individual-level racial/ethnic and socioeconomic disparities in hypertension may be linked to the spatial locations of these groups. We focus on hypertension because it is a significant health problem in the United States that is unevenly distributed across racial/ethnic groups (Hertz, Unger, Cornell, & Saunders, 2005) and there are compelling theoretical reasons for expecting that the spatial locations of racial/ethnic and socioeconomic groups may be linked to hypertension. For example, spatial location and segregation may differentially expose members of affected groups to sources of chronic stress and social support in their residential environments, which could in turn generate group disparities in blood pressure levels. Segregation may also differentially structure the level and quality of care individuals receive for diagnosing and treating hypertension, which could lead to disparities in not only the prevalence of hypertension, but also awareness, treatment, and control of hypertension. The goal of this paper is to assess the extent to which social disparities in blood pressure and hypertension prevalence, awareness, treatment, and control are associated with differences in the areas where these groups tend to live. We accomplish this by decomposing racial/ethnic and socioeconomic disparities in systolic (SBP) and diastolic (DBP) blood pressure, and hypertension prevalence, awareness, treatment, and control into within- and between-area components. This is a necessary first step in assessing the extent to which neighborhood residential context matters for social disparities in all these aspects of hypertension. It will thus target and focus future research that aims to identify whether and through what specific mechanisms residential environments may be causally related to hypertension and aspects of its diagnosis and treatment.

BACKGROUND

As a major risk factor for heart and kidney disease and the major risk factor for cerebrovascular disease (stroke), hypertension is an important contributor to the burden of disease, disability and death in the population. Hypertension and its consequences are also unevenly distributed. In the United States, African Americans or blacks, have higher incidence, prevalence, and longer duration of hypertension than whites (Gillum, 1996; Saunders, 1995).[i] Moreover, compared to whites, hypertension in African Americans has an earlier age of onset, is more aggressive, difficult to treat and severe in terms of target organ damage such as renal failure (Jamerson, 2004; Weir & Hanes, 1996). Hispanics have levels of hypertension that are comparable or lower to those of whites, but the rates have been increasing in recent years, and Hispanics with hypertension are less likely to have their blood pressure treated and controlled compared to whites and African Americans (Perez-Stable & Salazar, 2004).

The key factors underlying the elevated rates of hypertension among blacks are not clearly understood. Despite evidence that they are linked more to the psychosocial factors than to genetic factors and access to care (Cooper, Rotimi, & Ward, 1999; Jamerson, 2004; Pincus, Esther, DeWalt, & Callahan, 1998; Williams, 1992) no specific aspects of the social environment that are responsible for the elevated rates of hypertension among blacks have been clearly identified. Although individual measures of socioeconomic position probably play a role, they are unlikely to fully account for racial differences in blood pressure. SEP gradients for hypertension are relatively weak (Pickering, 1999), and hypertension prevalence is high for blacks irrespective of sex and SEP (Mensah, A.H., Ford, Greenlund, & Croft, 2005).

Nonetheless, chronic stress linked to the larger social environment is widely regarded as an important contributor to hypertension risk (Pickering, 1999) and there is a long history of interest in the ways in which the residential environment can contribute to cardiovascular risk including hypertension (Diez Roux, 2003). An early study in Detroit found that both blacks and whites who resided in low stress areas (based on area measures of economic deprivation, crime and marital instability) had lower levels of blood pressure than those in high stress areas (Harburg, Erfurt, Hauenstein, Chape, Schull, & Schork, 1973). This association was stronger for blacks than for whites, and there was no racial difference in blood pressure for males who resided in low-stress areas. More recently, analyses of national data for the U.S. revealed that area measures of deprivation are positively related to elevated blood pressure independent of individual SES (Cubbin, Hadden, & Winkleby, 2001). Studies in Europe have also found that neighborhood and housing characteristics are associated with blood pressure (Aslanyan, Weir, Lees, Reid, & McInnes, 2003; Galorbardes & Morabia, 2003).

In addition, specific stressors in residential environments such as industrial noise, airport noise, traffic noise, overcrowding, violence, cold indoor temperatures show a positive association with blood pressure (Collins, 1986; Herbold, Hence, & Keil, 1989; Krantz, DeQuattro, Blackburn, Eaker, Haynes, James et al., 1987; Wilson, Kliewer, & Sica, 2004). Economic deprivation in the neighborhood, as well as neighborhood influences on physical activity and access to nutritious foods have also been identified as potential pathways (Diez Roux, 2003).

Area characteristics have also been related to access to medical care in general and the treatment of hypertension in particular. U.S. research reveals that blacks are more likely than whites to live in areas where the quality of care is low (Baicker, Chandra, Skinner, & Wennberg, 2004). Thus, many African Americans receive most of their care from a small group of physicians who are less likely than other doctors to be board certified and are less able to provide high quality care and referral to specialty care (Bach, Pham, Tate, & Hargraves, 2004). In addition, pharmacies in low-income black neighborhoods are less likely to have adequate medication supplies (Morrison, Wallenstein, Natale, Senzel, & Huang, 2000) and hospitals in those neighborhoods are more likely to close (Buchmueller, Jacobson, & Wold, 2004; McLafferty, 1982; Whiteis, 1992). Other data reveal that county-level characteristics such as racial composition predict the use of preventive services (Benjamins, Kirby, & Bond Huie, 2004) and that characteristics of the health care system, such as not having a primary care physician and receiving care in the emergency room instead of in an office or clinic are associated with increased likelihood of having uncontrolled hypertension (Shea, Misra, Ehrlich, Field, & Francis, 1992).

The current study contributes to the literature on racial/ethnic and socioeconomic disparities in hypertension in several ways. First, it is one of the only studies to simultaneously examine individual- and neighborhood-level variation in physical measurements of blood pressure in a large sample that covers a diverse range of urban neighborhood environments. Second, it seeks to better understand the possible contribution of residential segregation to social disparities in hypertension by decomposing disparities into within- and between-area components. Third, we advance the literature by analyzing social disparities in and the association of neighborhood characteristics with multiple outcomes related to hypertension, including continuous measures SBP and DBP and categorical measures of hypertension prevalence, awareness, treatment, and control. Specifically, we (1) estimate, via individual-level regression models, racial/ethnic and socioeconomic disparities in systolic SBP and DBP as well as prevalence, awareness, treatment, and control of hypertension, net of several sets of potentially confounding individual-level variables; (2) estimate, via fixed effects and multilevel models, the degree to which these disparities are reduced after adjustments for the neighborhood context in which people live as well as individual-level confounding factors; and (3) estimate, via multilevel models, associations between a set of neighborhood characteristics and our various blood pressure/hypertension outcomes.

METHODS

Data

We analyze data from the Chicago Community Adult Health Study (CCAHS), which was designed to increase understanding of the role of residential context, in conjunction with individual and household factors, in affecting both self-reported and biomedical indicators of adult health. Between May, 2001 and March, 2003, we interviewed and made direct physical health measurements on a probability sample of 3105 adults aged 18 and over, living in the city of Chicago, IL and stratified into 343 neighborhood clusters (NCs) previously defined by the Project on Human Development in Chicago Neighborhoods (PHDCN) (Sampson, Raudenbush, & Earls, 1997). One individual was interviewed per household, with a response rate of 71.8 percent, which is quite high for surveys in large urban areas. Each NC usually included two census tracts (roughly 8,000 people) with meaningful physical and social identities and boundaries (Sampson, Raudenbush, & Earls, 1997).[ii] Persons in 80 focal areas previously defined by PHDCN were sampled at twice the rate of those in others. The sample contains an average of 9.1 subjects per NC (14.3 per NC in the focal areas and 7.5 per NC in the non-focal areas). All data and analyses are weighted to take account of the different rates of selection (and also different rates of subsampling for final intensive interview completion efforts) as well as household size and differential coverage and nonresponse across NCs, such that the weighted sample matches the 2000 Census population estimates for the city of Chicago in terms of age, race/ethnicity and sex.[iii]

We collected three measures (approximately one minute apart) of SBP and DBP using highly reliable oscillographic devices certified by the European Society of Hypertension (O'Brien, Waeber, Parati, Staessen, & Myers, 2001).[iv] We analyze the average of the final two measures of SBP and DBP as outcomes.[v] We also analyze binary measures of being hypertensive, being aware of a hypertensive condition, receiving treatment for hypertension, and having hypertension under control. The sample mean for SBP was 122.5 mmHg, and for DBP it was 77.3 mmHg. We considered subjects to be hypertensive if they (a) had an average SBP of 140 mmHg or higher, or an average DBP of 90 mmHg or higher, or (b) reported that they had taken antihypertensive medications in the last 12 months (Chobanian, Bakris, Black, Cushman, Green, Izzo et al., 2003; Fields, Burt, Cutler, Hughes, Roccella, & Sorlie, 2004; Hajjar & Kotchen, 2003).[vi] Subjects were considered to be aware of their hypertension if they (a) were defined as hypertensive and (b) answered "yes" to the survey question "Has a doctor or health professional ever told you that you have high blood pressure or hypertension?" Subjects were considered to be treated if they reported that they took antihypertensive medications in the last 12 months, and they were considered to have their hypertension controlled if they (a) reported that they had taken antihypertensive medications in the last 12 months and (b) had an average SBP less than 140 mmHg and an average DBP less than 90 mmHg (Chobanian, Bakris, Black et al., 2003; Fields, Burt, Cutler et al., 2004; Hajjar & Kotchen, 2003).

In our sample, 33.8 percent of the subjects were hypertensive at the time of our measurements (25.6 percent of the sample had measured blood pressure in the hypertensive range and 8.1 percent did not but were on antihypertensive medication). Of these, 68.3 percent were aware of their condition; 85.6 percent of those who were aware were also receiving treatment for their hypertension; and among those being treated, 45.1 percent had their hypertension under control at the time of our measurements.

Analytic Plan

The focus of this analysis is on the extent to which estimates of racial/ethnic and socio-economic disparities in blood pressure/hypertension outcomes change when variation in neighborhood context is taken into account.[vii] Our analysis proceeds in three stages. In the first stage, we apply conventional regression models (ordinary least squares for continuous blood pressure outcomes and logistic regression for dichotomous outcomes) to estimate racial/ethnic and socioeconomic disparities in blood pressure/hypertension outcomes ignoring neighborhood context. We estimate one model with a limited set of individual-level covariates, including sex, age, race/ethnicity, immigrant generation, education, and income. This model provides a baseline estimate of social disparities in each outcome. A second model includes a more expansive set of individual-level covariates, some of which have been suggested in the literature as possible explanations for socioeconomic and racial/ethnic disparities in blood pressure/hypertension (e.g., body mass index, regularity of medical care, physical activity, smoking, and drinking) and others we include not only because they may predict blood pressure but also because of their potential role in sorting people into neighborhoods (e.g., marital status and the presence of children in the household). These models were estimated with Stata software, version 9. Summary statistics on the individual-level covariates used in our models are presented in Table 1, and definitions for selected variables (i.e., those not obvious from Table 1) are provided in Appendix 1.

In the second stage of our analysis we examine how adjusting for neighborhood context changes estimates of individual-level disparities in blood pressure/hypertension by restricting comparisons of social groups to people who share the same residential neighborhoods. In the case of our continuous outcomes (SBP and DBP), we accomplish this by adding a fixed effect for each neighborhood (with one omitted as the reference category) to the OLS models. Because nonlinear fixed-effect models become inconsistent with many strata (Breslow & Day, 1980; Cox & Hinkley, 1974), we used a different procedure for the dichotomous outcomes (hypertension prevalence, awareness, treatment, and control). For these outcomes we added a hierarchical structure to the logistic regression models and, following Raudenbush and Bryk (2002: 137), centered each individual-level covariate around its neighborhood mean to estimate its within-neighborhood partial association with the log-odds of the dependent variable.[viii] We estimated these models using the HLM software package, version 6. The common feature of both methods – the fixed effect models for continuous outcomes and the random effects models with neighborhood-mean centered covariates for dichotomous outcomes – is that they adjust for group differences in neighborhood context by restricting comparisons to people who share the same neighborhoods. We estimate these models first with the limited set individual-level covariates set and then with the more expansive set.

The final stage of our analysis adds a more finely specified contextual adjustment, introducing neighborhood-level variables into our hierarchical models. Unlike the neighborhood fixed effects models, these hierarchical models impose a structure on the neighborhood-level model, which entails additional assumptions. The comparative advantage of this approach is that it provides more power to discern within-neighborhood disparities, because rather than restricting comparisons to people who live in the same neighborhood, this approach essentially compares people who live in similar types of neighborhoods (based on the structure of the neighborhood model).[ix] Again we estimate these models first with a more limited and then with a more expansive set of individual-level covariates.

Neighborhood-Level Variables

To construct a set of neighborhood-level variables that would characterize the sociodemographic structure of Chicago neighborhoods we conducted a principal factor analysis with an orthogonal varimax rotation of 20 variables from the 2000 Census that include NC-level measures of racial/ethnic composition, socioeconomic status, age composition, family structure, owner-occupied housing, and residential stability. Our aim was to derive a parsimonious set of factors that capture the shared variance of a broad spectrum of neighborhood structural characteristics in order to use these factors to adjust social disparities in blood pressure for neighborhood context. The results are displayed in Table 2.[x] The first four factors account for 96 percent of the variance in these variables, and the first three have eigenvalues over 1.0 (the conventional cut-off), while the fourth has an eigenvalue of 0.86. All of the resulting factor scores were standardized to have a mean of zero and a standard deviation of one.

