GEOGRAPHIC VARIATION IN HYPERTENSION PREVALENCE AMONG BLACKS AND WHITES: THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS

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Abstract

BACKGROUND—Many studies have examined differences in hypertension across race/ethnic groups but few have evaluated differences within groups.

METHODS—We investigated within-group geographic variations in hypertension prevalence among 3322 black and white participants of the Multi-Ethnic Study of Atherosclerosis. Place of birth and place of residence were included in multivariate Poisson regression analyses.

RESULTS—Blacks born in southern states were 1.11 (95% confidence interval (CI): 1.02, 1.23) times more likely to be hypertensive than non-southern states after adjusting for age and sex. Findings were similar, though not statistically significant, for Whites (prevalence ratio (PR): 1.15, 95% CI: 0.98, 1.35). Blacks and Whites living in Forsyth (Blacks, PR: 1.23, 95% CI: 1.07, 1.42; Whites, PR: 1.32, 95% CI: 1.09, 1.60) and Baltimore (Blacks, PR: 1.14, 95% CI: 1.00, 1.31; Whites, PR: 1.24, 95% CI: 1.05, 1.47) were also significantly more likely to be hypertensive than those living in Chicago after adjusting for age and sex. Among Blacks, those living in New York were also significantly more likely to be hypertensive. Geographic heterogeneity was partially explained by socioeconomic indicators, neighborhood characteristics or hypertension risk factors. There was also evidence of substantial heterogeneity in Black-White differences depending on which geographic groups were compared (ranging from 82% to 13% higher prevalence in Blacks compared with Whites).

CONCLUSIONS—A better understanding of geographic heterogeneity may inform interventions to reduce racial/ethnic disparities.

Introduction

It is well known that hypertension prevalence is higher among African Americans than it is for any other race/ethnic group in the US.[1,2] Despite a growing body of research suggesting that social, environmental, and lifestyle factors may play an important role, the reasons for these disparities remain unclear.[3−6] Understanding potential explanations for this variation within race/ethnic groups could help identify factors leading to hypertension and inform strategies to reduce racial/ethnic disparities.

Studies of race/ethnic differences in hypertension in the United States rarely investigate heterogeneity within groups, although some research has suggested that important geographic heterogeneity may exist. For example, evidence suggests that Blacks and Whites living in the South have higher hypertension prevalence and risk than those living in the rest of the country.[7,8] In addition, a longitudinal study of young adults found that black men living in Chicago and Minneapolis were significantly less likely to develop elevated blood pressure levels over a 7-year period than black men living in Birmingham, after adjusting for education and established risk factors.[9] A similar trend was observed among black women. Although no studies have investigated associations of region of birth with hypertension prevalence, being born in the South has been linked to increased cardiovascular disease mortality.[10−12] However, the determinants of these geographic differences are not well understood.

Using data from black and white participants of the Multi-Ethnic Study of Atherosclerosis (MESA) we examined associations of region of birth and place of residence with the prevalence of hypertension. We also examined the contribution of the neighborhood environment, socioeconomic characteristics, and traditional hypertension risk factors to observed geographic differences. In addition, we explored how black-white differences in hypertension changed depending on which geographic subgroups were compared.

Methods

Study population

MESA is an observational cohort study designed to examine the determinants of subclinical cardiovascular disease in adults aged 45–84 years.[13] Participants free of clinical cardiovascular disease at baseline were recruited from six study sites (New York, New York; Baltimore City and County, Maryland; Forsyth County, North Carolina; Minneapolis, Minnesota; Los Angeles County, California; and Chicago, Illinois) between 2000 and 2002.[13] This study used the cross-sectional data collected at baseline. At each site, random population samples were selected using various lists of area residents. Additional details are provided elsewhere.[13] Of the selected persons deemed eligible after screening, 59.8% participated in the study. White participants were recruited from all six study sites; black participants were recruited from all sites except Minneapolis. In order to facilitate comparisons across race groups, these analyses are restricted to the five sites from which both groups were recruited. Institutional Review Board approval was obtained at each site and all participants gave informed consent. MESA participants represented four race/ethnic groups, but our analyses focused on self-identified Blacks and Whites only since data on Hispanics and Asian Americans were collected in fewer study sites.

