

Acculturation Is Associated With Hypertension in a Multiethnic Sample

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Background: Hypertension varies in prevalence among race/ethnic groups in the United States. Within-ethnic group differences associated with acculturation have been less frequently examined. We studied the association of three measures of acculturation (language spoken at home, place of birth, and years living in the US) with hypertension in a population sample of 2619 white, 1898 African American, 1,494 Hispanic, and 803 Chinese participants in the Multiethnic Study of Atherosclerosis.

Methods: Multivariate Poisson regression was used to estimate the association between the acculturation variables and hypertension.

Results: Birthplace outside the US and speaking a non-English language at home were each associated with a lower prevalence of hypertension after adjustment for age, gender, and socioeconomic status (prevalence ratio [95% confidence intervals] 0.82 (0.77–0.87) for non-US born versus US born and 0.80 (0.74–0.85) for those not speaking English at home versus speakers of English at

home, both $P < .001$). For participants born outside of the US, each 10-year increment of years in the US was associated with a higher prevalence of hypertension after adjustment for age, gender, and socioeconomic status (P for trend $< .01$). The associations between acculturation variables and hypertension were weakened after adjustment for race/ethnic category and risk factors for hypertension. Compared to US-born Hispanics, those born in Mexico or South America had lower prevalence of hypertension, but those born in the Caribbean and Central America had higher prevalence of hypertension.

Conclusions: Acculturation and place of birth are associated with hypertension in a multiethnic sample. Am J Hypertens 2007;20:354–363 © 2007 American Journal of Hypertension, Ltd.

Key Words: Hypertension, acculturation, ethnicity, Chinese, Hispanic, African-American.

Within the US, the prevalence of hypertension differs between ethnic groups. African Americans have a higher prevalence of hypertension than whites,^{1,2} and Mexican Americans have a lower prevalence of hypertension compared with whites and African Americans, although rates of hypertension among Mexican Americans appear to be increasing over time.¹ However, these race/ethnic groups are not necessarily homogeneous. Gradients in hypertension prevalence across geographically separate populations from the same racial

group highlight the role of environmental exposures in the etiology of hypertension.^{3–7}

Acculturation is the adoption of the traditions, values, and cultural practices of a host country.^{8,9} The relationship of acculturation to the burden of hypertension is important due to rising numbers of immigrants in the US, currently constituting 10% of the US population and a larger proportion of many minority groups.¹⁰ Of foreign born persons in the US, 51% are Hispanic and 26% were born in Asia.^{11–13} The US studies have linked acculturation to

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hypertension in Hispanic populations,¹⁴ although these were predominantly Mexican American. Little is known about acculturation and hypertension in Hispanic Americans of Caribbean or South- and Central American origin, or in Chinese Americans.

The Multi-Ethnic Study of Atherosclerosis (MESA) is a multiethnic cohort study of subclinical atherosclerosis in six communities in the United States.¹⁴ The study included substantial numbers of Chinese and Hispanic immigrants. We used information regarding years lived in the US, place of birth, and language spoken at home to examine the association of acculturation with hypertension in MESA. We hypothesized that greater levels of acculturation would be associated with a higher prevalence of hypertension. We also hypothesized that this relationship would be independent of age, but would be partially mediated by traditional risk factors for hypertension (ie, obesity, smoking, a high sodium diet, and alcohol consumption).

Methods

Study Population and Design

MESA is a 10-year longitudinal study with the goal of identifying risk factors for subclinical atherosclerosis and transition from subclinical disease to clinical events.¹⁴ MESA recruited 6814 men and women aged 45 to 84 years from six field centers: Baltimore, MD; Chicago, IL; Forsyth County, NC; Los Angeles, CA; New York, NY; and St. Paul, MN. A probability sample of more than 1000 (ranging from 1066 to 1319) participants was selected at each site through population-based approaches (commercial lists of area residents, Health Care Financing Administration (HCFA) lists of area residents [for participants aged 65 years and older], area residents enrolled in a union health plan [in New York City], and random digit dialing [New York City and Los Angeles]). Only persons free of clinical cardiovascular disease at baseline were eligible. Non-Hispanic white participants were recruited at all sites; non-Hispanic African American participants were recruited at all sites except St. Paul; Hispanic participants were recruited in New York, Los Angeles, and St. Paul; and Asian participants were recruited in Los Angeles and Chicago. The baseline visit for the MESA cohort took place in 2000 to 2002. The study was approved by the Institutional Review Boards of the participating institutions using principles outlined in the Declaration of Helsinki and Title 45 of the US Code of Federal Regulations. All participants gave written informed consent, and all study procedures were in accordance with local institutional guidelines.