The first factor, which we interpret as socioeconomic disadvantage, is characterized by strong positive loadings on the percentage of families with incomes of less than $10,000, the percentage of families in poverty, the percentage of families on public assistance, the percentage of unemployed adults in the civilian labor force, the percentage of families that are female-headed, and the percentage of adults who have never been married; and negative loadings on percentage of families with incomes of $50,000 and over and the percentage of owner-occupied homes. The second factor represents a mix of characteristics associated with neighborhood affluence (high education and a concentration in professional occupations) and gentrification (a residentially mobile population consisting of young adults and few kids under the age of 18) and is notably orthogonal to neighborhood socioeconomic disadvantage. It has strong positive loadings for the percentage of adults with 16 or more years of education, the percentage of adults in professional or managerial occupations, the percentage of people age 18-29 and the percentage age 30-39; and negative loadings on the percentage of people who lived in the same residence in 1995 and the percentage under age 18. The third factor represents racial/ethnic/immigrant composition. It has strong positive loadings for percent Hispanic and percent foreign born and a negative loading for percent non-Hispanic black (we do not include the percent non-Hispanic white in this analysis because it would be collinear with the other variables already in the model). The final factor captures older age composition, with positive loadings for percent over the age of 70 and percent between ages 50-69, and negative loadings for the percent between ages 18-29 and the percent never married.

One concern with the strategy of using neighborhood-level variables to adjust racial/ethnic and socioeconomic disparities in blood pressure outcomes is that high levels of residential segregation may preclude us from making comparisons between members of different social groups who live in similar types of neighborhoods, in which case regression estimates of the adjusted disparities would be based largely on extrapolations (Oakes, 2004). For example, if the distribution of neighborhood affluence among blacks does not overlap with the affluence distribution for whites, then the estimate of the black-white gap that we get after controlling for neighborhood affluence using regression may depend sensitively on linearity or other assumptions about affluence's contribution to the regression.

In our analyses incorporating neighborhood effects but not neighborhood-level variables (stage 2), disparity estimates are built from within-neighborhood comparisons, a protection from their conclusions' being driven by extrapolation. Our analyses that also incorporate neighborhood-level covariates (stage 3) necessarily sacrifice this protection to enhance power. To explore the potential for extrapolation to affect them, we present cross-tabulated frequencies of individual-level race/ethnicity, education, and income by quartiles of all four neighborhood-level factors in Appendix 2. Despite substantial variance in the distribution of neighborhood characteristics across social groups, we find fairly sizable representations of all groups across the distribution of most neighborhood characteristics. Only in two cases does the cell count drop below 50 (there are only 28 Hispanics in the lowest quartile of the Hispanic/Immigrant/Non-Black neighborhood factor and there are only 44 people with incomes of less than $10,000 in the lowest quartile of socioeconomic disadvantage). Not surprisingly, there is less overlap in the distribution of the Hispanic/Immigrant/Non-Black factor across racial/ethnic groups than there is with other factors. However, substantial numbers of blacks and whites can be found at all quartiles of neighborhood affluence/gentrification, older age composition, and, to a lesser extent, disadvantage. On the whole, the tabulations show substantial overlap in the distributions of neighborhood characteristics across the racial/ethnic and socioeconomic groups on which we focus.

RESULTS

Systolic and Diastolic Blood Pressure

We begin by examining social disparities in our continuous measures of blood pressure. Table 3 presents the results for SBP. The first model uses OLS to estimate disparities by race/ethnicity, education, and income, adjusted for age and sex, and immigrant generation. The results show that blacks have significantly higher SBP than whites. The black-white gap, adjusting for other covariates, is 3.8 mmHg. Neither Hispanics nor people of other racial/ethnic groups (who are mainly of Asian descent) have significantly different SBP than whites. SBP is higher among those with lower levels of education, but only the gap between those with 12-15 vs. 16 or more years of education is significant in model 1. There are no significant differences in SBP across levels of income. In the second model we add controls for marital status, presence of children, BMI, health insurance and regularity of medical care, exercise, walking, drinking, and smoking. Adding these controls has little effect on the black-white gap in SBP, which drops to 3.0 mmHg but remains statistically significant. The addition of these controls widens educational disparities in SBP (the SBP gap between people with less than 12 years and 16 or more years of education increases to 2.8 mmHg, while the gap between those with 12-15 and 16 or more years increases to 2.9 mmHg). In models 3 and 4 we adjust for differences in neighborhood context using neighborhood fixed effect models. When neighborhood fixed effects are added to the model, the black-white gap drops precipitously (to 1.7 mmHg in model 3 and 0.9 mmHg in model 4) and is reduced to non-significance. There are also no longer significant differences in SBP by level of education in models 3 and 4.

We introduce neighborhood-level covariates into random effects models of SBP in models 5 and 6 and find that estimates of the black-white gap and educational disparities in SBP are very similar to what they were in the neighborhood fixed effects models. Thus, whether we account for neighborhood context through neighborhood fixed effects models or random effect models that include specific neighborhood-level characteristics, we find that SBP differences between blacks and whites and across educational groups are reduced to non-significance (with the exception of a significant gap in model 6 between those with 12-15 years of education and those with 16 or more years), with the decline of the black-white gap being especially pronounced. The random effect models also suggest that net of other controls, SBP is lower among people who live in more affluent neighborhoods and among those who live in neighborhoods with higher proportions of older people. Both of these associations hold up after introducing the more expansive set of individual-level controls in model 6. The association between neighborhood affluence and blood pressure is particularly strong. For example, a one-standard deviation increase in neighborhood affluence, which is approximately the distance between the 25th and the 75th percentiles of affluence, is associated with a drop of 1.6 mmHg in SBP; while a 2.5 standard-deviation increase in neighborhood affluence, which is approximately the distance between the 10th and 90th percentile, is associated with a 4.0 mmHg drop in SBP.[xi]

Table 4 presents this same set of models for DBP. There are no significant differences in DBP between whites and other racial/ethnic groups, nor are there any differences across immigrant groups or levels of income. There is a discernible gap between those with 12-15 years of education and those with 16 or more years in model 1, which remains significant after controlling for the expanded set of individual-level covariates in model 2. However, this gap is reduced to non-significance when we condition on neighborhoods in models 3-6. Models 5 and 6 show that neighborhood affluence is associated with lower DBP, net of other controls. A one standard-deviation increase in the neighborhood affluence scale is associated with a 0.9 mmHg drop in DBP. Neighborhood older age composition is also associated with lower DBP in model 5, but the coefficient gets reduced and becomes non-significant when the expanded set of individual-level covariates are added in model 6.

Hypertension Prevalence, Awareness, Treatment, and Control

Next we turn to the analysis of hypertension prevalence, awareness, treatment, and control. In Table 5 we present results from the analysis of hypertension prevalence. Model 1 shows that the odds of being hypertensive are 80 percent higher for blacks compared to whites, 70 percent higher for those with less than 12 years of education compared to those with 16 or more years and 60 percent higher for those with 12-15 years of education compared to 16 or more years. All of these disparities remain significant, if slightly reduced, after controlling for the expanded set of individual-level covariates in model 2. There is also some suggestion that the odds of hypertension are greater among those with incomes under $10,000, but this association is only marginally significant. Estimates of social disparities in hypertension change fairly dramatically when we control for neighborhood context in random effect models, by either centering all covariates around their neighborhood means (models 3 and 4) or introducing neighborhood-level variables (models 5 and 6). There are no longer significant differences in the odds of hypertension between blacks and whites or across levels of education after adjusting for neighborhood differences in models 3-6. We also find that higher levels of neighborhood affluence are related to lower odds of being hypertensive in models 5 and 6. A one-standard deviation change in neighborhood affluence is associated with a 30 percent reduction in the odds of being hypertensive. These results are quite consistent with those for continuously measured SBP and DBP.

In Table 6 we analyze the log odds of ever being diagnosed with hypertension by a doctor or health professional, conditional on being hypertensive (which reduces the analytic sample to 1,029). Model 1 shows that the odds of being aware of hypertension are 80 percent higher for blacks compared to whites, but this association is reduced slightly and becomes marginally significant when the full set of individual-level controls are added in model 2. Controlling for neighborhood context in models 3-6 further reduces the gap between blacks and whites in awareness, which suggests that odds of awareness tend to be higher in neighborhoods where blacks live. Hispanics are less likely than whites to be aware of their hypertension, and this gap becomes more significant after adjusting for neighborhoods. The odds of awareness are higher among people with lower levels of education, but this association only becomes significant after controlling for neighborhood context in models 3-6 (and it is marginally significant in model 5). In models 5 and 6 we find that the odds of awareness are higher in more disadvantaged neighborhoods and in neighborhoods where more African Americans live, but lower in places where more Hispanics and first-generation immigrants live. Thus, there is an association between neighborhood context and being aware of hypertension, and controlling for neighborhoods accounts for a large part of the differential between blacks and whites in awareness, but it does not explain why Hispanics are less aware of their hypertension than whites or why people with lower levels of education are less aware than those with 16 or more years.

In Table 7 we model the log odds of being treated for hypertension, conditional on being aware. The sample size for this analysis is relatively small compared to previous analyses (n=719), and there is not as much variation in this outcome (86 percent of those who are aware of hypertension are also being treated with antihypertensive medications).[xii] As a result, there are few significant predictors of being treated. Model 1 shows that there are no discernible racial/ethnic or educational disparities in being treated for hypertension among those already aware. There is one, possibly chance, significant difference across income groups: people who make between $10,000-$29,999 are more likely to receive treatment for hypertension than those who make $50,000 or more. Estimates of racial/ethnic and socioeconomic differences in treatment change little when neighborhood fixed effects are added in models 3 and 4, and there are no significant associations with neighborhood-level covariates in models 5 and 6.[xiii] In short, the available evidence suggests that treatment for hypertension is not strongly patterned by race/ethnicity, immigrant generation, education, or income, nor does neighborhood context appear to play any role in the likelihood of being treated.

The final piece of our analysis examines control of hypertension among those who are taking antihypertensive medication. The results are displayed in Table 8. Here again, the sample size is relatively small (*n*=569), but there is more variation to explain (only 45% of those who had been treated for hypertension had their blood pressure measured within the normal range) than was the case with treatment. Model 1 shows that the odds of having one's hypertension under control are 50 percent lower for blacks compared to whites, and this gap persists after adjusting for the expanded set of individual-level covariates and for neighborhood context in subsequent models (although it is not significant when covariates are centered around their neighborhood means). The odds of having hypertension under control are higher in neighborhoods with older age compositions, although this association becomes marginally significant after adding the expanded set of individual-level covariates. In supplementary analysis that checked for non-linear associations at the neighborhood level, we also found an association, between neighborhood affluence and hypertension control: in the neighborhood-level model we substituted dummy variables to mark the quartiles of each factor for the continuous factor scores and found that living in a neighborhood at the highest quartile of affluence (compared to the lowest quartile) was associated with higher odds of having one's hypertension under control (OR=2.3, [1.1, 4.9]), perhaps reflecting access to or quality of health care, but we found no significant association with neighborhood age composition or any of the other neighborhood factors in this model.

CONCLUSION

The central aim of this study is to understand the potential contribution of residential neighborhoods to social disparities in blood pressure and hypertension prevalence, awareness, treatment, and control. We found that blacks and people with lower levels of education have significantly higher levels of SBP and higher odds of hypertension than their respective comparison groups (i.e., whites and people with 16 or more years of education), but that after adjusting for neighborhood context these disparities diminished and became statistically insignificant. There were fewer significant racial/ethnic or socioeconomic disparities in DBP, and none that were significant after conditioning on neighborhoods. Previous research indicates that elevated levels of DBP are not as strongly associated with the risk of cardiovascular disease as are elevated levels of SBP (Psaty, Furberg, Kuller, Cushman, Savage, Levine et al., 2001; Stamler, Neaton, & Wentworth, 1989; Stamler, Stamler, & Neaton, 1993).

Despite the differences in the individual-level determinants of systolic and diastolic blood pressure, we found a common pattern of neighborhood associations for both types of blood pressure and for hypertension: the risk of high blood pressure and hypertension is lower in more affluent and gentrified neighborhoods (i.e., places with a high level of residential turnover and with greater shares of people in their 20s and 30s who have16 or more years of education and are in professional or managerial occupations), even after adjusting for BMI, health care access, family structure, physical activity, smoking, drinking, and other neighborhood-level controls. What other specific factors may account for the association between neighborhood affluence and blood pressure/hypertension is a topic for future research. One hypothesis is that such areas may have cultures that promote behavioral patterns (e.g., exercise, lower body mass, non-smoking) that reduce levels of blood pressure.[xiv]

Among those with hypertension, the odds of being diagnosed by a doctor or health professional were higher for blacks compared to whites and people with lower levels of education compared to those with 16 or more years, which is consistent with previous research (Hajjar & Kotchen, 2003). We also found that awareness was higher among people who live in more disadvantaged neighborhoods and neighborhoods with higher proportions of blacks (and fewer Hispanics and foreign-born). Among those who are aware of their hypertension, there were no significant social disparities in the odds of receiving medical treatment. All of this suggests that the public health and health care system is effective at diagnosing and initiating treatment of high-risk groups. Also, the finding that more disadvantaged and black neighborhoods are associated with higher odds of awareness, and that these neighborhood factors account for the remaining differences in awareness between blacks whites, suggests that some of these public health initiatives to increase awareness of hypertension have been effectively targeted at places rather than just people at risk for hypertension.

Despite the encouraging findings regarding awareness and treatment, we found that blacks were less successful in controlling their hypertension, and that neighborhood context failed to explain racial disparities in hypertension control. Pharmacologic treatment of hypertension appears not to be as effective for African Americans. Explanations for this disparity should be pursued in future research. One possibility is that treatment of hypertension may not work as well for persons under high stress, in part because such people are less able to comply with treatment regimens (Williams, 1992). To the extent that stress is related to neighborhood exposures, we would expect racial disparities to diminish after taking neighborhoods into account, but they do not.[xv] Alternatively, considerable evidence suggests that the quality and intensity of treatment of a broad range of medical conditions vary by race, with African Americans and other minorities receiving poorer quality of care than whites (Smedley, Stith, & Nelson, 2003). Inadequate levels of control of hypertension among African Americans seeking treatment remains a significant scientific and public health problem, but neighborhood context (at least as it varies within a city like Chicago as opposed to between cities and other areas) does not appear to be a major factor to be pursued in further efforts to understand and alleviate this disparity. However, we also note that our analysis of hypertension control among those being treated for hypertension is based on much smaller sample sizes, both at the individual- and neighborhood-levels, which reduces our power to detect significant neighborhood effects.