Hypertension definition and measurement

Resting seated blood pressure was measured three times at a single baseline visit by trained and certified clinic staff using a Dinamap PRO 100 automated oscillometric device (Critikon, Tampa, FL), and the average of the last two measurements was used in the analyses.[14] Hypertension was defined as having a mean systolic blood pressure greater than

or equal to 140 mm Hg, a mean diastolic blood pressure greater than or equal to 90 mm Hg, or a self-reported history of hypertension and report of being on medication for it.15

Geographic measures

Participants were asked to report the state in which they were born. Place of birth was categorized as southern state, non-southern state, and foreign-born. The South is often defined as those states that seceded from the Union during the Civil War.16 One critique of such a categorization is that it fails to take into consideration the shared history and culture of certain states in the southern part of the country. In an attempt to account for this, we included the following as southern states in these analyses: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Given their physical and cultural distance from the Deep South, we did not include Delaware, Maryland, and District of Columbia (states that are considered the South by the US Census17) as southern states. Instead, we included them in the non-southern-born category. The foreign-born category included all participants born outside the US. Place of residence was defined as the study site in which the participant lived at baseline: Forsyth County, North Carolina; New York, New York; Baltimore City and County, Maryland; Chicago, Illinois; and Los Angeles, California.

Covariates

Several sets of covariates were examined as potential contributors to observed geographic differences including socioeconomic position; neighborhood factors; and traditional risk factors for hypertension.

Individual socioeconomic position—Parental education was categorized as less than high school (HS), HS, and college or more. Education information was collected on both parents, and the education level of the parent with the higher level of attainment was used in the analyses. Individual education was measured as the highest level completed and categorized as HS or less, some college/technical school, and bachelors degree or more. Annual household income was grouped into quartiles (less than $25,000; $25,000-$39,999; $40,000–$74,999; and $75,000 and greater). Baseline income was available and used for 91.6% of black participants and 97.3% of white participants. When baseline income was missing, Exam 2 data were used (5.1% of black participants and 1.4% of white participants).

Neighborhood environment—We examined four survey-based scale measures of the neighborhood environment previously shown to be associated with hypertension in this cohort18: neighborhood safety (3 items), social cohesion (5 items), walkability (6 items), and healthy food availability (2 items). Each participant's scores were based on the average of the responses given by all other participants living within a mile of the participant, and higher scores represented better environments.

Because some of these neighborhood characteristics were highly correlated, these four scores were entered into a factor analysis with oblique rotation. Two factors were identified that accounted for 81.3 percent of the variation in the data. Factor 1, the physical environment, included neighborhood walkability and healthy food availability. Factor 2, the social environment, consisted of neighborhood safety and social cohesion. Factor-based scores were created for the neighborhood physical and social environments by summing the respective scales within each factor. All factor loadings were comparable (physical environment: 0.87, 0.93; social environment: 0.79, 0.88), so these scales were not weighted by their respective loadings. Number of years living in current neighborhood was included as a control variable to account for varying lengths of exposure to a given neighborhood environment.

Hypertension risk factors—Body mass index (BMI) and health behaviors that are known risk factors for hypertension were assessed as potential mediators of the associations between region of birth/residence, individual SEP and the neighborhood environment and hypertension prevalence. Height and weight measured at baseline were used to calculate BMI. Alcohol use and cigarette smoking were based on self-report and dichotomized as current versus not current. Exercise was measured as metabolic equivalent (MET) hours per day spent in intentional activity and categorized for analyses as high, some, and no activity, with high representing levels above the median (2.0 MET-hours per day).