Predictor Variables

Race and ethnicity were based on participants' responses to the ethnicity and race questions from the 2000 US census. Information on age, gender, place of birth, time in the US (for those not born in the US), language spoken at

home, income, and education were obtained using questionnaires administered as part of the baseline visit in English, Spanish, or Chinese. Family income and level of education were selected from 13 categories and 8 categories, respectively, and collapsed into a smaller number of categories for our analyses. Information on smoking, alcohol use, body mass index (BMI), and use of medications was also measured at baseline. Physical activity was self-reported as number of minutes per week spent in moderate or vigorous activities using a semiquantitative questionnaire adapted from the Cross-Cultural Activity Participation Study.¹⁵ We examined metabolic equivalents (METs)/min/week of leisure, walking, sports/dancing, and occupational physical activity. Dietary salt (grams per day) was reported in the MESA food frequency questionnaire, modified from the Insulin Resistance Atherosclerosis study in which comparable validity was observed for non-Hispanic white, African American, and Hispanic individuals.¹⁶

Blood Pressure Measurements

Resting blood pressure was measured at the MESA baseline examination using the Dinamap Monitor PRO 100 (Critikon, Tampa, FL) automated oscillometric device. Three measurements were obtained at 1-min intervals in the seated position after 5 min of rest with an appropriate sized cuff, with the cuff at the level of the heart, using a standardized protocol. The average of the second and third measurements was recorded as the resting blood pressure. Hypertension was defined as a systolic blood pressure greater than 140 mm Hg, a diastolic blood pressure greater than 90 mm Hg, or currently taking medications for blood pressure control.¹⁷

Acculturation Variables

We investigated three variables as surrogates for acculturation: place of birth, language spoken at home, and number of years residing in the US. These variables were chosen because they represent some of the main factors associated with acculturation,¹⁸ and because detailed race/ethnic specific acculturation questionnaires were not used in MESA. Place of birth was categorized as born in the US or born outside of the US or in Puerto Rico. Hispanic participants born outside of the US or in Puerto Rico were also grouped by region of birth: Mexican, South American, Central American, or Caribbean. Because Puerto Rico is generally culturally more similar to other Caribbean islands than to the mainland US, participants born in Puerto Rico were included in the Caribbean category. Language spoken at home was categorized into two groups: exclusively English or another language \pm English. We subsequently recoded language spoken at home so that participants speaking only English at home and those speaking English plus another language were grouped together. Place of birth and language spoken at home were strongly associated and therefore investigated

in separate models. Duration of time living in the US was analyzed only in the subgroup born outside of the US or in Puerto Rico. Years living in the US was first examined in two broad categories (<10 years or ≥10 years) and was subsequently categorized into 10-year categories to investigate trends.

Statistical Analysis

Differences in covariates by levels of acculturation were tested with χ^2 tests or *t* tests. We used Poisson regression to model the prevalence ratio of hypertension as a function of acculturation variables before and after adjustment for covariates (confounders or mediators of the acculturation effect).¹⁹ The association between acculturation and hypertension was estimated in the entire MESA cohort and within race/ethnic categories. Race/ethnic category was tested for interaction with acculturation by including interaction terms in the regression models along with age, education, and income. Among Hispanic participants, we

investigated the prevalence of hypertension by region of birth. All *P* values correspond to two-tailed tests. Statistical analyses were performed using Stata statistical software (Stata Corp, College Station, TX).

