

Racial/Ethnic Differences in Hypertension and Hypertension Treatment and Control in the Multi-Ethnic Study of Atherosclerosis (MESA)

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Background: Most previous studies investigating the association between ethnicity and hypertension focused on differences between African Americans and whites and did not include other racial/ethnic groups such as Chinese or Hispanics.

Methods: We used data from the Multi-Ethnic Study of Atherosclerosis (MESA), a population-based study of 6814 adults without clinical cardiovascular disease, to examine the association between ethnicity and hypertension and hypertension treatment among white, African American, Chinese, and Hispanic ethnic groups.

Results: The prevalence of hypertension, defined as systolic blood pressure (BP) <140 mm Hg and diastolic BP <90 mm Hg or self-reported treatment for hypertension, was significantly higher in African Americans compared to whites (60% v 38%; $P < .0001$), whereas prevalence in Hispanic (42%) and Chinese participants (39%) did not differ significantly from that in whites. After adjustment for age, body mass index, prevalence of diabetes mellitus, and smoking, African American (odds ratio [OR] 2.21; 95% confidence interval [95% CI] 1.91–2.56) and Chinese (OR 1.30; 95% CI 1.07–1.56) ethnicity were significantly associated with hypertension compared to

whites. Among hypertensive MESA participants, the percentage of treated but uncontrolled hypertension in whites (24%) was significantly lower than in African Americans (35%, $P < .0001$), Chinese (33%, $P = .003$), and Hispanics (32%, $P = .0005$), but only African-American race/ethnicity remained significantly associated with treated but uncontrolled hypertension after controlling for socioeconomic factors (OR 1.35; 95% CI 1.07–1.71). Diuretic use was lowest in the Chinese (22%) and Hispanic participants (32%) and was significantly lower in these groups compared with white participants (47%; $P < .0001$ for both comparisons).

Conclusions: Programs to improve hypertension treatment and control should focus on a better understanding of differences in the prevalence of hypertension and hypertension control among minority groups in the United States, especially African Americans, compared with whites, and on techniques to prevent hypertension and improve control in high-risk groups. Am J Hypertens 2004;17:963-970 © 2004 American Journal of Hypertension, Ltd.

Key Words: Race, ethnicity, hypertension, hypertension control, MESA.

The detection, treatment, and control of hypertension have contributed substantially to the decline in cardiovascular mortality in many developed countries in the past 30 years. However, the decline in cardiovascular deaths in the United States has not been

uniformly distributed across racial groups^{1,2} and half of the mortality disparity between African Americans and whites is directly attributable to hypertension.³ Ethnicity reflects differences in social and cultural influences such as health behaviors, access to health care, and environmental

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exposures that may all affect blood pressure (BP).^{4,5} Examining factors associated with BP differences between ethnic groups has demonstrated that education, income, and financial stress all influence BP.^{6–9} However, the majority of such studies focused on African American/white differences and did not include Asian or Hispanic ethnic groups and therefore did not reflect the changing demographics of the United States. Moreover, few studies have examined whether use of different classes of antihypertensives vary by racial/ethnic group. In light of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure guidelines, which recommend diuretics as initial therapy for most patients with hypertension,¹⁰ it is important to determine whether certain racial/ethnic groups are more likely to be treated with diuretics than others.

The Multi-Ethnic Study of Atherosclerosis (MESA), a study of the characteristics of subclinical cardiovascular disease in white, African-American, Chinese, and Hispanic adults, provides an opportunity to compare the independent association between ethnicity and the presence of hypertension and hypertension treatment and control among men and women without established cardiovascular disease. Because hypertensive individuals without established cardiovascular disease would be targeted for the primary prevention of cardiovascular disease, we also examined whether use of different classes of antihypertensives differs by racial/ethnic group.