Statistical analyses

Key covariates were compared across place of birth and place of residence using analysis of variance (ANOVA) and the χ^2 statistic. Because hypertension is not a rare condition, the odds ratio is not a good approximation of the prevalence ratio.[19] As recommended in prior work,[20, 21] Poisson regression with robust variance estimates was used to estimate prevalence ratios of hypertension comparing the different place of birth (with US birth outside the South as the reference group) and place of residence (with Chicago as the reference group) categories. Although we did not find a statistically significant interaction between race/ethnicity and place of birth or place of residence, all analyses were conducted separately for white and black participants in order to assess within-race variation in hypertension by area and race-specific predictors. Models were sequentially adjusted for socioeconomic characteristics, neighborhood characteristics, and cardiovascular risk factors.

In addition, we conducted analyses pooling Whites and Blacks in order to contrast different race-geography combinations. We analyzed differences by place of birth and place of residence separately. We used two different reference groups for these analyses: Whites born in/residing in the area with the highest hypertension prevalence and Whites born in/residing in the area with the lowest hypertension prevalence. This was done to investigate how contrasts between Whites and Blacks differ depending on which geographic subgroups are compared.

Of the 1894 Blacks and 2018 Whites living in the 5 MESA study sites at baseline, 324 Blacks and 249 Whites were missing information on state of birth, parental or personal SEP, or neighborhood characteristics. An additional 8 Blacks and 9 Whites were missing data on BMI or health behaviors, leaving 1562 Blacks and 1760 Whites for analysis. All analyses were conducted using SAS 9.2 (Cary, NC).

Results

Descriptive statistics comparing covariates by place of birth and place of residence for Blacks and Whites are shown in Table 1. Most participants living in Forsyth at baseline were born in southern states (91.3%), and between 34.1% and 45.5% of those living in the other sites were born in southern states (not shown). Unadjusted hypertension prevalence among Blacks was highest in those born in the southern states and lowest among the foreign-born. Prevalence of hypertension was highest among those living in Forsyth and lowest in those living in Chicago. Blacks born in southern states generally had the lowest levels of parental education and individual SEP while those born in non-southern states had the highest. New York residents had the lowest levels of parental education and individual education of all the sites, but the best reported neighborhood social environment. Those living in Chicago generally had the highest levels of parental education and individual SEP of all the sites, as well as the best neighborhood physical environment.

Hypertension prevalence among Whites was lower than among Blacks within every place of birth and place of residence category. Just over 67% of Whites living in Forsyth were born

in southern states (not shown); a much smaller percentage of Whites living in the other sites were born in southern states (between 2.5% and 10.2%). Whites born in the South had the highest unadjusted hypertension prevalence and foreign-born Whites had the lowest. As with Blacks, Whites living in Forsyth had the highest hypertension prevalence and those living in Chicago had the lowest. Whites born in non-southern states had the highest level of parental education and individual SEP, whereas those born in southern states had the lowest parental and individual educational attainment. Whites living in Forsyth and Baltimore had the lowest parental education levels and individual SEP, while those in Los Angeles had the best. Chicago residents reported the best physical environments and Forsyth residents reported the best social environments.

Table 2 shows prevalence ratios of hypertension among Blacks by place of birth and place of residence. Blacks born in southern states were 1.11 (95% confidence interval (CI): 1.01, 1.23) times more likely to be hypertensive than those born in non-southern states. This association was not substantially modified after adjustment for individual SEP and neighborhood characteristics (prevalence ratio (PR): 1.10, 95% CI: 0.99, 1.22). Further adjustment for risk factors had little effect. Blacks living in Forsyth (PR: 1.23, 95% CI: 1.07, 1.42), New York (PR: 1.16, 95% CI: 1.00, 1.34), and Baltimore (PR: 1.14, 95% CI: 1.00, 1.31) were all significantly more likely to be hypertensive than those living in Chicago. All associations were slightly attenuated after adjustment for individual SEP but a larger reduction in associations (especially for Forsyth) was observed when neighborhood characteristics were accounted for (Forsyth, PR: 1.13, 95% CI: 0.90, 1.42; New York, PR: 1.09, 95% CI: 0.94, 1.26; Baltimore, PR: 1.06, 95% CI: 0.89, 1.26). These associations were slightly reduced after additional adjustment for hypertension risk factors.