Results

The MESA baseline examination was completed by 6814 subjects and these were included in this analysis. The mean age was 63 years, 53% were women, and 38% were white, 28% African American, 22% Hispanic, and 12% Chinese (Table 1). Compared to the white and African American subgroups, Chinese and Hispanic subjects were less likely to have been born in the US and more likely to speak a language other than English in the home. Among the persons not born in the US, the median time lived in the US was longest for whites and shortest for Chinese (median years in US: 41 in whites [*n* = 133], 18 in Chinese [*n* = 720], 28 in African Americans [*n* = 130],

Table 1. Sociodemographic characteristics, blood pressure, and prevalence of hypertension, the Multiethnic Study of Atherosclerosis (MESA) 2000–2002

	All participants (<i>n</i> = 6814)	Whites (<i>n</i> = 2619)	African Americans (<i>n</i> = 1898)	Hispanics (<i>n</i> = 1494)	Chinese (<i>n</i> = 803)	<i>P</i> *
Age (mean (SD))	62.7 (10.3)	63.1 (10.3)	62.7 (10.1)	61.8 (10.4)	62.9 (10.3)	<.001
Gender (%) women	52.8	51.9	55.5	51.9	51.4	.06
Language spoken at home (%)						
English	70.8	97.3	97.2	29.3	5.9	<.001
Other language ± English	27.2	1.8	1.7	70.4	92.7	
Unknown	2.0	0.9	1.1	0.3	1.5	
Place of birth (%)						
US	68.3	93.2	90.4	1.3	3.7	
Other country†	31.4	6.5	8.9	68.7	96.1	<.001
Unknown	0.3	0.3	0.7	0.0	0.1	
Annual family income (\$US, %)						
<20,000	22.6	10.5	19.9	38.4	41.3	
20,000 to 49,999	34.7	31.2	37.3	41.9	29.6	<.001
≥50,000	37.6	55.6	34.1	17.3	28.3	
Unknown	4.0	2.7	8.5	2.3	0.7	
Education (% distribution)						
<High school	18.9	4.9	12.2	44.6	24.8	
High school/some college	46.1	45.3	53.5	45.4	36.2	<.001
≥Bachelor's degree	34.7	49.5	33.6	9.9	38.9	
Unknown	0.3	0.3	0.7	0.0	0.1	
Systolic blood pressure (mm Hg)	127 (21.5)	124 (20.4)	132 (21.6)	127 (21.9)	125 (21.6)	<.001
Diastolic blood pressure (mm Hg)	72 (10.3)	70 (10.0)	75 (10.2)	72 (10.1)	72 (10.4)	<.001
Percent hypertension‡ adjusted for age	43.8	36.1	59.4	41.6	35.2	§

* *P* values are from χ^2 tests for categorical variables and ANOVA for continuous variables, except where noted for differences in age-adjusted hypertension prevalence.

† Other country was defined as non-US. Puerto Rico was categorized as "other country".

‡ Hypertension was defined as either systolic blood pressure of 140 mm Hg or greater, diastolic blood pressure of 90 mmHg or greater, or treatment with antihypertensive medications.

§ Prevalence of hypertension was significantly higher in African Americans and Hispanics compared to whites (*P* ≤ .001 for both); the difference in prevalence between Chinese and whites was not significant (*P* = .79). *P* values are from age-adjusted logistic regression models.

and 30 in Hispanics [$n = 909$]; Kruskal-Wallis $P \leq .001$ [data not shown in Table 1]). The prevalence of hypertension was higher in African Americans than in the other ethnic groups. The prevalence of hypertension in Hispanics was intermediate between the prevalence in African Americans and the prevalence in white and Chinese participants.

Compared to participants born in the US and speaking exclusively English at home, participants born outside the US and participants who spoke a language other than English at home were more likely to be Chinese or Hispanic, and had relatively lower income and education levels (Table 2). Non-US born participants and those who spoke a language other than English at home were also less likely to be current drinkers or smokers, were less physically active, and had a lower mean BMI and sodium intake (Table 3). Age-adjusted prevalence of hypertension was lower in the participants born outside of the US or in Puerto Rico and in participants who spoke a language other than English at home, although hypertensive members of these groups were also less likely to be on antihypertensive medications (Table 3). Higher acculturation participants had higher median physical activity levels (METs in min/week) of all types except for occupational physical activity, which was similar across acculturation categories (data not shown). When language spoken at home was categorized into three levels (English only, English plus another language, other language only) the group speaking English plus another language was small ($n = 306$) and generally similar to the other-language-only group (results not shown).