In sum, we found that neighborhoods appear to play a role in explaining social disparities in high blood pressure and hypertension prevalence and awareness, but not in the treatment and control of hypertension. Our analysis also highlights the potentially protective effects of neighborhood affluence for helping people maintain low blood pressure, reducing the risk of hypertension, and increasing the likelihood that people on anti-hypertensive medication will be able to control their condition. This study is part of a growing literature that has found neighborhood SEP to be associated with a variety of health outcomes (Diez-Roux, 2000; Morenoff & Lynch, 2004a; Robert, 1999), but it also makes some distinctive contributions. First, this is the only study of which we are aware that attempts to decompose social disparities in health into their within- and between-neighborhood components, thus focusing on the role of neighborhoods in explaining racial/ethnic and socioeconomic disparities. Second, most previous studies of neighborhood SEP and health have focused on markers of neighborhood disadvantage, whereas we assess both disadvantage and affluence and find the latter to be a stronger predictor of blood pressure and hypertension. Third, unlike many previous studies, we sampled adults from all neighborhoods in a major urban area, Chicago, and collected physical measurements on health rather than relying on self-reports. Fourth, few prior studies have explored social disparities in awareness, treatment, and control of hypertension (Hajjar & Kotchen, 2003), and ours is the first (of which we are aware) to examine associations between these outcomes and neighborhood context.

Our study has several limitations. First, it is a study of a single U.S. city with a unique social geography and a high degree of residential segregation (Frey & Meyers, 2005; Logan). It is conceivable that in other cities, or in the U.S. population as a whole, much less other nations, hypertension, neighborhoods, and social groups associate in different patterns than in Chicago. By concentrating on a single city, we have been able to sample clusters of individuals in small geographic areas, which is important for multilevel comparisons within and between neighborhoods. Chicago is also particularly well-suited to studying social disparities in health because it is one of the few major cities to contain substantial representations of whites, African Americans, and Mexicans, as well as other ethnic groups.

Second, the study does not identify specific mechanisms linking individual-level race/ethnicity and SEP, or neighborhood sociodemographic characteristics to blood pressure. Nor can a cross-sectional study of this type draw any clear conclusions about causal relationships. Our findings indicate that features of neighborhoods may be stronger or more consistent markers of hypertension risk than race or SEP, but not that either of these in itself causes hypertension (Kraemer, Kazdin, Offord, Kessler, Jensen, & Kupfer, 1997).[xvi]

A possible third limitation is that segregated cities or metropolitan areas may provide too few comparisons between individually similar people living in different neighborhood environments to identify neighborhood effects, or to disentangle the individual-level effects of race/ethnicity and SEP from the contextual effects of neighborhood characteristics (Diez Roux, 2004; Merlo & Chaix, 2006; Morenoff, Diez Roux, Osypuk, & Hansen, Forthcoming; Oakes, 2004, 2006). We addressed this issue empirically by examining the overlap in the distributions of neighborhood characteristics across different social groups (Appendix 2) and by running neighborhood fixed effects models, which implicitly base comparisons of social groups upon within-neighborhood comparisons of members those groups. While segregation limited our ability to distinguish neighborhood and individual contributions to hypertension risk, this limitation was not total.

This study takes measured but important steps towards understanding the potentially substantial role that place of residence, and factors that vary with it, play in the etiology of hypertension. Future research should be more specific as to the attributes of areas that increase the risk of such hypertension. Candidates for such neighborhood mechanisms include indicators of stress (e.g., crime and disorder), features of the built environment that encourage exercise and walking (e.g., mixed land use), the availability and type of grocery stores and restaurants in and around the neighborhood, the proximity of health care providers, and the availability of social support. Future analysis must also utilize designs (e.g., experimental or longitudinal) that support stronger causal inferences. A better understanding of the causal mechanisms through which neighborhood environments shape the risk of hypertension risk could also help inform decisions as to where future community-level interventions should be targeted.

Endnotes

[1] There is some evidence suggesting that racial differences in blood pressure may be more pronounced in the U.S. than elsewhere. In a meta-analysis of 18 studies on racial/ethnic differences in daytime and nighttime SBP and DBP, Profant and Dimsdale (1999) found that blacks from all countries had higher levels of SBP and DBP than whites on average, both at night and during the day, and blacks experienced less of a fall in SBP and DBP at night compared to whites, but racial differences in blood pressure follow a somewhat different pattern for American and non-American blacks. Non-American blacks experienced significantly less nocturnal fall in SBP and DBP compared to American blacks, and daytime SBP for non-American blacks was not significantly different from that of whites (although daytime DBP and nighttime SBP and DBP were significantly higher for both American and non-American blacks compared to whites).

[2] Decisions about which tracts to combine were informed by local geographic knowledge (e.g., ecological boundaries such as parks, railroad tracks and freeways) and a cluster analysis of census data (Sampson, Raudenbush, & Earls, 1997).

[3] The design weight used in this analysis is a multiplicative combination of (1) a weight to adjust for the oversampling of cases in focal vs. non focal areas at a ratio of 2:1 (and hence a weight ratio of 1:2), (2) a weight to adjust for whether a respondent was selected for intensive nonresponse follow-up at the end of the survey vs. those eligible but not so selected at a ratio of 1:2 (or a weight ratio of 2:1), and (3) a combined nonresponse and post stratification weight which was the inverse of the ratio of the proportion of respondents in each NC to the proportion of the eligible population in each NC by age, sex, and race/ethnicity. The weight was centered to have a mean of 1.0. The standard deviation of the weight is 0.7, and the weight ranges from a minimum of 0.2 to a maximum of 5.4. We also used robust standard errors throughout our analysis to account for the clustering of sample members within neighborhood clusters.

[4] We conducted the blood pressure measures about two-thirds of the way through the survey interview, so most subjects were seated for at least 45-60 minutes prior to having their blood pressure measured.

[5] All values of SBP and DBP were extensively cleaned to check for out-of-range values and to take into account interviewer remarks about any problems that arose while measuring respondents' blood pressure. In cases where only two blood pressure measurements were taken, we used the average of the two to define

SBP and DBP, and in cases where blood pressure was measured only once, we used SBP and DBP values from that measurement. All of our results are robust to the inclusion of dummy variables in our models to flag cases in which we did not have three blood pressure observations and thus could not compute the average of the final two. For 155 cases (8 percent of the sample), we were unable to get even one blood pressure reading for a variety of reasons ranging from occasional respondent refusal to interviewer problems in getting the blood pressure monitor to work for some respondents (due to excessively large or small cuff sizes, irregular heart beats, or other reasons). The resulting sample size for our analysis of SBP and DBP is 2,860.

[6] We coded hypertension for all cases that had non-missing data on (1) systolic and diastolic blood pressure or (2) the survey question on whether the respondent is taking anti-hypertensive medication. The resulting sample size for our analysis of hypertension is 2,933.

[7] We use the terms race and ethnicity conjointly because our categorization is based on separate survey questions that ask the respondent to identify both Hispanic ethnicity and race (see Appendix for more details on this categorization). We recognize that race and ethnicity, as we have defined them, refer to socially defined and constructed groups rather than to any biological designation.

[8] When the outcome variable is continuous, centering each of the covariates around its neighborhood mean is functionally equivalent to introducing a fixed effect for each neighborhood into the model (Raudenbush, personal communication). We verified this empirically by estimating hierarchical models of our two continuous outcomes (SBP and DBP) with neighborhood-mean centered covariates. Thus, centering each of the covariates around its neighborhood mean, like adding fixed effects for each neighborhood, is a method for removing the across-neighborhood component from estimates of blood pressure disparities. We present the more familiar fixed-effect models in the case of our continuous outcomes and the group-mean centered hierarchical models for our dichotomous outcomes.

[9] This approach assumes that neighborhood covariates are linearly related to the outcome. We assessed this assumption by running supplemental models with non-parametric specifications of neighborhood-level covariates, and we report any differences we found with those results.

[10] We took several steps to examine the robustness of this factor structure to alternative specifications. First, because factor analysis assumes multivariate normality, we applied arcsine transformations to all of the variables, in the interest of variance stabilization, and reran the factor analysis. Second, we tried multiple methods for conducting the analysis including principle factor, iterated principal factor, and principal component analysis. The factor structure displayed in Table 2 was robust to all specifications of the model. We report the results of the factor analysis rather than the principal components because factor analysis is usually the preferred tool for exploring the dimensionality of a set of variables.

[11] To check the assumption that the association between neighborhood affluence and SBP is linear, we ran a non-parametric specification of the neighborhood-level model, using dummy variables to mark the quartiles of each neighborhood factor score rather than continuous measures. The results showed that the association was relatively linear and that the SBP gap between people who live in neighborhoods at the lowest and highest quartiles of neighborhood affluence was 5.7 mmHg.

[12] Due to the small sample size and lack of variation, the "non-Hispanic other" race category perfectly predicted treatment for hypertension, and so we had to remove it from the model. Thus, the reference group for racial/ethnic comparisons in this model includes both whites and those in the non-Hispanics other category.

[13] Chi-square tests indicated that there was significant residual variance at the neighborhood level that was not fully explained by the model suggesting that there is still unobserved heterogeneity in the way that rates of treatment for hypertension varies across neighborhoods.

[14] SBP was also lower and control of hypertension more likely in neighborhoods with greater shares of older adults. It is likely that these neighborhoods have a greater density of health care facilities and thus provide greater health care access, especially to older adults, and we intend to explore this association further in future research.

[15] It is possible that better measures of stressful neighborhoods, such as crime or disorder, explain some of the black-white disparity in control among people being treated for hypertension. We intend to investigate more specific neighborhood exposures such as these in future research.

[16] Although hypertension itself may not be a strong determinant of how people selectively sort themselves into neighborhoods (in part because it is largely asymptomatic), there may be other health conditions that are either predictors (e.g., BMI) or outgrowths (e.g., cardiovascular disease) of hypertension that could in part determine how people select themselves/are selected into neighborhoods.

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Table 1. Summary Statistics on Covariates: CCAHS 2002 (*n* =3,105)

Covariate	Frequency (unweighted)	*Percent (weighted)*	Mean SBP (weighted)	Mean DBP (weighted)
Sex				
Male	1,235	*47.4*	126.3	75.7
Female	1,870	*52.6*	118.9	79.0
Age				
Age 18-29	800	*27.5*	111.5	71.6
Age 30-39	748	*22.7*	117.7	77.1
Age 40-49	608	*18.7*	121.8	80.4
Age 50-59	402	*12.9*	130.5	82.2
Age 60-69	286	*9.0*	137.8	81.4
Age 70+	261	*9.2*	142.0	77.7
Race/Ethnicity				
Non-Hisp White	983	*38.4*	121.9	77.2
Non-Hisp Black	1,240	*32.1*	126.1	78.8
Hispanic	802	*25.8*	119.5	75.6
Non-Hisp Other	80	*3.8*	117.2	77.1
Immigrant status				
1st Generation Immigrant	773	*26.9*	121.8	77.0
2nd Generation Immigrant	378	*13.7*	119.5	75.4
3rd+ Generation Immigrant	1,954	*59.4*	123.4	77.9
Education				
<12 years of education	792	*23.4*	126.4	77.6
12-15 years of education	1,576	*48.7*	122.9	77.7
16+ years of education	737	*27.9*	118.5	76.4
Income				
Income < $10,000	365	*10.1*	121.5	76.1
Income $10,000-$29,999	876	*26.2*	123.4	76.5
Income $30,000-$49,999	581	*18.4*	121.2	77.0
Income $50,000+	698	*26.5*	122.0	78.7
Missing data on income	585	*18.8*	123.6	77.4
Marital Status				
Married	1,091	*41.8*	123.4	78.3
Separated/Divorced	584	*14.8*	127.7	79.8
Widowed	257	*6.7*	138.8	80.6
Never Married	1,173	*36.7*	116.2	74.6
Presence of Children				
No Children	1,767	*59.6*	125.1	78.0
1 Child	475	*15.2*	119.5	76.4
2 Children	433	*13.3*	119.0	76.5
Table 9 (Continued)	430	*11.8*	116.6	76.1
Body Mass Index				
BMI < 22	441	*14.5*	112.3	71.5
BMI 22-24.9	588	*20.5*	116.9	73.8
BMI 25-29.9	1,010	*33.3*	125.3	78.9
BMI 30-34.5	599	*18.2*	128.3	80.8
BMI 35+	467	*13.5*	128.1	81.1
Health Insurance				
Has health insurance	2,464	*80.0*	123.0	77.5
No health insurance	641	*20.0*	120.1	76.7

Table 1 (Continued)

Covariate	Frequency (unweighted)	*Percent (weighted)*	Mean SBP (weighted)	Mean DBP (weighted)
Regular Source of Medical Care				
Has regular source of care	2,363	*74.7*	123.5	77.9
No regular source of care	742	*25.3*	119.4	75.4
Exercise				
Never Exercises	649	*20.4*	127.8	79.0
Light-Moderate Exercise	1,149	*35.9*	122.1	77.5
Regular Exercise	1,307	*43.7*	120.3	76.4
Walking				
Never walks 20+ minutes	278	*10.0*	125.4	78.1
Walks 20+ minutes once a week or less	464	*14.8*	121.5	77.0
Walks 20+ minutes 2-5 times a week	1,049	*34.4*	121.7	77.1
Walks 20+ minutes almost every day	1,192	*37.1*	121.8	77.1
Missing data on walking	122	*3.8*	131.8	80.1
Drinking				
Always abstained from drinking	606	*18.6*	123.3	77.6
Has less than 4 drinks per month	688	*21.2*	120.9	77.2
Has 5-13 drinks per month	446	*14.8*	120.4	77.3
Has 14-30 drinks per month	390	*13.8*	121.0	79.6
Has 31+ drinks per month	340	*12.4*	125.5	76.2
No longer drinks	635	*19.1*	124.0	76.7
Smoking				
Never smoked more than 100 cigs	1,687	*54.9*	120.4	76.5
Smokes less than 6 cigarettes per day	266	*8.7*	120.4	78.3
Smokes 6-10 cigarettes per day	250	*7.1*	122.2	79.2
Smokes 11+ cigarettes per day	290	*9.2*	125.1	78.6
No longer smokes	612	*20.2*	127.8	76.5