Whites born in southern states were 1.15 (95% CI: 0.98, 1.35) times more likely to be hypertensive than those born in non-southern states (Table 3). This association was slightly attenuated with each subsequent adjustment for parental SEP and individual SEP, was not substantially modified after adjustment for neighborhood characteristics, and increased after adjustment for hypertension risk factors (PR: 1.17, 95% CI: 1.00, 1.38). Whites living in Forsyth (PR: 1.32, 95% CI: 1.09, 1.60) and Baltimore (PR: 1.24, 95% CI: 1.05, 1.47) had significantly higher hypertension prevalence compared with those living in Chicago. Los Angeles residents also had higher hypertension prevalence than those in Chicago, though this association was not statistically significant (PR: 1.20, 95% CI: 0.93, 1.56), possibly due to the smaller sample size. These associations were weakened after adjusting for parental and individual SEP but were strengthened after subsequent adjustment for neighborhood characteristics.

Table 4 shows prevalence ratios for categories based on race and place of birth and race and place of residence in separate models. We report two models for place of birth and two models for place of residence: one with Whites with the lowest hypertension prevalence as the reference (models 1 and 3), and another with Whites with the highest hypertension prevalence as the reference category (models 2 and 4). Results show that the magnitude of Black-White differences varies substantially depending on which subgroups of Blacks and Whites are compared. Substantial variability exists when subgroups when different places of birth are compared: the largest race difference was observed when Blacks born in the southern states were compared with non-southern-born Whites (Model 1, PR: 1.57, 95% CI: 1.41, 1.74). In contrast, a much smaller race difference was observed when foreign-born Blacks were compared with southern-born Whites (Model 2, PR 1.18, 95% CI: 0.95, 1.47). The most extreme race difference was observed when Forsyth Blacks are compared with Chicago Whites (PR: 1.82, 95% CI: 1.43, 2.31) whereas the smallest difference was observed when Chicago Blacks are compared with Forsyth Whites (PR: 1.13, 95% CI: 0.92, 1.39).

Discussion

Our findings confirm that there is important geographic variation in hypertension prevalence among US Blacks and Whites. Hypertension prevalence was higher among Blacks born in southern states than those born in non-southern states, and was significantly higher among Blacks living in Forsyth, Baltimore and New York than in those living in Chicago. Important heterogeneity was also observed in Whites: Southern-born Whites had marginally higher hypertension prevalence than non-southern-born Whites and Whites living in Forsyth and Baltimore had significantly higher hypertension prevalence than those in Chicago. Adjustment for SEP and neighborhood characteristics reduced many of these associations. Additional adjustment for hypertension risk factors generally had little impact.

An important consequence of this geographic heterogeneity is that differences in hypertension prevalence between Blacks and Whites are not constant but vary substantially depending on which geographic groups are compared. In a model adjusted for demographics, parental and individual SEP, and neighborhood characteristics, hypertension prevalence was 57% higher among southern-born Blacks compared with non-southern-born Whites. In contrast, hypertension prevalence was only 18% higher among foreign-born Blacks compared with southern-born Whites. The differences were even more striking when comparing race differences in hypertension prevalence across place of residence. Hypertension prevalence was 82% higher among Blacks living in Forsyth compared with Whites living in Chicago. On the other hand, hypertension prevalence was just 13% higher among Blacks living in Chicago compared with Whites living in Forsyth, a difference similar to within-race differences in hypertension prevalence by residence. The presence of large variations in Black-White differences suggests that race differences are not immutable and may vary substantially according to the social and environmental context.

Adjustment for hypertension risk factors had little impact on the associations between place of residence and hypertension. Although diet was not included in the analyses due to missing data, the inclusion of a Dietary Approaches to Stop Hypertension (DASH)[22, 23] adherence measure derived from a food frequency questionnaire did not substantially modify results (not shown). The failure of established risk factors to fully explain geographic variability is consistent with prior studies.[7, 9] Possible explanations include measurement error in risk factors and an absence of risk factor history, which both limit our ability to examine the role of these factors as contributors to geographic differences.