Participants born outside of the US or in Puerto Rico were grouped into two categories: those living in the continental US for 10 years or less, and those living in the continental US for more than 10 years. Compared to participants living in the US for more than 10 years, participants in the US for 10 years or less were more likely to be Chinese than Hispanic, had a similar education level but a lower income level, were less likely to use alcohol, and had a lower BMI (Tables 2 and 3). The age-adjusted prevalence of hypertension was lower in persons in the US 10 years or less than in persons in the US 10 years or more. Among hypertensives, those in the US 10 years or less were less likely to be on antihypertensive medications.

In the full sample, speaking a language other than English at home and birthplace outside of the US were associated with a lower prevalence of hypertension after adjusting for age and gender (Table 4). Adjustment for income and education strengthened the associations. Adjustment for race/ethnicity weakened the associations, largely due to substantially higher prevalence of hypertension in African Americans who were more likely to have been born in the US and to speak English at home. Adjustment for known risk factors for hypertension—smoking, alcohol use, low physical activity, high BMI, and high dietary salt—slightly weakened the association of language spoken at home and place of birth with hy-

pertension. Redefining language spoken at home so that participants speaking English plus another language were grouped with participants speaking only English did not appreciably change the results.

Among participants born outside of the US, more years living in the US was associated with a higher age and sex-adjusted prevalence ratio of hypertension (Table 5). Associations remained largely unchanged after adjustment for socio-economic status (SES) and race/ethnicity but were weakened after additional adjustment for hypertension risk factors, although the trend remained statistically significant.

Analyses stratified by race/ethnicity (not shown) showed some variability in associations of language and place of birth variables with hypertension, but were limited by small sample size. Longer residence in the US was associated with greater prevalence ratio of hypertension in all race/ethnic groups, although the strength of the associations varied, with the strongest associations in African Americans and Hispanics (not shown). Differences in associations of hypertension and acculturation by race/ethnicity were not statistically significant for any of the acculturation variables (P for interaction $\geq .3$ for all three).

We subsequently categorized Hispanic participants by place of birth (US, Mexico, South America, Central America, or the Caribbean [including Puerto Rico]). Among Hispanics born outside of the US, years in the US did not differ by place of birth. Mexican- and Caribbean-born participants were more likely to be in the lower income categories, and the Mexican-born were the most likely to be in the lower educational categories and to have diabetes (data not shown). Compared to Hispanic participants born in the US, participants born in Mexico or South America had a lower prevalence of hypertension, and participants born in the Caribbean or Central America had a higher prevalence after adjustment for age, gender, income, education, and risk factors for hypertension (Table 6).

Discussion

We studied the relation between measures of acculturation and the presence of hypertension in a large, multiethnic population that was free of cardiovascular disease, and found that being born outside of the US, speaking a language other than English at home, and fewer years living in the US were associated with a decreased prevalence of hypertension. The associations between acculturation and hypertension remained after adjustment for age, income, and education. There were no statistically significant interactions between acculturation and race/ethnicity, but sample size limited race/ethnic-specific analyses. Within Hispanic participants, there was evidence of substantial heterogeneity in the prevalence of hypertension by place of birth.

Studies of immigrants have demonstrated that residence in increasingly industrialized societies is associated with

Table 2. Demographic characteristics of MESA participants according to category of language spoken at home, place of birth, and years living in the US

	Language spoken at home* N = 6753		Place of birth† N = 6888		Years living in the US‡ (participants born outside of the US or in Puerto Rico only) N = 1892	
	English only	Other language with or without English	United States	Outside the U.S. or in Puerto Rico	>10 years	≤10 years
Number (%)	4878 (72.2)	1875 (27.8)	4748 (68.9)	2140 (31.1)	1576 (83.3)	316 (16.7)
Age (mean (SD))	62.8 (10.2)	62.4 (10.4)	63.0 (10.2)	62.1 (10.4)	62.5 (10.2)	61.6 (10.8)
P§		.25		.002		.14
Gender (%)						
Women	52.8	53.0	51.8	53.5	52.9	55.5
P		.89		.49		.23
Race/ethnic category (%)						
Whites	52.2	2.5	52.4	8.0	7.8	3.2
African Americans	37.8	1.7	37.0	7.9	7.7	2.5
Hispanics	13.0	56.1	10.0	48.0	49.9	38.6
Chinese	1.0	39.7	0.7	36.1	34.5	55.7
P		<.001		<.001		<.001
Annual family income (\$US, %)						
≤20,000	14.9	43.6	15.1	39.4	37.3	54.6
20,000 to 49,999	34.8	36.3	34.4	35.6	36.9	28.5
>50,000	45.9	18.1	44.1	23.0	24.6	11.7
Unknown	4.4	2.0	6.4	2.0	1.0	5.1
P		<.001		<.001		<.001
Education (%)						
<High school	8.7	42.4	8.7	37.8	37.9	38.9
High school/some college	50.6	36.9	49.9	37.7	37.6	38.0
≥Bachelor's	40.7	20.7	39.4	24.5	24.5	23.1
P		<.001		<.001		.87

Significant P values are in bold.