Methods

Study Population

The MESA investigation is a population-based study of 6814 men and women age 45 to 85 years, without clinical cardiovascular disease, recruited from six United States communities (Baltimore, MD; Chicago, IL; Forsyth County, NC; Los Angeles County, CA; northern Manhattan, NY; and St. Paul, MN). The main objective of MESA is to determine the characteristics of subclinical cardiovascular disease and its progression. Sampling and recruitment procedures have been previously described in detail.¹¹ Adults with symptoms or history of medical or surgical treatment for cardiovascular disease were excluded. During the recruitment process, potential participants were asked about their race/ethnicity. Questions on race/ethnicity were based on the U.S. 2000 census questionnaire. Subjects who self-reported their racial/ethnic group as white or Caucasian, black or African-American, Chinese, or Spanish/Hispanic/Latino were asked to participate. Race/ethnicity was then categorized as white (non-Hispanic), African-American (non-Hispanic), Chinese, and Hispanic. Subjects were enrolled between August 1, 2000, and July 30, 2002. Institutional Review Board approval was obtained at all MESA sites.

BP, Hypertension, and Treatment

All MESA subjects completed self-administered questionnaires and were interviewed by trained research staff to collect information pertaining to demographic characteristics, medical history, medication, alcohol, and tobacco use. These self-administered questionnaires were available in English, Spanish, and Chinese. Trained and certified clinic staff obtained BP and anthropometric measurements on all MESA participants during the baseline visit. After a 5-min rest BP was measured three times at 1-min intervals using a Dinamap PRO 100 automated oscillometric device (Critikon, Tampa, FL) with the subject in a seated position with the back and arm supported.¹² The average of the second and third BP measurements was used for this analysis. Diagnosis of hypertension was defined as self-reported treatment for hypertension with one of six common classes of antihypertensive medications (thiazide diuretics, β -blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors (ACEI), angiotensin-2 receptor blockers (ARB), and other (α -blockers or peripheral vasodilators) or a systolic BP ≥ 140 mm Hg or diastolic BP ≥ 90 mm Hg. Hypertension control was defined as systolic BP < 140 mm Hg and diastolic BP < 90 mm Hg among patients who reported treatment for hypertension with one of the six classes of antihypertensive medications. Acknowledged but untreated hypertension was defined as the participant reporting a previous physician diagnosis of hypertension but not taking antihypertensive medication. Participants with a systolic BP ≥ 140 mm Hg or diastolic BP ≥ 90 mm Hg who reported no previous physician diagnosis of hypertension on the questionnaire were defined as being unaware of their hypertension.

Covariates

Presence of diabetes mellitus (DM) was based on self-reported physician diagnosis, use of insulin and/or oral hypoglycemic agent, or a fasting glucose value ≥ 126 mg/dL at the MESA baseline examination. Alcohol intake (average number of drinks per week) and current smoking status were based on self-report. Height was measured to the nearest 0.1 cm with the subject in stocking feet and weight was measured to the nearest pound with the subject in light clothing using a balanced scale. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

Information on socioeconomic factors including highest degree or level of school completed, total household income, financial strain, use of medical services, and health insurance was collected from the MESA participants using questionnaires. The total household income included money from jobs, net income from business, farm or rent, pensions, dividends, welfare, social security payments, and any other income received by the participant and all household members living with the participant. Participants were instructed to choose 1 of 13 income categories that best represented the total family income for

Table 1. Characteristics of the MESA subjects by racial/ethnic group

	White n = 2612	African-American n = 1894	Chinese n = 803	Hispanic n = 1494
Age (y)*	63.1 (10.3)	62.7 (10.0)	62.9 (10.3)	61.8 (10.4)‡
Female (%)	52.0	55.5	51.4	51.9
SBP (mm Hg)*	123.5 (20.4)	131.7 (21.6)‡	124.6 (21.6)	126.7 (21.9)‡
DBP (mm Hg)*	70.2 (10.0)	74.5 (10.2)‡	72.0 (10.3)‡	71.5 (10.1)‡
HTN (%)†	38	60‡	39	42
BMI (kg/m ²)*	27.7 (5.1)	30.2 (5.9)‡	24.0 (3.3)‡	29.4 (5.1)‡
DM (%)	7	19‡	14‡	19‡
Current smoker (%)	12	18‡	6‡	13

BMI = body mass index; DBP = diastolic blood pressure; DM = diabetes mellitus; SBP = systolic blood pressure.