Other work has previously reported differences in hypertension incidence and prevalence by region within the US, and our findings are generally consistent with prior results showing higher levels of hypertension among those living in southern states.[7−9] Our study builds on prior research by examining not only place of current residence, but also place of birth. We found that being born in southern states was associated with increased probability of being hypertensive independent of place of residence. These findings are consistent with mortality studies in Ohio and New York City which showed that cardiovascular disease mortality rates were higher among Blacks born in the South than those born in other parts of the country regardless of where they later lived.[10, 11]

There are several plausible mechanisms through which characteristics of place of birth may influence hypertension. Individuals who leave the South may bring along adverse eating habits. Persons living in the South report consuming lower levels of fiber and higher amounts of sodium and cholesterol compared with persons living in the Northeast, the Midwest, and the West.[24] Lower socioeconomic position in childhood may have persistent effects leading to hypertension in adulthood,[25−27] and educational attainment and per capita income have traditionally been lower in the South than other parts of the country.[28,

29 In our study, associations were not substantially modified after adjustment for parental or adult SEP or available behavioral factors, but the measures we had available were limited. The DASH dietary adherence measure we investigated in sensitivity analyses was not associated with hypertension in this sample, and did not contribute to geographic differences. However, diet is notoriously difficult to measure and deserves further exploration as a contributor to geographic differences. In addition, a number of studies have reported an inverse relationship between birth weight and adult blood pressure30 and the prevalence of low birth weight is higher in the South.31 Unfortunately birth weight data were not available in our sample.

One limitation of this study is that we do not have complete information on where the participants lived between when they were born and the time they joined the MESA study. However, we do have a 20-year residential history on 3380 black and white participants included in these analyses. These data show that the majority of Blacks and Whites (approximately 80–87% depending on the state) lived in the same state 20 years ago as they did at the start of the study. These data suggest that measures based on current residence reflect long term exposures.

Our results reveal substantial geographic heterogeneity in hypertension prevalence within race/ethnic groups and also demonstrate that Black-White differences vary substantially depending on which geographic groups are compared. A better understanding of the presence and causes of geographic differences in hypertension within and across race/ethnic groups may help guide efforts to prevent the disease and reduce the disparity.

Acknowledgments

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Table 1

Selected socioeconomic, neighborhood, and risk factor characteristics of Blacks and Whites by place of birth and place of residence, the MESA study 2000–2002

Blacks

	Born in southern state (n=801)	Born in non-southern state (n=618)	Foreign (n=143)	p-value*	Forsyth (n=401)	New York (n=330)	Baltimore (n=434)	Los Angeles (n=134)	Chicago (n=263)	p-value*
Hypertensive (%)	64.9	51.8	44.1	<0.0001	65.6	56.7	57.4	53	50.6	0.002
Age (years)†	63.4 (9.6)	60.2 (9.9)	57.1 (8.9)	<0.0001	61.6 (9.6)	61.1 (9.9)	61.6 (9.7)	61.6 (10.3)	61.7 (10.3)	0.94
Sex (% male)	44.2	46.9	49	0.42	44.9	41.8	45.4	49.1	52.2	0.23
Parental education less than HS (%)	53.6	30.1	49.7	<0.0001	44.9	48.2	47.5	35	36.6	0.003
Income < $25,000 (%)	33.1	23.8	32.2	0.0005	28.2	27.3	33.2	19.4	44.8	<0.0001
High school education or less (%)	32.3	22.2	35.7	<0.0001	26.2	37.9	31.8	14.8	29.9	<0.0001
Neighborhood physical environment†	6.9 (0.9)	7.3 (0.7)	7.7 (0.6)	<0.0001	6.2 (0.7)	6.6 (0.3)	6.9 (0.4)	7.1 (0.4)	8.0 (0.5)	<0.0001
Neighborhood social environment†	7.1 (0.6)	6.9 (0.5)	6.7 (0.5)	<0.0001	7.5 (0.5)	7.9 (0.3)	7.1 (0.4)	7.0 (0.4)	6.7 (0.4)	<0.0001
BMI (kg/m²)†	30.0 (5.6)	30.3 (5.8)	29.5 (5.3)	0.36	30.2 (5.4)	30.1 (6.0)	30.5 (5.6)	29.5 (5.8)	29.4 (5.5)	0.07
Current cigarette smoker (%)	16.4	22.2	6.3	<0.0001	15.5	16.1	18	20.5	22.4	0.24
Current alcohol drinker (%)	46.9	56	49	0.003	41.9	50.3	46.5	70.3	53	<0.0001
No intentional exercise (%)	24.1	21.5	25.2	0.44	22.7	18.5	27.7	19.4	29.1	0.008