* Language spoken at home missing data for 135 participants.

† Place of birth missing data for missing 96 participants.

‡ Number of years living in the US missing data for missing 248 subjects.

§ P values were from t tests for continuous variables, and χ^2 tests for categorical variables.

Table 3. Hypertension and risk factors for hypertension in MESA participants according to category of language spoken at home, place of birth, and years living in the US

	Language spoken at home* N = 6753		Place of birth† N = 6,888		Years living in the US‡ (participants born outside of the US or in Puerto Rico only) N = 1892	
	English only	Other language with or without English	United States	Outside the U.S. or in Puerto Rico	>10 years	≤10 years
Current alcohol use (%)	61.8	38.1	60.1	41.9	42.5	36.7
<i>P</i> §		<.001		<.001		.06
Current smoking (%)	10.1	2.2	14.5	9.9	9.4	10.8
<i>P</i>		<.001		<.001		.35
Physical activity (min/week, %)						
None	38.8	53.4	38.1	49.8	48.8	59.2
1-700 min	29.2	19.5	29.0	19.8	21.7	13.0
>700 min	32.0	29.2	31.0	30.4	29.5	27.9
<i>P</i>		<.001		<.001		<.001
BMI (kg/m ² , mean (SD))	28.9 (5.6)	27.0 (5.0)	28.9 (5.6)	27.0 (5.0)	27.3 (5.1)	25.5 (4.3)
<i>P</i>		<.001		<.001		<.001
Dietary sodium (g/d)	2.4 (1.4)	2.3 (1.4)	2.4 (1.5)	2.2 (1.4)	2.2 (1.3)	2.4 (1.6)
<i>P</i>		.02		<.001		.91
Systolic BP (mm Hg)	127 (21.3)	126 (22.0)	127 (21.4)	126 (21.7)	126 (21.3)	125 (23.3)
<i>P</i>		.24		.02		.65
Diastolic BP (mm Hg)	72 (10.3)	72 (10.2)	72 (10.3)	72 (10.1)	72 (10.2)	72 (10.0)
<i>P</i>		.32		.78		.47
Hypertension (%)	46.1	39.6	45.8	39.3	41.2	32.3
<i>P</i>		<.001		<.001		<.001
% Hypertension on antihypertensive medications	75.0	69.7	74.8	70.8	72.0	62.6
<i>P</i>		.01		.02		.06

Significant *P* values are in bold.

* Language spoken at home missing data for 135 participants.

† Place of birth missing data for missing 96 participants.

‡ Number of years living in the US missing data for missing 248 subjects.

§ *P* values were from *t* tests for continuous variables, and χ^2 tests for categorical variables.

|| Age-adjusted prevalence of hypertension. Hypertension was defined as either systolic blood pressure of 140 mm Hg or greater, diastolic blood pressure of 90 mm Hg or greater, or treatment with antihypertensive medications for blood pressure control.

Table 4. Adjusted prevalence ratio of hypertension by measures of acculturation the Multiethnic Study of Atherosclerosis (MESA) 2000–2002