Table 2. Factor Analysis of Neighborhood Cluster Sociodemographic Characteristics: Census 2000 (*n* =343 Neighborhood Clusters)

	Rotated Factor Loadings			
Variable	Disadvantage	Affluence/ Gentrification[a]	Hispanic/ Immigrant/ Non-Black[a]	Older Age Composition[a]
%Families with Income Less Than $10k	0.91	-0.24	-0.21	0.00
%Families with Income $50k or Higher	-0.83	0.45	-0.02	0.07
%Families in Poverty	0.86	-0.37	-0.19	-0.15
%Families on Public Assistance	0.75	-0.40	-0.41	-0.09
%Unemployed in Civilian Labor Force	0.67	-0.41	-0.47	-0.07
%Families Female Headed	0.71	-0.34	-0.57	-0.07
%Never Married	0.61	0.25	-0.39	-0.55
%Less than 12 years of education	0.40	-0.73	0.38	-0.26
%16 or more years of education	-0.26	0.93	0.00	-0.10
%Professional/Managerial Occupation	-0.23	0.92	-0.15	0.02
%Non-Hispanic Black	0.43	-0.26	-0.79	0.11
%Hispanic	-0.14	-0.34	0.77	-0.39
%Foreign Born	-0.16	-0.04	0.91	-0.07
%Homes Owner Occupied	-0.81	-0.21	-0.17	0.36
%In Same Residence in 1995	-0.20	-0.65	-0.41	0.41
%0-17 Years Old	0.39	-0.85	-0.16	-0.18
%18-29 Years Old	0.04	0.51	0.30	-0.71
%30-39 Years Old	-0.17	0.72	0.31	-0.38
%50-69 Years Old	-0.38	0.08	-0.38	0.70
%70+ Years Old	-0.15	0.20	-0.03	0.87
Eigenvalue	8.83	4.36	3.54	0.86
Correlation with SBP (weighted)	-0.01	**-0.11**	**-0.10**	**0.05**
Correlation with DBP (weighted)	**-0.05**	**-0.08**	**-0.08**	0.04

[a] Factor loadings have been multiplied by -1 in order to facilitate interpretation.
Boldface indicates correlations are significant at $p<.05$

Table 3. Weighted OLS and Hierarchical Linear Models of Systolic Blood Pressure: CCAHS 2002 (*n* =2,860)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
NC Fixed Effects in Model?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		No		No		Yes		Yes	
	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*
Female	**-8.9**	*[-10.5, -7.3]*	**-7.4**	*[-9.1, -5.7]*	**-8.5**	*[-10.1, -6.9]*	**-7.1**	*[-8.9, -5.3]*	**-8.9**	*[-10.4, -7.3]*	**-7.3**	*[-9, -5.7]*
Age (ref=age 18-29)												
Age 30-39	**5.9**	*[4, 7.8]*	**5.1**	*[3.2, 7.1]*	**5.9**	*[3.9, 8]*	**5.7**	*[3.6, 7.8]*	**5.8**	*[3.9, 7.8]*	**5.2**	*[3.3, 7.2]*
Age 40-49	**10.1**	*[7.8, 12.4]*	**8.8**	*[6.4, 11.1]*	**10.6**	*[8.2, 13]*	**9.8**	*[7.2, 12.3]*	**10.1**	*[7.9, 12.4]*	**9.0**	*[6.7, 11.3]*
Age 50-59	**18.6**	*[15.9, 21.2]*	**16.4**	*[13.5, 19.3]*	**19.1**	*[16.2, 22]*	**17.5**	*[14.3, 20.7]*	**18.8**	*[16.1, 21.5]*	**16.8**	*[13.9, 19.7]*
Age 60-69	**26.7**	*[23.5, 30]*	**23.4**	*[19.4, 27.4]*	**26.2**	*[22.6, 29.8]*	**23.4**	*[19.1, 27.8]*	**26.9**	*[23.6, 30.2]*	**23.7**	*[19.7, 27.7]*
Age 70+	**30.2**	*[26, 34.5]*	**27.9**	*[23, 32.8]*	**30.5**	*[26.2, 34.8]*	**28.5**	*[23.6, 33.4]*	**30.5**	*[26.2, 34.8]*	**28.3**	*[23.5, 33.2]*
Race/Ethnicity (ref=non-Hisp white)												
Non-Hisp Black	**3.8**	*[1.7, 5.9]*	**3.0**	*[0.9, 5.2]*	1.7	*[-1.7, 5.1]*	0.9	*[-2.5, 4.2]*	1.6	*[-1.7, 4.9]*	0.9	*[-2.3, 4]*
Hispanic	0.3	*[-2.2, 2.8]*	-1.0	*[-3.5, 1.6]*	-1.6	*[-4.7, 1.5]*	-2.8	*[-5.8, 0.3]*	-1.1	*[-3.8, 1.6]*	-2.2	*[-4.9, 0.5]*
Non-Hisp Other	-1.8	*[-6.1, 2.5]*	-1.1	*[-5.3, 3.1]*	-0.4	*[-5.6, 4.9]*	-0.2	*[-5.3, 4.8]*	-1.5	*[-5.9, 2.9]*	-0.9	*[-5.2, 3.4]*
Immigrant Status (ref=3rd+ generation)					55.4		71.4					
1st Generation Immigrant	0.5	*[-1.8, 2.7]*	1.2	*[-1.2, 3.6]*	0.3	*[-2.4, 2.9]*	1.3	*[-1.4, 4.1]*	0.9	*[-1.5, 3.3]*	1.7	*[-0.8, 4.2]*
2nd Generation Immigrant	-1.1	*[-4.1, 1.9]*	-0.9	*[-3.8, 1.9]*	-1.7	*[-5, 1.7]*	-1.3	*[-4.5, 1.9]*	-1.0	*[-4.1, 2]*	-0.8	*[-3.7, 2.1]*
Education (ref=16+ years)												
<12 years of education	2.4	*[-0.3, 5.1]*	**2.8**	*[0.1, 5.6]*	1.4	*[-1.7, 4.5]*	2.2	*[-0.8, 5.2]*	1.4	*[-1.4, 4.3]*	2.1	*[-0.7, 4.9]*
12-15 years of education	**2.6**	*[0.5, 4.7]*	**2.9**	*[0.7, 5.1]*	1.3	*[-0.9, 3.6]*	1.9	*[-0.4, 4.2]*	2.0	*[-0.1, 4.2]*	**2.4**	*[0.2, 4.5]*
Income (ref=$50,000+)												
Income < $10,000	-0.8	*[-3.9, 2.3]*	-1.1	*[-4.2, 2.1]*	-1.0	*[-4.2, 2.3]*	-1.5	*[-4.9, 1.8]*	-0.9	*[-4, 2.3]*	-1.3	*[-4.4, 1.9]*
Income $10,000-$29,999	-0.6	*[-3.1, 1.9]*	-1.5	*[-4.2, 1.1]*	-0.1	*[-2.8, 2.6]*	-1.0	*[-3.9, 1.8]*	-0.6	*[-3.1, 1.9]*	-1.6	*[-4.2, 1]*
Income $30,000-$49,999	-0.6	*[-2.9, 1.6]*	-0.7	*[-3, 1.6]*	-0.5	*[-2.9, 1.9]*	-0.7	*[-3.2, 1.8]*	-0.7	*[-2.9, 1.6]*	-0.8	*[-3.1, 1.5]*
Missing data on income	-0.6	*[-3.2, 2]*	-0.4	*[-3, 2.1]*	-0.3	*[-2.9, 2.3]*	-0.2	*[-2.7, 2.4]*	-1.0	*[-3.5, 1.5]*	-0.9	*[-3.4, 1.6]*
Marital Status (ref=married)												
Separated/Divorced			2.4	*[-0.3, 5]*			2.2	*[-0.5, 4.9]*			2.4	*[-0.2, 5]*
Widowed			**4.9**	*[0.2, 9.5]*			**5.1**	*[0.6, 9.7]*			**4.8**	*[0.3, 9.4]*
Never Married			0.8	*[-1.4, 2.9]*			1.9	*[-0.4, 4.1]*			1.1	*[-1, 3.2]*
Presence of Children (ref=no children)												
1 Child			-1.9	*[-4.1, 0.4]*			-1.9	*[-4.3, 0.5]*			-2.1	*[-4.4, 0.1]*
2 Children			-1.2	*[-3.6, 1.1]*			-1.6	*[-4.2, 1.1]*			-1.6	*[-4, 0.8]*
3+ Children			**-3.2**	*[-5.8, -0.5]*			**-2.9**	*[-5.6, -0.1]*			**-3.6**	*[-6.2, -0.9]*
BMI (ref=BMI<22)												
BMI 22-24.9			**2.6**	*[0.2, 5]*			2.2	*[-0.2, 4.7]*			**2.6**	*[0.2, 4.9]*
BMI 25-29.9			**7.6**	*[5.4, 9.9]*			**8.3**	*[5.9, 10.7]*			**7.6**	*[5.4, 9.9]*
BMI 30-34.5			**10.9**	*[8.4, 13.4]*			**11.5**	*[8.8, 14.2]*			**10.8**	*[8.3, 13.3]*
BMI 35+			**11.6**	*[8.6, 14.7]*			**11.2**	*[7.9, 14.4]*			**11.4**	*[8.4, 14.5]*

Table 3 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
NC Fixed Effects in Model?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		No		No		Yes		Yes	
	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*
Health Care												
No health insurance			1.2	*[-0.9, 3.2]*			0.6	*[-1.5, 2.7]*			1.1	*[-0.9, 3.1]*
No regular source of care			0.4	*[-1.3, 2.2]*			0.6	*[-1.3, 2.4]*			0.5	*[-1.3, 2.2]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			0.1	*[-2.5, 2.7]*			-0.2	*[-2.8, 2.4]*			0.5	*[-2.1, 3]*
Regular Exercise			0.4	*[-1.4, 2.3]*			0.3	*[-1.6, 2.2]*			0.2	*[-2.3, 2.8]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			0.4	*[-2.4, 3.2]*			-0.7	*[-3.7, 2.2]*			-0.6	*[-3.6, 2.4]*
Walks 20+ minutes 2-5 times a week			-0.5	*[-2.8, 1.8]*			0.2	*[-2.2, 2.5]*			0.0	*[-2.6, 2.7]*
Walks 20+ minutes almost every day			0.2	*[-1.6, 1.9]*			0.3	*[-1.5, 2.1]*			-0.2	*[-3, 2.5]*
Missing data on walking			-1.6	*[-8.1, 4.9]*			0.2	*[-6.5, 6.8]*			-1.4	*[-8, 5.2]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			-1.4	*[-4.1, 1.3]*			-1.1	*[-4, 1.8]*			-1.3	*[-4, 1.5]*
5-13 drinks per month			0.5	*[-2.3, 3.3]*			0.6	*[-2.4, 3.6]*			0.7	*[-2, 3.5]*
14-30 drinks per month			1.0	*[-2.1, 4]*			1.9	*[-1.2, 5]*			1.2	*[-1.8, 4.2]*
31+ drinks per month			**4.3**	*[1, 7.7]*			**3.7**	*[0.3, 7.1]*			**4.2**	*[0.9, 7.5]*
No longer drinks			-2.7	*[-5.5, 0.1]*			-2.7	*[-5.6, 0.2]*			-2.7	*[-5.4, 0.1]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			0.9	*[-1.9, 3.7]*			0.1	*[-2.7, 2.9]*			0.6	*[-2.2, 3.3]*
6-10 cigarettes per day			-0.3	*[-3.3, 2.7]*			-0.2	*[-3.5, 3]*			-0.5	*[-3.5, 2.5]*
11+ cigarettes per day			0.4	*[-2.3, 3.1]*			0.0	*[-2.9, 2.9]*			0.1	*[-2.6, 2.8]*
No longer smokes			-0.1	*[-2.2, 2.1]*			-0.4	*[-2.6, 1.8]*			-0.3	*[-2.4, 1.8]*
Neighborhood Factors												
Disadvantage									-0.2	*[-1.3, 0.9]*	0.0	*[-1.1, 1.1]*
Affluence/Gentrification									**-1.6**	*[-2.6, -0.5]*	**-1.6**	*[-2.6, -0.6]*
Hispanic/Immigrant/Non-Black									-1.1	*[-2.5, 0.4]*	-1.0	*[-2.4, 0.3]*
Older Age Composition									**-1.1**	*[-1.9, -0.2]*	**-0.9**	*[-1.7, -0.1]*
Intercept	**113.7**	*[111.5, 115.9]*	**107.3**	*[103, 111.6]*	**116.9**	*[113, 120.9]*	**109.7**	*[104.1, 115.4]*	**115.6**	*[112.8, 118.5]*	**109.2**	*[104.5, 114]*