Whites

	Born in southern state (n=429)	Born in non-southern state (n=1194)	Foreign (n=137)	p-value*	Forsyth (n=501)	New York (n=200)	Baltimore (n=431)	Los Angeles (n=122)	Chicago (n=506)	p-value*
Hypertensive (%)	47.1	35.8	32.9	<0.0001	45.7	31	42.2	36.9	30.8	<0.0001
Age (years)†	62.8 (10.0)	62.6 (9.7)	63.8 (10.5)	<0.0001	62.6 (9.6)	62.4 (9.7)	64.2 (10.0)	61.2 (10.7)	62.0 (9.7)	<0.0001
Sex (% male)	47.1	49.3	44.5	0.38	49.3	44	50.8	46.1	52.5	0.33
Parental education less than HS (%)	34.7	23.4	25.6	<0.0001	32.3	25	34.8	16.2	15.6	<0.0001
Income < $25,000 (%)	13.8	11.3	15.3	0.21	13.6	7.5	18.6	6.7	14.8	<0.0001
High school education or less (%)	30.5	14.2	17.5	<0.0001	28.3	12	24.6	5.9	18	<0.0001
Neighborhood physical environment†	6.7 (1.0)	7.8 (1.1)	7.9 (1.0)	<0.0001	6.4 (0.7)	8.4 (0.4)	7.1 (0.6)	7.2 (0.3)	8.8 (0.4)	<0.0001
Neighborhood social environment†	7.7 (0.5)	7.3 (0.5)	7.2 (0.5)	<0.0001	7.9 (0.4)	7.1 (0.4)	7.3 (0.5)	7.2 (0.4)	7.2 (0.3)	<0.0001
BMI (kg/m²)†	27.6 (4.9)	27.4 (5.0)	26.9 (5.0)	0.41	27.7 (4.9)	26.4 (4.7)	28.1 (5.2)	27.6 (5.4)	26.8 (4.8)	<0.0001
Current cigarette smoker (%)	12.4	8	13.1	0.01	11.4	9	8.1	8.9	9.8	0.51
Current alcohol drinker (%)	55.9	77.1	78.8	<0.0001	56.5	81.5	69.6	86.8	68	<0.0001

	Born in southern state (n=429)	Born in non-southern state (n=1194)	Foreign (n=137)	p-value[*]		Whites					
						Forsyth (n=501)	New York (n=200)	Baltimore (n=431)	Los Angeles (n=122)	Chicago (n=506)	p-value[*]
No intentional exercise (%)	20.1	14	16.8	0.01		17.8	14	19.3	10.5	18.9	0.002

[*] p-value for test of overall association between site and each of the covariates

[†] Values in parentheses are standard deviations

Table 2

Prevalence ratios of hypertension among Blacks by place of birth and place of residence before and after adjustment for socioeconomic factors, neighborhood characteristics, and hypertension risk factors