All racial/ethnic groups compared with whites.

* Results are shown as mean (standard deviation); † Hypertension (HTN) defined as self-reported treatment with one of six classes of antihypertensive medications (thiazide diuretics, β blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, angiotensin-2 receptor blockers, and α blockers) or a SBP \geq 140 mm Hg or DBP \geq 90 mm Hg; ‡ $P < .0001$ compared with whites; P values for all other ethnic group comparisons with white ethnicity $> .017$.

the past 12 months. To estimate mean income, the mid-point of the range for each category was used. For the highest category income (\$100,000 and higher), \$120,000 was assigned. Financial strain was defined as the participant responding "Yes" to the question, "Has ongoing financial strain been a problem for you?" The questionnaire also inquired whether the participant used a primary care clinic versus the emergency room for routine health care services. Health insurance status was also ascertained (private health insurance, HMO, Medicaid, Medicare, Veteran's health care, or none).

Statistical Analysis

Means and standard deviations were used to summarize the characteristics of the study sample. Continuous variables were compared using ANOVA, and categorical variables were compared using the χ^2 statistic. When comparing racial/ethnic groups, ANOVA was used to assess differences of continuous variables among the four racial/ethnic groups. If the ANOVA test was significant, all non-white racial/ethnic groups were compared with whites. We set the level for statistical significance at $P < .017$ (.05/3) to account for multiple comparisons (whites versus three racial/ethnic groups).

Multivariate logistic regression was used to examine the association between racial/ethnic group and hypertension in the entire MESA population. Several different logistic regression models were examined so that changes in the parameter estimate with the addition of demographic and socioeconomic factors could be examined. Covariates for these models were selected based on previously published reports.^{6–8,13–16} Model 1 adjusted for age and sex, whereas model 2 added BMI, waist circumference, alcohol consumption, current tobacco use, and presence of DM to model 1. Model 3 added education, income, and financial strain to model 2. In all logistic regression models, age, BMI, waist circumference, and alcohol consumption were fitted as continuous variables

and current smoking, DM, and reported financial strain were included as binary variables (yes/no). Education was categorized as completion of grades 0 to 8, 9 to 11, high school or technical school, Associate degree or some college, or college degree or higher (reference group). Household income was divided into five categories (<\$25,000, \$25,000 to <\$50,000, \$50,000 to <\$75,000, \$75,000 to <\$100,000, and \geq \$100,000) and was included in the model with \geq \$100,000 as the reference group.

We also examined the association between racial/ethnic group and treated but uncontrolled hypertension among all MESA participants with treated hypertension. In addition to the three models used for the regression analysis of hypertension, we included a fourth model, which added use of a primary care clinic versus use of emergency room for acute illness, presence of health insurance versus none, and use of diuretics (yes/no). Effect modification between ethnicity and sex, education, income, and financial strain on hypertension and on treated but uncontrolled hypertension was examined by adding interaction terms to the multivariate models, which included all of the covariates.

Results

A total of 6814 men and women (38% white, 28% African American, 12% Chinese, 22% Hispanic) between the ages of 45 and 85 years completed the first MESA examination. The majority of both whites and African Americans reported being born in the United States or Puerto Rico ($>90\%$), whereas 96% of Chinese and 58% of Hispanics reported being born outside the United States. Among the Hispanics born outside the United States or Puerto Rico, birthplace was reported as Mexico in 43%, Dominican Republic in 20%, South America in 15%, Central America in 7%, and other countries in 15%. The characteristics of the MESA participants by racial/ethnic group are shown in Table 1. Each racial/ethnic group was compared to white ethnicity. Both systolic and diastolic BP were significantly