Note: Boldface indicates $p<.05$

Table 4. Weighted OLS and Hierarchical Linear Models of Diastolic Blood Pressure: CCAHS 2002 (*n* =2,860)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
NC Fixed Effects in Model?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		No		No		Yes		Yes	
	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*
Female	**-3.7**	*[-4.7, -2.7]*	**-3.1**	*[-4.1, -2]*	**-3.7**	*[-4.7, -2.7]*	**-3.2**	*[-4.3, -2.2]*	**-3.8**	*[-4.7, -2.8]*	**-3.1**	*[-4.1, -2.1]*
Age (ref=age 18-29)												
Age 30-39	**5.4**	*[4.1, 6.8]*	**4.4**	*[3.2, 5.7]*	**5.4**	*[4, 6.8]*	**4.8**	*[3.4, 6.1]*	**5.4**	*[4, 6.7]*	**4.5**	*[3.3, 5.8]*
Age 40-49	**8.7**	*[7.2, 10.2]*	**7.1**	*[5.6, 8.6]*	**9.0**	*[7.4, 10.5]*	**7.8**	*[6.2, 9.4]*	**8.7**	*[7.3, 10.2]*	**7.3**	*[5.8, 8.8]*
Age 50-59	**10.4**	*[8.6, 12.2]*	**8.0**	*[6.1, 9.9]*	**10.9**	*[9, 12.8]*	**8.8**	*[6.9, 10.8]*	**10.6**	*[8.8, 12.4]*	**8.3**	*[6.5, 10.2]*
Age 60-69	**10.2**	*[8.3, 12]*	**6.8**	*[4.6, 9]*	**10.0**	*[8.1, 12]*	**7.0**	*[4.6, 9.5]*	**10.2**	*[8.4, 12.1]*	**7.1**	*[4.8, 9.3]*
Age 70+	**5.9**	*[3.9, 8]*	**2.7**	*[0.2, 5.2]*	**5.9**	*[3.8, 8]*	**2.9**	*[0.4, 5.5]*	**6.0**	*[4, 8]*	**3.0**	*[0.5, 5.4]*
Race/Ethnicity (ref=non-Hisp white)												
Non-Hisp Black	1.2	*[-0.2, 2.7]*	0.5	*[-1, 2.1]*	1.2	*[-1.4, 3.9]*	0.6	*[-1.9, 3]*	1.0	*[-1.4, 3.5]*	0.5	*[-1.8, 2.7]*
Hispanic	-0.8	*[-2.2, 0.7]*	-1.8	*[-3.3, -0.3]*	-1.4	*[-3.1, 0.4]*	-2.3	*[-4.1, -0.4]*	-1.4	*[-3, 0.2]*	-2.3	*[-3.9, -0.6]*
Non-Hisp Other	0.7	*[-1.9, 3.3]*	1.2	*[-1.4, 3.9]*	1.9	*[-1.5, 5.3]*	2.0	*[-1.3, 5.3]*	1.2	*[-1.6, 3.9]*	1.6	*[-1.2, 4.3]*
Immigrant Status (ref=3rd+ generation)												
1st Generation Immigrant	-0.3	*[-1.6, 1.1]*	0.0	*[-1.5, 1.4]*	-0.3	*[-1.8, 1.1]*	-0.1	*[-1.7, 1.5]*	-0.2	*[-1.6, 1.2]*	0.0	*[-1.5, 1.6]*
2nd Generation Immigrant	0.0	*[-1.7, 1.8]*	0.2	*[-1.6, 2]*	-0.1	*[-2, 1.8]*	0.2	*[-1.8, 2.1]*	0.0	*[-1.8, 1.7]*	0.1	*[-1.7, 1.9]*
Education (ref=16+ years)												
<12 years of education	1.2	*[-0.6, 2.9]*	1.2	*[-0.5, 2.9]*	0.3	*[-1.5, 2]*	0.6	*[-1.2, 2.3]*	0.5	*[-1.2, 2.3]*	0.8	*[-0.9, 2.5]*
12-15 years of education	**1.5**	*[0.1, 2.9]*	**1.5**	*[0.1, 2.9]*	0.7	*[-0.8, 2.2]*	0.9	*[-0.6, 2.3]*	1.1	*[-0.3, 2.5]*	1.2	*[-0.2, 2.5]*
Income (ref=$50,000+)												
Income < $10,000	-0.9	*[-3.1, 1.4]*	-0.8	*[-3, 1.4]*	-0.8	*[-2.9, 1.4]*	-0.8	*[-3, 1.3]*	-0.6	*[-2.8, 1.6]*	-0.6	*[-2.8, 1.5]*
Income $10,000-$29,999	-0.7	*[-2.4, 1]*	-1.2	*[-2.8, 0.5]*	-0.1	*[-1.9, 1.7]*	-0.4	*[-2.3, 1.4]*	-0.5	*[-2.2, 1.2]*	-1.0	*[-2.7, 0.7]*
Income $30,000-$49,999	-0.5	*[-2.1, 1.1]*	-0.3	*[-1.9, 1.2]*	-0.2	*[-1.9, 1.4]*	-0.2	*[-1.8, 1.5]*	-0.4	*[-2, 1.1]*	-0.3	*[-1.9, 1.2]*
Missing data on income	-0.8	*[-2.4, 0.8]*	-0.6	*[-2.1, 1]*	-0.6	*[-2.2, 0.9]*	-0.2	*[-1.8, 1.4]*	-1.0	*[-2.5, 0.5]*	-0.7	*[-2.3, 0.8]*
Marital Status (ref=married)												
Separated/Divorced			0.9	*[-0.7, 2.5]*			0.6	*[-1.1, 2.3]*			0.9	*[-0.7, 2.5]*
Widowed			**3.4**	*[0.8, 5.9]*			**3.7**	*[1.2, 6.2]*			**3.4**	*[1, 5.9]*
Never Married			-0.1	*[-1.4, 1.2]*			0.4	*[-1, 1.8]*			0.1	*[-1.2, 1.5]*
Presence of Children (ref=no children)												
1 Child			-1.3	*[-2.7, 0.1]*			-1.3	*[-2.8, 0.2]*			-1.5	*[-2.8, -0.1]*
2 Children			-1.3	*[-2.8, 0.1]*			-1.6	*[-3.1, -0.1]*			-1.6	*[-3, -0.2]*
3+ Children			-1.5	*[-3.3, 0.3]*			-1.2	*[-3.1, 0.7]*			-1.6	*[-3.4, 0.2]*
BMI (ref=BMI<22)												
BMI 22-24.9			**1.7**	*[0.2, 3.2]*			1.0	*[-0.5, 2.6]*			**1.6**	*[0.1, 3]*
BMI 25-29.9			**5.8**	*[4.4, 7.1]*			**5.6**	*[4.2, 7.1]*			**5.7**	*[4.4, 7]*
BMI 30-34.5			**7.9**	*[6.3, 9.6]*			**7.5**	*[5.8, 9.3]*			**7.7**	*[6.1, 9.4]*
BMI 35+			**8.3**	*[6.3, 10.3]*			**7.9**	*[5.8, 10.1]*			**8.2**	*[6.2, 10.2]*

Table 4 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
NC Fixed Effects in Model?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		No		No		Yes		Yes	
	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*	Coef	*CI*
Health Care												
No health insurance			0.7	*[-0.5, 1.9]*			0.6	*[-0.7, 1.9]*			0.7	*[-0.5, 1.9]*
No regular source of care			**-1.1**	*[-2.2, 0]*			-1.1	*[-2.3, 0.1]*			**-1.1**	*[-2.2, 0]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			1.1	*[-0.5, 2.7]*			0.5	*[-1.2, 2.2]*			-0.2	*[-1.9, 1.5]*
Regular Exercise			0.8	*[-0.4, 2]*			0.6	*[-0.7, 1.8]*			-0.8	*[-2.4, 0.8]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			-0.1	*[-1.9, 1.7]*			-0.1	*[-2.1, 1.9]*			-0.3	*[-2.5, 1.8]*
Walks 20+ minutes 2-5 times a week			-0.6	*[-2.1, 0.9]*			0.0	*[-1.6, 1.6]*			0.2	*[-1.6, 2]*
Walks 20+ minutes almost every day			0.0	*[-1.2, 1.2]*			0.1	*[-1.1, 1.3]*			0.2	*[-1.7, 2]*
Missing data on walking			-0.2	*[-3.1, 2.7]*			-0.2	*[-3, 2.6]*			0.0	*[-3.1, 3.1]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			-1.4	*[-3, 0.2]*			-1.5	*[-3.2, 0.2]*			-1.4	*[-3, 0.2]*
5-13 drinks per month			0.1	*[-1.8, 2]*			-0.1	*[-2.1, 1.9]*			0.1	*[-1.8, 2.1]*
14-30 drinks per month			0.2	*[-1.7, 2.1]*			0.0	*[-2, 2]*			0.2	*[-1.7, 2.1]*
31+ drinks per month			**2.4**	*[0.2, 4.6]*			**1.4**	*[-0.9, 3.7]*			**2.2**	*[0, 4.4]*
No longer drinks			-2.3	*[-4, -0.6]*			-2.5	*[-4.3, -0.7]*			-2.3	*[-4, -0.6]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			0.0	*[-1.9, 1.9]*			-0.4	*[-2.4, 1.6]*			-0.2	*[-2, 1.7]*
6-10 cigarettes per day			0.3	*[-1.7, 2.2]*			0.4	*[-1.6, 2.5]*			0.3	*[-1.6, 2.2]*
11+ cigarettes per day			0.2	*[-1.5, 1.9]*			0.4	*[-1.5, 2.2]*			0.1	*[-1.6, 1.9]*
No longer smokes			0.0	*[-1.3, 1.3]*			0.2	*[-1.2, 1.6]*			0.0	*[-1.3, 1.2]*
Neighborhood Factors												
Disadvantage									-0.7	*[-1.5, 0.1]*	-0.5	*[-1.3, 0.2]*
Affluence/Gentrification									**-0.9**	*[-1.6, -0.1]*	**-0.7**	*[-1.4, 0]*
Hispanic/Immigrant/Non-Black									-0.2	*[-1.2, 0.9]*	0.0	*[-1, 0.9]*
Older Age Composition									**-0.5**	*[-1.1, 0]*	-0.4	*[-1, 0.1]*
Intercept	**72.9**	*[71.3, 74.5]*	**70.0**	*[67.2, 72.9]*	**79.9**	*[77.1, 82.8]*	**77.3**	*[73.5, 81]*	**73.6**	*[71.6, 75.6]*	**71.2**	*[68, 74.4]*

Note: Boldface indicates p<.05

Table 5. Weighted Logistic Regression and Hierarchical Generalized Linear Models of Hypertension Prevalence: CCAHS 2002 (*n* =2,933)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Female	**1.9**	*[0.5, 0.8]*	**0.7**	*[0.5, 0.9]*	**0.7**	*[0.6, 0.9]*	**0.8**	*[0.6, 1]*	**0.6**	*[0.5, 0.8]*	**0.7**	*[0.5, 0.9]*
Age (ref=age 18-29)												
Age 30-39	**0.9**	*[0.6, 1.3]*	**2.0**	*[1.4, 3]*	**0.9**	*[0.6, 1.3]*	**1.9**	*[1.4, 2.7]*	**0.9**	*[0.6, 1.3]*	**2.0**	*[1.4, 3]*
Age 40-49	**1.7**	*[1.2, 2.1]*	**3.9**	*[2.5, 6]*	**1.7**	*[1.2, 2.1]*	**4.0**	*[2.8, 5.6]*	**1.7**	*[1.2, 2.1]*	**4.1**	*[2.7, 6.2]*
Age 50-59	**2.6**	*[2.2, 3]*	**9.2**	*[5.6, 15.1]*	**2.6**	*[2.2, 3]*	**8.8**	*[5.7, 13.5]*	**2.6**	*[2.2, 3]*	**10.0**	*[6.2, 16]*
Age 60-69	**3.4**	*[2.9, 3.8]*	**18.7**	*[10.5, 33.3]*	**3.4**	*[2.9, 3.8]*	**17.3**	*[10.4, 28.6]*	**3.4**	*[2.9, 3.8]*	**20.7**	*[12.1, 35.5]*
Age 70+	**4.0**	*[3.4, 4.5]*	**33.8**	*[18, 63.5]*	**4.0**	*[3.4, 4.5]*	**31.0**	*[17.8, 53.9]*	**4.0**	*[3.4, 4.5]*	**38.4**	*[20.9, 70.4]*
Race/Ethnicity (ref=non-Hisp white)												
Non-Hisp Black	**1.8**	*[1.4, 2.5]*	**1.5**	*[1.1, 2.1]*	1.1	*[0.7, 1.9]*	1.0	*[0.6, 1.6]*	1.2	*[0.7, 2]*	1.0	*[0.6, 1.7]*
Hispanic	1.4	*[0.9, 2.1]*	1.1	*[0.7, 1.6]*	1.1	*[0.7, 1.6]*	0.8	*[0.6, 1.3]*	1.2	*[0.8, 1.7]*	0.9	*[0.6, 1.4]*
Non-Hisp Other	1.6	*[0.8, 3.3]*	2.0	*[0.9, 4.6]*	1.7	*[0.9, 3.3]*	**1.9**	*[1, 3.7]*	1.7	*[0.8, 3.4]*	2.0	*[0.9, 4.5]*
Immigrant Status (ref=3rd+ generation)												
1st Generation Immigrant	**0.7**	*[0.5, 0.9]*	**0.6**	*[0.4, 0.9]*	0.8	*[0.5, 1.1]*	0.8	*[0.5, 1.1]*	**0.7**	*[0.5, 1]*	**0.7**	*[0.5, 1]*
2nd Generation Immigrant	**0.6**	*[0.4, 1]*	**0.6**	*[0.4, 1]*	**0.7**	*[0.5, 1]*	**0.7**	*[0.5, 1]*	**0.7**	*[0.4, 1]*	**0.6**	*[0.4, 1]*
Education (ref=16+ years)												
<12 years of education	**1.7**	*[1.2, 2.5]*	**1.7**	*[1.1, 2.5]*	1.4	*[0.9, 2]*	**1.4**	*[1, 2]*	**1.5**	*[1, 2.1]*	**1.5**	*[1, 2.2]*
12-15 years of education	**1.6**	*[1.2, 2.1]*	**1.5**	*[1.1, 2.1]*	1.2	*[0.9, 1.6]*	1.2	*[0.9, 1.6]*	**1.4**	*[1, 1.8]*	**1.3**	*[1, 1.8]*
Income (ref=$50,000+)												
Income < $10,000	1.3	*[0.9, 2.1]*	1.5	*[0.9, 2.4]*	1.2	*[0.8, 1.8]*	1.3	*[0.8, 2]*	1.3	*[0.8, 2]*	1.4	*[0.9, 2.2]*
Income $10,000-$29,999	0.9	*[0.6, 1.3]*	0.9	*[0.6, 1.3]*	0.9	*[0.6, 1.2]*	0.9	*[0.6, 1.2]*	0.9	*[0.6, 1.3]*	0.8	*[0.6, 1.2]*
Income $30,000-$49,999	0.9	*[0.6, 1.3]*	0.9	*[0.6, 1.4]*	0.8	*[0.6, 1.2]*	0.9	*[0.6, 1.3]*	0.9	*[0.6, 1.2]*	0.9	*[0.6, 1.3]*
Missing data on income	0.9	*[0.6, 1.3]*	0.9	*[0.6, 1.3]*	0.9	*[0.7, 1.2]*	1.0	*[0.7, 1.4]*	0.8	*[0.6, 1.2]*	0.9	*[0.6, 1.2]*
Marital Status (ref=married)												
Separated/Divorced			1.1	*[0.8, 1.6]*			1.1	*[0.8, 1.5]*			1.1	*[0.8, 1.6]*
Widowed			1.4	*[0.8, 2.5]*			1.2	*[0.8, 1.9]*			1.3	*[0.8, 2.2]*
Never Married			0.8	*[0.6, 1.2]*			0.9	*[0.7, 1.2]*			0.9	*[0.6, 1.2]*
Presence of Children (ref=no children)												
1 Child			0.9	*[0.6, 1.3]*			0.9	*[0.6, 1.2]*			0.8	*[0.6, 1.2]*
2 Children			0.8	*[0.5, 1.2]*			0.8	*[0.5, 1.1]*			0.7	*[0.5, 1.1]*
3+ Children			0.9	*[0.6, 1.3]*			0.8	*[0.5, 1.1]*			0.8	*[0.5, 1.1]*
BMI (ref=BMI<22)												
BMI 22-24.9			**2.0**	*[1.3, 3]*			**1.8**	*[1.3, 2.4]*			**2.1**	*[1.4, 3]*
BMI 25-29.9			**3.7**	*[2.5, 5.5]*			**3.4**	*[2.5, 4.6]*			**3.9**	*[2.7, 5.7]*
BMI 30-34.5			**5.4**	*[3.6, 8]*			**4.5**	*[3.2, 6.3]*			**5.4**	*[3.7, 7.8]*
BMI 35+			**6.4**	*[3.9, 10.5]*			**5.1**	*[3.3, 7.7]*			**6.5**	*[4.1, 10.3]*