	Model 1*	Model 2*	Model 3*	Model 4†	Model 5‡
Born in southern state	1.11 (1.01, 1.23)	1.11 (1.00, 1.23)	1.10 (1.00, 1.22)	1.10 (0.99, 1.22)	1.10 (0.99, 1.22)
Foreign-born	0.90 (0.74, 1.09)	0.90 (0.74, 1.10)	0.88 (0.72, 1.07)	0.88 (0.72, 1.07)	0.87 (0.72, 1.06)
US-born, non-southern state	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Forsyth	1.23 (1.07, 1.42)	1.24 (1.07, 1.42)	1.20 (1.04, 1.38)	1.13 (0.90, 1.42)	1.10 (0.88, 1.38)
New York	1.16 (1.00, 1.34)	1.16 (1.00, 1.34)	1.09 (0.94, 1.26)	1.09 (0.94, 1.26)	1.06 (0.92, 1.23)
Baltimore	1.14 (1.00, 1.31)	1.14 (0.99, 1.31)	1.10 (0.96, 1.27)	1.06 (0.89, 1.26)	1.03 (0.87, 1.23)
Los Angeles	1.05 (0.86, 1.26)	1.05 (0.87, 1.27)	1.00 (0.83, 1.21)	0.97 (0.79, 1.20)	0.97 (0.79, 1.19)
Chicago	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Parental education less than HS		1.07 (0.94, 1.23)	1.04 (0.90, 1.19)	1.03 (0.90, 1.19)	1.02 (0.89, 1.17)
Parental education HS complete		1.09 (0.95, 1.24)	1.08 (0.94, 1.23)	1.07 (0.93, 1.23)	1.05 (0.92, 1.20)
Parental education college complete		1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
HS or less			1.07 (0.96, 1.19)	1.06 (0.95, 1.19)	1.03 (0.93, 1.15)
Some college/technical degree			1.01 (0.91, 1.13)	1.01 (0.91, 1.13)	0.99 (0.89, 1.10)
Bachelors/graduate school			1.00 (ref)	1.00 (ref)	1.00 (ref)
Income <$25,000			1.30 (1.10, 1.54)	1.28 (1.08, 1.52)	1.30 (1.09, 1.54)
Income $25,000 – $39,999			1.33 (1.13, 1.57)	1.32 (1.11, 1.56)	1.32 (1.12, 1.57)
Income $40,000 – $74,999			1.20 (1.02, 1.41)	1.19 (1.01, 1.40)	1.18 (1.01, 1.39)
Income >$74,999			1.00 (ref)	1.00 (ref)	1.00 (ref)
Neighborhood physical environment				0.95 (0.87, 1.04)	0.96 (0.88, 1.04)
Neighborhood social environment				0.97 (0.88, 1.07)	0.96 (0.87, 1.06)

*
Adjusted for age and sex in addition to all the variables shown

†
Adjusted for age, sex, years in current neighborhood in addition to all the variables shown

‡
Adjusted for age, sex, years in current neighborhood, BMI, alcohol use, cigarette smoking, diet, and exercise in addition to all the variables shown

Table 3

Prevalence ratios of hypertension among Whites by place of birth and place of residence before and after adjustment for socioeconomic factors, neighborhood characteristics, and hypertension risk factors