	Prevalence ratio	95% confidence interval	P
Language spoken at home (<i>n</i> = 6501)			
English only	1.0	—	—
Other language*, adjusted for age†, gender	0.87	(0.82–0.92)	<.001
Other language, adjusted for age, gender, education‡, and income.§	0.80	(0.74–0.85)	<.001
Other language, adjusted for age, gender, race/ethnic category , education, and income.	0.92	(0.82–0.98)	.20
Other language, adjusted for age, gender, education, income, and risk factors for hypertension.¶	0.86	(0.80–0.92)	<.001
Other language, adjusted for age, gender, race/ethnic category, education, income, and risk factors for hypertension.	0.94	(0.84–1.04)	.23
Place of birth (<i>n</i> = 6000)			
US	1.0	—	—
Other country#, adjusted for age, gender	0.87	(0.82–0.92)	<.001
Other country, adjusted for age, gender, education, and income.	0.82	(0.77–0.87)	<.001
Other country, adjusted for age, gender, race/ethnic category, education, and income.	0.93	(0.85–0.99)	.07
Other country, adjusted for age, gender, education, income, and risk factors for hypertension.	0.87	(0.83–0.95)	<.001
Other country, adjusted for age, gender, race/ethnic category, education, income, and risk factors for hypertension.	0.94	(0.86–1.02)	.14

* Participants speaking English and another language or another language only at home were included in this category.

† Age was entered as a continuous variable.

‡ Education was entered as three categories: < high school, high school ± some college, ≥ Bachelor's degree.

§ Annual family income was entered as three categories: ≤\$20,000, \$20,000 to \$49,999, and >\$50,000.

|| Race/ethnic category defined as white, African American, Hispanic, and Chinese.

¶ Risk factors for hypertension were smoking status (current, former never), current alcohol use (yes or no), physical activity (min/week), BMI (kg/m²), and dietary sodium (g/d).

Other country was defined as non-US or Puerto Rico.

graded increases in the prevalence of hypertension.^{3–8,20} Singh and Siahpush²¹ found that relative risk of hypertension increased with duration of residence in immigrants in the US in the National Health Interview Survey, but these data were not adjusted for risk factors. Higher acculturation was associated with hypertension in Hispanic populations in the 1982–1984 Hispanic HANES and the 1994 NHANES III.^{11,13} Vaeth and Willett¹² used a detailed acculturation scale to show that Hispanics of middle and high levels of acculturation in the Dallas Heart Study had a greater risk of hypertension compared to low-acculturation individuals. In contrast to prior work, which was often limited to a single ethnic group, we demonstrated associations of acculturation with hypertension in a large multiethnic sample. We also demonstrated a trend of increasing prevalence of hypertension with each 10 years that an immigrant resides in the US.

The weakening of the association between acculturation and hypertension after adjustment for hypertension risk factors suggests these associations may be partly mediated by exposure to tobacco smoke, alcohol, obesity,

and dietary salt. Not all risk factors for hypertension were lower in the less acculturated group; consistent with prior work, we found acculturation was associated with more, rather than less, physical activity.^{22–27} The association between years in the US and hypertension remained after adjusting for risk factors. In the Dallas Heart Study BMI, diabetes, and other variables only explained part of the relationship between acculturation and hypertension in Hispanics.¹² Measurement error or new confounding introduced with adjustment could explain why the association persisted after controlling for known risk factors. Higher acculturation could lead to hypertension through acculturative stress, psychological stress, or other unmeasured psychological and social factors.^{7,12} Alternately, immigrants and persons of lower acculturation in MESA could have a lower prevalence of hypertension due to dietary or lifestyle factors that occurred earlier in life, or because immigration selected for healthier individuals. However, the selection hypothesis (healthy migrant effect) does not explain the association between years in the US and the greater prevalence of hypertension we observed.

Table 5. Adjusted prevalence ratio (95% confidence intervals) of hypertension by 10-year category of years living in the US in 1892 participants born outside the US or in Puerto Rico, the Multiethnic Study of Atherosclerosis (MESA) 2000–2002

Years living in the US	<10 N = 316	10–19 N = 427	20–29 N = 440	≥30 N = 709	P value for trend
Age (mean ± SD)	61.6 ± 10.8	61.1 ± 10.7	59.3 ± 9.8	65.4 (9.3)	
Relative rate for hypertension, Adjusted for age* and gender only	1.0	1.09 (0.91–1.32)	1.23 (1.03–1.49)	1.35 (1.15–1.58)	<.001
Adjusted for age, gender, education†, income‡, and race/ethnic category§	1.0	1.10 (0.91–1.33)	1.19 (0.98–1.44)	1.34 (1.11–1.60)	<.01
Adjusted for age, gender, education, income, race/ethnic category, and risk factors for hypertension¶	1.0	1.05 (0.87–1.28)	1.13 (0.94–1.28)	1.26 (1.05–1.51)	.01

* Age was entered as a continuous variable.