Table 5 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Health Care												
No health insurance			**1.4**	*[1, 2]*			1.1	*[0.8, 1.5]*			1.3	*[0.9, 1.9]*
No regular source of care			**0.5**	*[0.4, 0.8]*			**0.6**	*[0.5, 0.8]*			**0.6**	*[0.4, 0.8]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			1.2	*[0.8, 1.6]*			0.9	*[0.7, 1.3]*			0.9	*[0.6, 1.2]*
Regular Exercise			1.0	*[0.7, 1.3]*			1.0	*[0.7, 1.3]*			0.9	*[0.7, 1.3]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			0.9	*[0.6, 1.3]*			1.1	*[0.7, 1.7]*			1.1	*[0.7, 1.7]*
Walks 20+ minutes 2-5 times a week			0.9	*[0.6, 1.3]*			1.2	*[0.8, 1.7]*			1.2	*[0.8, 1.8]*
Walks 20+ minutes almost every day			1.0	*[0.7, 1.3]*			1.2	*[0.8, 1.8]*			1.2	*[0.8, 1.8]*
Missing data on walking			1.1	*[0.5, 2.4]*			1.7	*[0.8, 3.5]*			1.3	*[0.6, 2.9]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			0.8	*[0.5, 1.1]*			0.8	*[0.6, 1.1]*			0.8	*[0.5, 1.1]*
5-13 drinks per month			1.1	*[0.7, 1.7]*			1.2	*[0.8, 1.8]*			1.2	*[0.8, 1.8]*
14-30 drinks per month			0.8	*[0.5, 1.2]*			0.9	*[0.6, 1.3]*			0.8	*[0.5, 1.2]*
31+ drinks per month			**2.0**	*[1.2, 3.1]*			**1.8**	*[1.2, 2.6]*			**1.9**	*[1.2, 3]*
No longer drinks			0.9	*[0.6, 1.4]*			0.9	*[0.6, 1.3]*			0.9	*[0.6, 1.3]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			1.1	*[0.7, 1.7]*			1.0	*[0.6, 1.4]*			1.0	*[0.6, 1.6]*
6-10 cigarettes per day			1.0	*[0.6, 1.5]*			1.1	*[0.7, 1.6]*			0.9	*[0.6, 1.4]*
11+ cigarettes per day			0.8	*[0.5, 1.2]*			0.9	*[0.6, 1.3]*			0.8	*[0.5, 1.2]*
No longer smokes			1.0	*[0.7, 1.3]*			0.8	*[0.6, 1.1]*			0.9	*[0.7, 1.2]*
Neighborhood Factors												
Disadvantage									1.0	*[0.9, 1.2]*	1.0	*[0.9, 1.2]*
Affluence/Gentrification									**0.7**	*[0.6, 0.9]*	**0.7**	*[0.6, 0.9]*
Hispanic/Immigrant/Non-Black									0.8	*[0.7, 1]*	0.8	*[0.7, 1]*
Older Age Composition									0.9	*[0.8, 1.1]*	**0.9**	*[0.8, 1.1]*
Intercept	**0.1**	*[0, 0.1]*	**0.0**	*[0, 0.1]*	**0.4**	*[0.4, 0.5]*	**0.4**	*[0.3, 0.5]*	**0.1**	*[0.1, 0.2]*	**0.0**	*[0, 0.1]*

Note: Boldface indicates p<.05

Table 6. Weighted Logistic Regression and Hierarchical Generalized Linear Models of Awareness of Hypertension: CCAHS 2002 (*n* =1,029)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Female	**1.6**	*[1.1, 2.3]*	1.4	*[0.9, 2.2]*	**1.6**	*[1.1, 2.3]*	1.5	*[1, 2.3]*	**1.7**	*[1.2, 2.4]*	**1.5**	*[1, 2.4]*
Age (ref=age 18-29)												
Age 30-39	**3.7**	*[1.7, 8.1]*	**2.7**	*[1.2, 6.3]*	**3.0**	*[1.1, 8.3]*	1.9	*[0.7, 5.1]*	**4.0**	*[1.8, 8.9]*	**2.8**	*[1.2, 6.4]*
Age 40-49	**3.5**	*[1.6, 7.5]*	2.3	*[1, 5.2]*	2.3	*[0.8, 6.2]*	1.4	*[0.5, 4]*	**3.6**	*[1.7, 7.8]*	**2.3**	*[1, 5.1]*
Age 50-59	**7.1**	*[3.3, 15.1]*	**4.4**	*[1.8, 10.6]*	**4.5**	*[1.7, 12]*	1.9	*[0.7, 5.8]*	**7.0**	*[3.2, 15.2]*	**3.4**	*[1.4, 8.3]*
Age 60-69	**6.5**	*[3, 13.8]*	**3.7**	*[1.4, 9.6]*	**5.1**	*[1.8, 14.1]*	2.3	*[0.7, 7.6]*	**7.1**	*[3.2, 15.6]*	**3.4**	*[1.3, 9]*
Age 70+	**10.5**	*[4.6, 23.8]*	**5.2**	*[1.9, 14.3]*	**5.3**	*[2, 14.5]*	1.7	*[0.5, 5.6]*	**10.9**	*[4.9, 24.4]*	**4.1**	*[1.5, 10.9]*
Race/Ethnicity (ref=non-Hisp white)												
Non-Hisp Black	**1.8**	*[1.1, 2.9]*	1.6	*[1, 2.7]*	0.9	*[0.4, 1.8]*	0.6	*[0.3, 1.4]*	0.9	*[0.5, 1.6]*	0.7	*[0.4, 1.3]*
Hispanic	0.6	*[0.3, 1.2]*	0.5	*[0.3, 1.1]*	0.5	*[0.2, 1]*	**0.4**	*[0.2, 0.8]*	**0.5**	*[0.3, 0.9]*	**0.4**	*[0.2, 0.8]*
Non-Hisp Other	0.6	*[0.1, 2.2]*	0.8	*[0.2, 2.6]*	0.7	*[0.1, 3.4]*	0.8	*[0.1, 4.5]*	0.5	*[0.1, 2.1]*	0.7	*[0.2, 2.7]*
Immigrant Status (ref=3rd+ generation)												
1st Generation Immigrant	1.5	*[0.7, 2.9]*	1.3	*[0.6, 2.7]*	1.6	*[0.7, 3.8]*	1.4	*[0.6, 3.3]*	**2.1**	*[1, 4.3]*	1.9	*[0.9, 3.9]*
2nd Generation Immigrant	1.6	*[0.9, 2.9]*	1.6	*[0.9, 2.9]*	1.4	*[0.6, 2.8]*	1.4	*[0.7, 2.8]*	**1.8**	*[1, 3.4]*	**1.8**	*[1.1, 3.2]*
Education (ref=16+ years)												
<12 years of education	1.6	*[0.9, 3.1]*	1.7	*[0.8, 3.4]*	**2.3**	*[1.2, 4.3]*	**2.5**	*[1.3, 4.7]*	1.8	*[1, 3.4]*	**2.1**	*[1.1, 3.8]*
12-15 years of education	1.3	*[0.8, 2.2]*	1.4	*[0.8, 2.4]*	**1.8**	*[1, 3.2]*	**1.8**	*[1, 3.3]*	1.5	*[0.9, 2.6]*	**1.7**	*[1, 2.8]*
Income (ref=$50,000+)												
Income < $10,000	1.2	*[0.6, 2.3]*	1.2	*[0.6, 2.6]*	1.2	*[0.6, 2.4]*	1.6	*[0.8, 3.5]*	1.2	*[0.6, 2.4]*	1.5	*[0.7, 3.2]*
Income $10,000-$29,999	1.4	*[0.8, 2.4]*	1.4	*[0.8, 2.7]*	0.8	*[0.5, 1.5]*	1.0	*[0.5, 2]*	1.2	*[0.7, 2]*	1.3	*[0.8, 2.4]*
Income $30,000-$49,999	1.1	*[0.7, 2]*	1.3	*[0.7, 2.3]*	1.0	*[0.6, 1.8]*	1.3	*[0.7, 2.4]*	1.1	*[0.7, 1.9]*	1.4	*[0.8, 2.4]*
Missing data on income	0.9	*[0.5, 1.5]*	1.0	*[0.6, 1.9]*	0.7	*[0.4, 1.3]*	1.0	*[0.5, 2]*	0.8	*[0.5, 1.4]*	1.0	*[0.6, 1.9]*
Marital Status (ref=married)												
Separated/Divorced			1.4	*[0.8, 2.2]*			1.1	*[0.7, 1.9]*			1.2	*[0.7, 2]*
Widowed			1.5	*[0.8, 2.8]*			0.9	*[0.5, 1.6]*			1.3	*[0.7, 2.3]*
Never Married			0.8	*[0.5, 1.4]*			0.7	*[0.4, 1.3]*			0.7	*[0.4, 1.2]*
Presence of Children (ref=no children)												
1 Child			1.0	*[0.6, 1.7]*			0.7	*[0.4, 1.2]*			0.8	*[0.5, 1.4]*
2 Children			1.1	*[0.6, 2.2]*			0.9	*[0.5, 1.8]*			1.0	*[0.5, 1.9]*
3+ Children			1.2	*[0.6, 2.4]*			0.8	*[0.4, 1.6]*			1.0	*[0.5, 1.9]*
BMI (ref=BMI<22)												
BMI 22-24.9			1.7	*[0.7, 4]*			1.1	*[0.5, 2.4]*			1.3	*[0.6, 2.8]*
BMI 25-29.9			**2.4**	*[1.1, 5.3]*			1.6	*[0.8, 3.2]*			1.8	*[0.9, 3.7]*
BMI 30-34.5			**3.1**	*[1.3, 7.5]*			2.1	*[1, 4.6]*			**2.7**	*[1.2, 6.1]*
BMI 35+			**2.9**	*[1.2, 7.2]*			**2.4**	*[1.1, 5.3]*			**2.5**	*[1.1, 5.9]*