	Model 1 *	Model 2 *	Model 3 *	Model 4 †	Model 5 ‡
Born in southern state	1.15 (0.98, 1.35)	1.14 (0.97, 1.34)	1.12 (0.95, 1.32)	1.13 (0.96, 1.33)	1.17 (1.00, 1.38)
Foreign-born	0.90 (0.71, 1.14)	0.91 (0.71, 1.15)	0.90 (0.71, 1.14)	0.90 (0.71, 1.15)	0.89 (0.71, 1.13)
Born in non-southern state	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Forsyth	1.32 (1.09, 1.60)	1.30 (1.08, 1.58)	1.23 (1.01, 1.50)	1.32 (0.95, 1.84)	1.29 (0.94, 1.78)
New York	1.01 (0.79, 1.28)	1.00 (0.79, 1.27)	0.99 (0.78, 1.26)	1.01 (0.80, 1.29)	1.03 (0.81, 1.31)
Baltimore	1.24 (1.05, 1.47)	1.22 (1.03, 1.44)	1.17 (0.98, 1.39)	1.26 (0.99, 1.60)	1.21 (0.91, 1.62)
Los Angeles	1.20 (0.93, 1.56)	1.20 (0.93, 1.55)	1.13 (0.88, 1.47)	1.22 (0.90, 1.66)	1.01 (0.85, 1.20)
Chicago	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Parental education less than HS		1.12 (0.95, 1.31)	1.03 (0.87, 1.23)	1.04 (0.87, 1.24)	1.01 (0.85, 1.20)
Parental education HS complete		1.03 (0.88, 1.20)	0.99 (0.84, 1.15)	0.99 (0.85, 1.16)	0.96 (0.82, 1.12)
Parental education college complete		1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
HS or less			1.24 (1.05, 1.47)	1.26 (1.06, 1.49)	1.24 (1.05, 1.47)
Some college/technical degree			1.17 (1.00, 1.36)	1.17 (1.01, 1.36)	1.16 (1.00, 1.35)
Bachelors/Graduate degree			1.00 (ref)	1.00 (ref)	1.00 (ref)
Income <$25,000			0.97 (0.80, 1.18)	0.98 (0.80, 1.21)	0.94 (0.76, 1.16)
Income $25,000–$39,999			1.02 (0.84, 1.22)	1.03 (0.85, 1.24)	0.98 (0.82, 1.19)
Income $40,000–$74,999			1.09 (0.94, 1.27)	1.10 (0.94, 1.28)	1.07 (0.92, 1.25)
Income > $74,999			1.01 (0.95, 1.07)	1.00 (ref)	1.00 (ref)
Neighborhood physical environment				1.05 (0.95, 1.16)	1.05 (0.96, 1.15)
Neighborhood social environment				1.05 (0.91, 1.22)	1.05 (0.91, 1.21)

*
Adjusted for age and sex in addition to all the variables shown

†
Adjusted for age, sex, years in current neighborhood in addition to all the variables shown

‡
Adjusted for age, sex, years in current neighborhood, BMI, alcohol use, cigarette smoking, diet, and exercise in addition to all the variables shown

Table 4

Prevalence ratios of hypertension by race and study site

	Model 1[*]	Model 2[*]	Model 3[*]	Model 4[*]
Southern-born Blacks	1.57 (1.41, 1.74)	1.39 (1.23, 1.56)		
Foreign-born Blacks	1.33 (1.09, 1.63)	1.18 (0.95, 1.47)		
Non-southern-born Blacks	1.45 (1.29, 1.62)	1.28 (1.11, 1.48)		
Southern-born Whites	1.13 (0.99, 1.29)	1.00 (ref)		
Foreign-born Whites	0.89 (0.70, 1.13)	0.79 (0.61, 1.02)		
Non-southern-born Whites	1.00 (ref)	0.89 (0.78, 1.01)		
Forsyth Blacks			1.82 (1.43, 2.31)	1.41 (1.25, 1.60)
New York City Blacks			1.61 (1.35, 1.93)	1.26 (1.03, 1.53)
Baltimore Blacks			1.65 (1.35, 2.01)	1.28 (1.11, 1.48)
Chicago Blacks			1.45 (1.21, 1.75)	1.13 (0.92, 1.39)
Los Angeles Blacks			1.49 (1.18, 1.88)	1.16 (0.95, 1.41)
Forsyth Whites			1.29 (1.01, 1.63)	1.00 (ref)
New York City Whites			0.98 (0.77, 1.25)	0.76 (0.58, 1.01)
Baltimore Whites			1.19 (0.97, 1.45)	0.92 (0.78, 1.09)
Los Angeles Whites			1.14 (0.87, 1.51)	0.89 (0.68, 1.16)
Chicago Whites			1.00 (ref)	0.78 (0.61, 0.99)

[*] Models adjusted for age, sex, place of residence, parental education, individual SEP, and neighborhood characteristics