† Education was entered as three categories: <high school, high school ± some college, ≥Bachelor's degree.

‡ Annual family income was entered as three categories: ≤\$20,000, \$20,000 to \$49,999, and >\$50,000.

§ Race/ethnic category defined as white, African American, Hispanic, and Chinese.

¶ Risk factors for hypertension were current smoking status, current alcohol use (yes or no), physical activity (min/week), BMI (kg/m²), and dietary sodium (g/d).

Table 6. Prevalence of hypertension and prevalence ratio of hypertension by place of birth in Hispanic participants, the Multiethnic Study of Atherosclerosis (MESA) 2000–2002

Country of birth	US-born (reference) (n = 654)	Mexican-born (n = 371)	South American-born (n = 115)	Caribbean-born* (n = 229)	Central American-born (n = 125)
Percent hypertension, adjusted for age, gender, income, and education.	40.2	33.1	34.0	47.1	47.6
Prevalence ratio (95% CI) for hypertension, adjusted for age, gender, income, and education.	1.0	0.85 (0.71–1.00)	0.87 (0.69–1.09)	1.14 (0.97–1.33)	1.16 (0.94–1.43)
P		.06	.23	.11	.16
Prevalence ratio (95% CI) for hypertension, adjusted for age, gender, income, education, and risk factors for hypertension†	1.0	0.89 (0.75–1.06)	0.91 (0.73–1.14)	1.18 (1.01–1.38)	1.25 (1.13–1.54)
P		.21	.43	.04	.04

* Caribbean-born included participants born in Puerto Rico.

† Risk factors for hypertension were current smoking status, current alcohol use (yes or no), physical activity (min/week), BMI (kg/m²), and dietary sodium (g/d).

Previous studies have shown a lower age-adjusted prevalence of hypertension in Mexican-Americans compared to US non-Hispanic whites and African Americans,¹ but few studies have described the epidemiology of hypertension in Hispanics born in other regions. A study of the 1982–1984 Hispanic HANES found a similar prevalence of hypertension among Hispanic subgroups.²⁸ Our analysis found that Mexican- and South American-born Hispanics had a lower prevalence of hypertension than US-born Hispanics, but Caribbean- and Central America-born Hispanics had a higher prevalence of hypertension than US-born Hispanics. Our results may differ from the HHANES results because of increasing prevalence of hypertension in all Hispanics during the intervening 20 years, or different age ranges, sampling of different Hispanic subgroups, or combining participants born in the US or outside of the US in their study. The higher prevalence of hypertension in participants born in Central America or the Caribbean compared to those born in Mexico or South America in MESA may be due to a higher exposure to the dietary and lifestyle practices of the US within those countries before immigration. Other biological and social factors related to ancestry could also play a role.

The main strength of this study is the inclusion of a large, multiethnic, population-based sample. A limitation of this study was the lack of a validated scale that assessed the multiple dimensions of acculturation.^{11,12} Acculturation scales are ethnic group specific, making their administration in a multiethnic sample complex and limiting comparisons across groups. Our measures—place of birth, language spoken at home, and years living in the US—had the advantage of being simple and objective variables, which have been used in previously as proxies for acculturation.²⁹ Nevertheless, use of simple categorical variables necessarily resulted in misclassification, which could have biased the result toward no association between acculturation and hypertension. We also lacked any information about the characteristics of the immigrant MESA participants before they migrated. The MESA sample was not designed as a nationally representative sample of race and ethnic groups, possibly limiting the generalizability of our results. However, our findings are consistent with analyses of nationally representative datasets.¹¹ This analysis was cross-sectional, which limits causal inferences, although it is unlikely that hypertension causes more acculturation.

We found an association between acculturation and hypertension in a large, multiethnic population that appeared independent of age and socioeconomic status, and only partly mediated through diet, obesity, alcohol use, and smoking. In Hispanic participants from different regions of birth, hypertension prevalence varied considerably, suggesting that we cannot assume that data describing the burden of hypertension in one Hispanic subgroup can be generalized to others. Our results confirm the presence of important heterogeneity in the prevalence of hypertension within race and ethnic groups and suggest

that coordinated responses to the epidemic of hypertension in the United States should target immigrant populations, and take level of acculturation into account.

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