Table 6 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Health Care												
No health insurance			1.2	*[0.7, 2]*			1.3	*[0.7, 2.2]*			1.1	*[0.7, 1.9]*
No regular source of care			**0.4**	*[0.2, 0.7]*			**0.3**	*[0.1, 0.5]*			**0.3**	*[0.2, 0.5]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			1.2	*[0.7, 2.1]*			1.3	*[0.8, 2.2]*			1.2	*[0.7, 2.1]*
Regular Exercise			1.5	*[1, 2.2]*			0.8	*[0.5, 1.3]*			0.8	*[0.5, 1.3]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			0.7	*[0.4, 1.5]*			1.1	*[0.6, 2.2]*			1.3	*[0.7, 2.6]*
Walks 20+ minutes 2-5 times a week			0.9	*[0.5, 1.7]*			1.1	*[0.6, 1.9]*			1.3	*[0.7, 2.3]*
Walks 20+ minutes almost every day			0.9	*[0.6, 1.5]*			1.5	*[0.8, 2.6]*			1.5	*[0.8, 2.7]*
Missing data on walking			1.8	*[0.7, 4.8]*			1.6	*[0.7, 3.6]*			2.2	*[0.9, 5.4]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			0.7	*[0.4, 1.4]*			0.7	*[0.4, 1.4]*			0.7	*[0.4, 1.4]*
5-13 drinks per month			0.9	*[0.5, 1.9]*			0.7	*[0.4, 1.4]*			0.9	*[0.5, 1.6]*
14-30 drinks per month			1.1	*[0.5, 2.5]*			0.7	*[0.3, 1.6]*			1.0	*[0.5, 2.2]*
31+ drinks per month			0.9	*[0.4, 1.9]*			1.4	*[0.7, 2.9]*			1.1	*[0.6, 2.3]*
No longer drinks			1.2	*[0.6, 2.2]*			1.5	*[0.8, 2.5]*			1.3	*[0.7, 2.3]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			0.7	*[0.3, 1.4]*			0.5	*[0.3, 1]*			**0.5**	*[0.3, 1]*
6-10 cigarettes per day			0.7	*[0.3, 1.3]*			0.7	*[0.4, 1.3]*			0.7	*[0.3, 1.3]*
11+ cigarettes per day			0.6	*[0.3, 1]*			0.7	*[0.4, 1.4]*			0.6	*[0.4, 1]*
No longer smokes			1.1	*[0.7, 1.8]*			1.0	*[0.6, 1.7]*			1.0	*[0.6, 1.7]*
Neighborhood Factors												
Disadvantage									**1.3**	*[1, 1.6]*	**1.4**	*[1, 1.8]*
Affluence/Gentrification									1.1	*[0.9, 1.4]*	1.2	*[0.9, 1.4]*
Hispanic/Immigrant/Non-Black									**0.6**	*[0.5, 0.8]*	**0.6**	*[0.4, 0.8]*
Older Age Composition									0.8	*[0.7, 1]*	0.8	*[0.6, 1]*
Intercept	**0.2**	*[0.1, 0.4]*	**0.1**	*[0, 0.5]*	**2.2**	*[1.8, 2.7]*	**2.3**	*[1.8, 2.8]*	**0.2**	*[0.1, 0.5]*	**0.2**	*[0, 0.9]*

Note: Boldface indicates p<.05

Table 7. Weighted Logistic Regression and Hierarchical Generalized Linear Models of Treatment for Hypertension: CCAHS 2002 (*n* =719)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Female	1.6	*[0.9, 2.7]*	1.4	*[0.7, 2.8]*	1.4	*[0.9, 2.2]*	1.1	*[0.7, 1.9]*	**1.5**	*[1, 2.3]*	1.3	*[0.8, 2.2]*
Age (ref=age 18-29)												
Age 30-39	0.7	*[0.2, 2.4]*	0.4	*[0.1, 1.9]*	1.1	*[0.3, 4.5]*	1.0	*[0.3, 3.8]*	1.0	*[0.3, 3]*	0.8	*[0.3, 2.6]*
Age 40-49	1.3	*[0.4, 4]*	0.6	*[0.1, 2.4]*	1.9	*[0.5, 6.6]*	1.0	*[0.3, 3.3]*	1.6	*[0.6, 4.6]*	0.8	*[0.3, 2.5]*
Age 50-59	2.7	*[0.9, 8.4]*	1.2	*[0.3, 5.1]*	2.8	*[0.7, 10.4]*	1.0	*[0.3, 3.6]*	2.7	*[0.9, 7.8]*	1.1	*[0.3, 3.3]*
Age 60-69	**11.5**	*[3.5, 37.2]*	4.6	*[1, 21.8]*	**9.9**	*[3, 33]*	3.0	*[0.8, 11.3]*	**10.9**	*[4, 30]*	**3.8**	*[1.2, 12.2]*
Age 70+	**8.8**	*[2.3, 34.1]*	2.6	*[0.5, 13.2]*	**8.1**	*[2.3, 29]*	1.4	*[0.4, 5.5]*	**8.7**	*[3, 25.7]*	2.0	*[0.6, 6.6]*
Race/Ethnicity (ref=non-Hisp white and other)												
Non-Hisp Black	1.1	*[0.5, 2.6]*	1.1	*[0.5, 2.5]*	1.7	*[0.4, 6.5]*	1.7	*[0.5, 5.8]*	1.9	*[0.6, 5.7]*	1.8	*[0.6, 5.4]*
Hispanic	1.3	*[0.6, 3.1]*	1.0	*[0.4, 2.6]*	1.4	*[0.6, 3.4]*	1.0	*[0.4, 2.4]*	1.3	*[0.6, 2.7]*	0.9	*[0.4, 2]*
Immigrant Status (ref=3rd+ generation)												
1st Generation Immigrant	0.6	*[0.2, 1.3]*	0.5	*[0.2, 1.2]*	0.9	*[0.4, 1.8]*	0.8	*[0.3, 1.7]*	0.8	*[0.4, 1.5]*	0.7	*[0.3, 1.3]*
2nd Generation Immigrant	0.9	*[0.3, 3]*	0.9	*[0.3, 3.1]*	1.6	*[0.7, 3.4]*	1.9	*[0.9, 4]*	1.2	*[0.5, 2.9]*	1.7	*[0.7, 4.1]*
Education (ref=16+ years)												
<12 years of education	1.0	*[0.4, 2.6]*	0.9	*[0.4, 2.4]*	1.1	*[0.4, 2.6]*	1.0	*[0.4, 2.4]*	1.0	*[0.4, 2.1]*	0.9	*[0.4, 2.1]*
12-15 years of education	0.8	*[0.3, 1.9]*	0.7	*[0.3, 1.5]*	1.1	*[0.4, 2.9]*	1.0	*[0.5, 2.1]*	0.9	*[0.4, 2]*	0.8	*[0.4, 1.5]*
Income (ref=$50,000+)												
Income < $10,000	1.4	*[0.5, 3.7]*	1.8	*[0.6, 5.1]*	1.2	*[0.5, 2.9]*	1.6	*[0.6, 4.3]*	1.2	*[0.5, 2.7]*	1.6	*[0.6, 3.8]*
Income $10,000-$29,999	**2.7**	*[1.1, 6.3]*	**3.5**	*[1.4, 8.7]*	1.9	*[0.8, 4.4]*	**2.9**	*[1.3, 6.6]*	**2.4**	*[1.2, 4.9]*	**3.5**	*[1.8, 7.1]*
Income $30,000-$49,999	1.2	*[0.5, 2.6]*	1.3	*[0.6, 2.8]*	1.3	*[0.5, 3.5]*	2.3	*[1, 5.2]*	1.3	*[0.6, 2.9]*	1.9	*[0.9, 3.8]*
Missing data on income	**3.2**	*[1.3, 7.8]*	**4.5**	*[1.5, 13.2]*	**2.6**	*[1, 6.5]*	**3.3**	*[1.4, 7.8]*	**2.7**	*[1.2, 6.2]*	**3.9**	*[1.6, 9.1]*
Marital Status (ref=married)												
Separated/Divorced			0.5	*[0.2, 1]*			0.6	*[0.4, 1.1]*			0.6	*[0.4, 1]*
Widowed			0.7	*[0.2, 2.2]*			0.9	*[0.4, 1.7]*			0.9	*[0.4, 1.9]*
Never Married			**0.3**	*[0.2, 0.7]*			**0.3**	*[0.1, 0.7]*			**0.3**	*[0.2, 0.6]*
Presence of Children (ref=no children)												
1 Child			1.5	*[0.7, 3.3]*			1.5	*[0.8, 2.9]*			1.8	*[0.9, 3.3]*
2 Children			1.3	*[0.5, 3.3]*			0.8	*[0.4, 1.6]*			0.9	*[0.5, 1.7]*
3+ Children			0.7	*[0.3, 1.8]*			0.6	*[0.2, 1.4]*			0.6	*[0.3, 1.3]*
BMI (ref=BMI<22)												
BMI 22-24.9			0.6	*[0.1, 2.8]*			0.5	*[0.1, 1.6]*			0.3	*[0.1, 1.4]*
BMI 25-29.9			0.7	*[0.2, 2.9]*			0.7	*[0.2, 2.1]*			0.6	*[0.2, 2.2]*
BMI 30-34.5			0.6	*[0.1, 2.6]*			0.5	*[0.2, 1.7]*			0.5	*[0.1, 1.8]*
BMI 35+			0.5	*[0.1, 2]*			0.4	*[0.1, 1.2]*			0.3	*[0.1, 1.1]*

Table 7 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Health Care												
No health insurance			0.7	*[0.3, 1.6]*			0.9	*[0.4, 1.7]*			0.9	*[0.4, 1.7]*
No regular source of care			0.4	*[0.2, 1]*			0.4	*[0.2, 1.1]*			0.4	*[0.2, 1]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			0.8	*[0.3, 2]*			**1.9**	*[1.1, 3.3]*			1.6	*[0.9, 2.8]*
Regular Exercise			1.2	*[0.6, 2.3]*			1.2	*[0.7, 2.2]*			1.1	*[0.6, 1.9]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			**3.7**	*[1.1, 12.9]*			0.5	*[0.2, 1.2]*			**0.4**	*[0.2, 0.9]*
Walks 20+ minutes 2-5 times a week			0.9	*[0.4, 2.1]*			**0.5**	*[0.3, 1]*			**0.4**	*[0.2, 0.8]*
Walks 20+ minutes almost every day			1.0	*[0.5, 1.8]*			0.7	*[0.4, 1.4]*			0.5	*[0.3, 1.1]*
Missing data on walking			2.6	*[0.6, 11]*			1.4	*[0.6, 3.2]*			0.9	*[0.4, 2.1]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			0.6	*[0.2, 1.5]*			**0.5**	*[0.3, 0.9]*			**0.5**	*[0.3, 0.9]*
5-13 drinks per month			0.5	*[0.1, 1.4]*			0.4	*[0.1, 1]*			0.5	*[0.2, 1.2]*
14-30 drinks per month			0.9	*[0.3, 3]*			**0.2**	*[0.1, 0.5]*			**0.4**	*[0.2, 0.9]*
31+ drinks per month			0.4	*[0.1, 1]*			**0.2**	*[0.1, 0.5]*			**0.2**	*[0.1, 0.5]*
No longer drinks			1.5	*[0.6, 3.8]*			0.9	*[0.5, 1.5]*			1.2	*[0.6, 2.2]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			0.6	*[0.2, 2]*			**0.3**	*[0.1, 0.7]*			0.4	*[0.2, 1]*
6-10 cigarettes per day			1.4	*[0.4, 4.5]*			0.9	*[0.4, 2.2]*			1.0	*[0.3, 2.6]*
11+ cigarettes per day			1.1	*[0.4, 3]*			1.4	*[0.7, 3]*			1.4	*[0.6, 2.9]*
No longer smokes			0.8	*[0.4, 1.6]*			1.1	*[0.6, 1.9]*			0.9	*[0.5, 1.5]*
Neighborhood Factors												
Disadvantage									1.0	*[0.8, 1.5]*	1.1	*[0.8, 1.6]*
Affluence/Gentrification									1.0	*[0.7, 1.5]*	1.2	*[0.8, 1.8]*
Hispanic/Immigrant/Non-Black									1.3	*[0.9, 1.9]*	1.3	*[0.9, 1.9]*
Older Age Composition									1.0	*[0.7, 1.3]*	1.0	*[0.8, 1.3]*
Intercept	1.3	*[0.3, 4.6]*	**11.6**	*[1.2, 114.7]*	**6.0**	*[4.5, 8.1]*	**6.3**	*[4.7, 8.6]*	0.8	*[0.2, 3.4]*	**20.3**	*[2.1, 196.4]*

Note: Boldface indicates p<.05

Table 8. Weighted Logistic Regression and Hierarchical Generalized Linear Models of Control of Hypertension: CCAHS 2002 (*n* =569)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Covariates Centered around NC Means?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Female	**1.7**	*[1.1, 2.7]*	**2.0**	*[1.2, 3.3]*	1.6	*[0.9, 2.9]*	**2.2**	*[1.1, 4.1]*	**1.6**	*[1.1, 2.6]*	**2.0**	*[1.3, 3.3]*
Age (ref=age 18-29)												
Age 30-39	0.9	*[0.2, 4.5]*	0.8	*[0.2, 3.4]*	0.3	*[0, 1.7]*	0.8	*[0.1, 4.2]*	0.8	*[0.2, 3.4]*	0.8	*[0.2, 3.5]*
Age 40-49	1.3	*[0.3, 6.2]*	1.1	*[0.3, 4.2]*	0.7	*[0.1, 4.2]*	1.8	*[0.3, 9.7]*	1.1	*[0.2, 4.7]*	1.1	*[0.3, 4.1]*
Age 50-59	0.7	*[0.2, 2.9]*	0.4	*[0.1, 1.6]*	0.3	*[0.1, 1.6]*	0.6	*[0.1, 3]*	0.5	*[0.1, 2]*	0.4	*[0.1, 1.4]*
Age 60-69	0.6	*[0.1, 2.4]*	0.4	*[0.1, 1.6]*	0.2	*[0, 1.3]*	0.3	*[0, 1.8]*	0.4	*[0.1, 1.6]*	0.3	*[0.1, 1.3]*
Age 70+	0.4	*[0.1, 1.9]*	0.3	*[0.1, 1.4]*	0.2	*[0, 1]*	0.2	*[0, 1.3]*	0.3	*[0.1, 1.3]*	0.3	*[0.1, 1.1]*
Race/Ethnicity (ref=non-Hisp white)												
Non-Hisp Black	**0.5**	*[0.3, 0.9]*	**0.4**	*[0.2, 0.7]*	0.3	*[0.1, 1]*	0.3	*[0.1, 1.1]*	**0.5**	*[0.2, 1]*	**0.4**	*[0.2, 0.8]*
Hispanic	0.6	*[0.3, 1.3]*	0.5	*[0.2, 1.1]*	0.8	*[0.2, 2.7]*	0.8	*[0.2, 2.9]*	0.8	*[0.3, 1.8]*	0.7	*[0.3, 1.7]*
Non-Hisp Other	1.9	*[0.4, 9.5]*	1.7	*[0.3, 10.1]*	0.4	*[0.1, 2.3]*	0.3	*[0, 2]*	1.7	*[0.4, 8.1]*	1.3	*[0.2, 7]*
Immigrant Status (ref=3rd+ generation)												
1st Generation Immigrant	0.6	*[0.3, 1.2]*	0.5	*[0.2, 1.1]*	0.7	*[0.2, 2.5]*	0.8	*[0.3, 2.6]*	0.5	*[0.2, 1.1]*	0.5	*[0.2, 1.1]*
2nd Generation Immigrant	0.7	*[0.3, 1.7]*	0.6	*[0.2, 1.4]*	1.3	*[0.3, 5.1]*	1.2	*[0.3, 4.3]*	0.8	*[0.3, 2.1]*	0.7	*[0.3, 1.7]*
Education (ref=16+ years)												
<12 years of education	0.7	*[0.3, 1.4]*	0.5	*[0.2, 1]*	0.8	*[0.3, 2]*	0.7	*[0.3, 1.9]*	0.7	*[0.4, 1.5]*	0.5	*[0.2, 1.1]*
12-15 years of education	0.7	*[0.3, 1.3]*	0.5	*[0.3, 1]*	0.6	*[0.3, 1.3]*	0.6	*[0.2, 1.4]*	0.6	*[0.3, 1.1]*	**0.5**	*[0.2, 0.8]*
Income (ref=$50,000+)												
Income < $10,000	1.6	*[0.7, 3.5]*	2.4	*[1, 6]*	1.5	*[0.5, 4.8]*	1.9	*[0.6, 6.2]*	2.0	*[0.9, 4.8]*	**3.1**	*[1.2, 8]*
Income $10,000-$29,999	1.2	*[0.6, 2.3]*	1.5	*[0.7, 3.1]*	1.2	*[0.5, 3.1]*	1.9	*[0.7, 4.8]*	1.5	*[0.7, 2.9]*	2.0	*[1, 4.1]*
Income $30,000-$49,999	1.4	*[0.7, 2.7]*	1.4	*[0.7, 2.9]*	1.2	*[0.5, 3.1]*	1.2	*[0.5, 3]*	1.5	*[0.8, 3.1]*	1.6	*[0.8, 3.4]*
Missing data on income	**2.3**	*[1, 5]*	**3.0**	*[1.3, 7.1]*	2.2	*[0.7, 6.8]*	2.7	*[0.9, 8]*	2.9	*[1.3, 6.6]*	**4.0**	*[1.7, 9.4]*
Marital Status (ref=married)												
Separated/Divorced			0.6	*[0.4, 1.1]*			**0.3**	*[0.2, 0.7]*			**0.5**	*[0.3, 0.9]*
Widowed			**0.5**	*[0.3, 0.9]*			0.8	*[0.4, 1.7]*			**0.5**	*[0.3, 0.9]*
Never Married			**0.4**	*[0.2, 0.8]*			0.5	*[0.2, 1.5]*			**0.4**	*[0.2, 1]*
Presence of Children (ref=no children)												
1 Child			**2.3**	*[1.1, 4.8]*			1.4	*[0.5, 3.7]*			2.0	*[1, 4.2]*
2 Children			1.3	*[0.6, 3.1]*			1.7	*[0.6, 4.9]*			1.5	*[0.7, 3.4]*
3+ Children			1.1	*[0.5, 2.9]*			0.7	*[0.2, 2.4]*			0.9	*[0.4, 2.5]*
BMI (ref=BMI<22)												
BMI 22-24.9			1.3	*[0.3, 5.5]*			1.0	*[0.2, 5.8]*			1.2	*[0.3, 4.6]*
BMI 25-29.9			1.0	*[0.3, 3.7]*			0.9	*[0.2, 4.3]*			0.9	*[0.3, 3]*
BMI 30-34.5			1.2	*[0.3, 4.6]*			1.0	*[0.2, 5.1]*			1.0	*[0.3, 3.5]*
BMI 35+			1.2	*[0.3, 4.6]*			1.5	*[0.3, 7.6]*			1.1	*[0.3, 3.8]*

Table 8 (Continued)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
NC Fixed Effects in Model?	No		No		Yes		Yes		No		No	
NC Random Effects in Model?	No		No		Yes		Yes		Yes		Yes	
	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*	OR	*CI*
Health Care												
No health insurance			1.2	*[0.6, 2.4]*			1.2	*[0.5, 2.9]*			1.3	*[0.7, 2.5]*
No regular source of care			0.5	*[0.2, 1.2]*			**0.2**	*[0.1, 1]*			**0.4**	*[0.1, 1]*
Exercise (ref=never exercises)												
Light-Moderate Exercise			0.7	*[0.4, 1.3]*			0.8	*[0.4, 1.7]*			0.9	*[0.5, 1.6]*
Regular Exercise			0.7	*[0.4, 1.2]*			1.1	*[0.5, 2.4]*			1.2	*[0.7, 2.1]*
Walking (ref=never walks 20+ min)												
Walks 20+ minutes once a week or less			1.1	*[0.5, 2.3]*			1.3	*[0.4, 3.8]*			1.5	*[0.6, 3.5]*
Walks 20+ minutes 2-5 times a week			1.7	*[0.8, 3.4]*			0.5	*[0.2, 1.1]*			0.6	*[0.3, 1.2]*
Walks 20+ minutes almost every day			0.8	*[0.4, 1.4]*			0.4	*[0.2, 1.1]*			0.8	*[0.4, 1.6]*
Missing data on walking			0.9	*[0.4, 2.2]*			0.4	*[0.1, 1.2]*			0.6	*[0.2, 1.5]*
Drinking (ref=Never a drinker)												
Less than 4 drinks per month			0.7	*[0.3, 1.3]*			0.6	*[0.2, 1.5]*			0.6	*[0.3, 1.1]*
5-13 drinks per month			1.2	*[0.5, 2.7]*			1.3	*[0.4, 4.1]*			1.2	*[0.5, 2.8]*
14-30 drinks per month			**0.4**	*[0.1, 0.9]*			**0.3**	*[0.1, 1]*			**0.3**	*[0.1, 0.9]*
31+ drinks per month			1.1	*[0.3, 3.2]*			1.6	*[0.4, 6.1]*			1.1	*[0.4, 3.3]*
No longer drinks			1.3	*[0.7, 2.4]*			0.7	*[0.3, 1.6]*			1.1	*[0.6, 2]*
Smoking (ref=Never a smoker)												
Less than 6 cigarettes per day			0.6	*[0.2, 1.7]*			0.5	*[0.2, 1.6]*			0.6	*[0.2, 1.5]*
6-10 cigarettes per day			1.1	*[0.5, 2.7]*			1.2	*[0.4, 3.2]*			1.1	*[0.5, 2.5]*
11+ cigarettes per day			**2.2**	*[1, 4.8]*			2.5	*[1, 6.5]*			**2.4**	*[1.2, 5]*
No longer smokes			1.2	*[0.7, 2]*			1.8	*[0.9, 3.7]*			1.4	*[0.8, 2.4]*
Neighborhood Factors												
Disadvantage									1.1	*[0.8, 1.4]*	1.1	*[0.8, 1.4]*
Affluence/Gentrification									1.2	*[0.9, 1.6]*	1.2	*[0.9, 1.6]*
Hispanic/Immigrant/Non-Black									0.9	*[0.6, 1.3]*	0.8	*[0.6, 1.2]*
Older Age Composition									**1.3**	*[1, 1.6]*	1.3	*[1, 1.6]*
Intercept	1.6	*[0.3, 8.5]*	1.4	*[-0.6, 3.3]*	**0.8**	*[0.7, 1]*	**1.4**	*[-0.6, 3.3]*	1.8	*[0.4, 8.3]*	1.4	*[-0.6, 3.3]*

Note: Boldface indicates p<.05

Appendix 1. Definitions of Selected Variables

Variable	Definition/Notes
Race/Ethnicity	The CCAHS survey instrument allowed respondents to identify with multiple ethnic and/or racial groups and it included separate questions about Hispanic ethnicity and racial identification. For the purpose of this analysis, we imposed a mutually exclusive categorization of race/ethnicity on this multiracial/multiethnic data structure consisting of the following categories: - Hispanic: subjects who reported being of Latino/Hispanic origin, regardless of their racial identification - Non-Hispanic Black: subjects who identified as African American/Black in any of their responses to the race question excluding those who also report Latino/Hispanic origins - Non-Hispanic White: subjects who listed White/Caucasian as their first response to the race question excluding those who also identified as either Latino/Hispanic or Black/African-American - Non-Hispanic Other Race: subjects who identified as American Indian, Asian, or Pacific Islander as their first response to the race question and also did not identify as either Latino/Hispanic or Black/African-American. Also, anyone who identified as Filipino was coded in this category, even if they also identified as Latino/Hispanic or Black/African American.
Immigrant Generation	- First-generation immigrants are individuals born outside of the United States, including individuals born in a U.S. territory (e.g., Puerto Rico, U.S. Virgin Islands, Guam). - Second-generation immigrants are individuals who have at least one parent born outside the U.S. or in a U.S. territory. - All other individuals were classified as third- or higher-generation immigrants.
Presence of Children	Children were defined as anyone age 17 or younger living in the same household as the respondent.
Body Mass Index (BMI)	BMI = (body weight in kilograms)/(height in meters)^2 - Height was measured using a tape measure while respondents stood in a doorway in stocking feet. - Weight was measured in stocking feet and street clothes (less sweaters or other heavy over-garments) using digital scales.
No Regular Source of Medical Care	Respondents were coded as not having a regular source of care if they answered "no" to the following question: "Do you have a particular doctor or clinic that you would call your regular doctor or clinic?"
Exercise	An exercise scale was constructed from questions derived from the National Health Interview Survey that asked respondents (1) whether they are currently confined to a bed or chair for most or all of the day because of their health, (2) how many days a week do they do light or moderate leisure activities other than walking or working around the house for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate, (3) when they do light/moderate leisure activities, do they generally do them for 20 minutes or more, (4) how many days a week do they do vigorous activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate, and (5) each time they do vigorous activities, do they generally do

	them for 20 minutes or more? We used the following categories in our analysis: - Never Exercises: Individuals who said they (a) never engage in light-moderate leisure activities, (b) never engage in vigorous activity, or (c) were confined to a bed or chair. - Light-Moderate Exercise: Individuals who engage in (a) light-moderate physical activity 1-3 times per week or less, regardless of duration; (b) light-moderate activity 4 or more times per week for less than 20 minutes; or (c) vigorous activity once per week or less, regardless of duration. - Regular Exercise: Individuals who engage in (a) light-moderate activity 4 or more times per week for more than 20 minutes or (b) vigorous activity 2 or more times per week, regardless of duration.
Walking	This survey-based measure is based on the following question: "On the average over the past year, how many days a week do you walk continuously for 20 minutes or more, either to get somewhere or just for exercise or pleasure?" We used the following categories in our analysis: - Never walks 20+ minutes - Walks 20 minutes or more once a week or less - Walks 20 minutes or more 2-5 times a week - Walks 20 minutes or more almost every day
Drinking	A drinking measure was constructed from survey questions that asked respondents (1) whether they ever drink beer, wine, or liquor; (2) whether they have always abstained from drinking; (3) in a typical month, about how many days do they drink. We used the following categories in our analysis: - Has always abstained from drinking - Has less than 4 drinks per month - Has 5-13 drinks per month - Has 14-30 drinks per month - Has 31+ drinks per month - No longer drinks but once did (former drinker)
Smoking	A smoking measure was constructed from survey questions that asked respondents (1) whether they have smoked more than 100 cigarettes in their lifetime; (2) whether they currently smoke cigarettes; (3) in an average day, how many cigarettes do they usually smoke. We used the following categories in our analysis: - Has never smoked more than 100 cigarettes in lifetime - Currently smokes less than 6 cigarettes per day - Currently smokes 6-10 cigarettes per day - Currently smokes 11+ cigarettes per day - No longer smokes, but has smoked more than 100 cigarettes in lifetime

Appendix 2. Unweighted Frequencies of Social Groups by Quartiles of Neighborhood Factors (n =3,105)

	Quartiles of Disadvantage				Quartiles of Affluence/ Gentrificiation				Quartiles of Hispanic/Immigrant/ Non-Black				Quartiles of Older Age Composition				
Social Groups	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	Total
Race/Ethnicity																	
Non-Hispanic White	373	315	225	70	121	138	307	417	57	202	461	263	256	212	207	308	983
Non-Hispanic Black	243	196	303	498	322	480	286	152	663	416	100	61	188	380	386	286	1,240
Hispanic	136	279	284	103	407	136	159	100	28	70	191	513	403	210	96	93	802
Education																	
Less than 12 years	134	195	243	220	336	193	175	88	176	146	150	320	289	225	157	121	792
12-15 years	412	399	395	370	441	457	418	260	445	365	365	401	363	428	387	398	1,576
16 or more years	218	230	204	85	81	115	177	364	135	191	268	143	218	166	170	183	737
Income																	
Less than $10,000	44	76	102	143	112	101	88	64	116	108	57	84	100	107	76	82	365
$10,000-$29,999	156	213	264	243	276	246	193	161	230	183	182	281	286	236	197	157	876
$30,000-$49,999	137	176	147	121	157	127	145	152	119	133	165	164	179	153	131	118	581
$50,000 or more	242	213	159	84	116	140	195	247	152	169	227	150	168	167	170	193	698
Total	764	824	842	675	858	765	770	712	756	702	783	864	870	819	714	702	

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