higher among African Americans and Hispanics compared with whites. Hypertension was noted in 38% of whites, 60% of African Americans, 39% of Chinese participants, and 42% of Hispanics. Compared with whites, the prevalence of hypertension was higher in African Americans ($P < .0001$), whereas no significant difference was noted between white and Chinese ($P = .78$) participants. The frequency of hypertension was higher among Hispanics compared with whites but the difference did not reach statistical significance after accounting for multiple comparisons ($P = .026$) (the level for statistical significance was set at $P < .017$ (.05/3) to account for multiple comparisons as stated in the Statistical Analysis section).

The characteristics of the subjects by racial/ethnic group and by presence of hypertension are listed in Table 2. Hypertensive individuals were significantly older, had higher BMI and waist circumference, and were more likely to have DM compared with normotensives in each racial/ethnic group. Normotensives reported approximately 25% higher mean total household income compared with hypertensives except among whites where normotensives reported 19% higher income compared with hypertensives. The lowest reported household income was noted among the Chinese and Hispanic participants with hypertension. In each racial/ethnic group, the percentage of adults who graduated from high school was lower among adults with hypertension compared with normotensive adults. This difference was significant in all ethnicity groups ($P = .004$ for whites; $P < .0001$ for African Americans; and $P = .0046$ for Hispanics) except the Chinese ($P = .018$). The lowest percentage of subjects who completed high school was noted among Hispanics with 51% and 58% in hypertensives and normotensives, respectively.

Figure 1 shows the percentage of treated and controlled or uncontrolled hypertension, and acknowledged but untreated hypertension among hypertensive MESA participants by racial/ethnic group. The prevalence of hypertension was not calculated by national origin among the Hispanic MESA participants due to the small numbers in several of the groups. The characteristics of the MESA participants by racial/ethnic group are listed in Table 1. The percentage of treated but uncontrolled hypertension among whites (24%) was significantly lower than African American (35%, $P < .0001$), Chinese (33%, $P = .003$), and Hispanic (32%, $P = .0005$) MESA participants. Acknowledged but untreated hypertension ranged from 6% in African Americans to 8% in Hispanics and did not differ among the four racial/ethnic groups. The African Americans had a significantly lower percentage of men and women who were unaware of their hypertension compared with whites (13% v 23%; $P < .0001$), whereas no difference was noted between the white and Chinese and white and Hispanic participants.

Table 3 lists the class of current antihypertensive medications reported among the treated hypertensive MESA participants with the percentage using each class as mono-

Table 2. Characteristics of subjects by race/ethnicity and by presence of hypertension

	White		African-American		Chinese		Hispanic	
	HTN+ n = 997	HTN- n = 1615	HTN+ n = 1137	HTN- n = 757	HTN+ n = 311	HTN- n = 492	HTN+ n = 623	HTN- n = 871
Age (y)*	67.0 (9.6)	60.7† (9.9)	65.1 (9.4)	59.0† (10.0)	67.1 (9.5)	60.3† (10.0)	66.3 (9.5)	58.5† (9.8)
% Male	48	48	43	47	45	51	44	51
BMI (kg/m ²)*	29.0 (5.3)	27.0† (4.8)	30.8 (5.9)	29.3† (5.7)	24.8 (3.5)	23.5† (3.1)	30.1 (5.2)	29.0† (5.0)
Waist circumference (cm)*	102.1 (14.3)	95.4† (13.9)	103.2 (14.5)	98.2† (14.5)	90.1 (9.9)	85.2† (9.5)	103.0 (13.1)	98.9† (12.8)
% DM	11	5†	25	10†	19	11	29	12†
% Smoking (current)	8	13§	15	22§	5	6	10	16§
% High school education	93	96§	85	92†	71	78	51	58
Total household income (in thousands)*†	58.8 (36.4)	69.5† (37.5)	41.9 (29.7)	53.6† (33.7)	33.5 (32.5)	43.1§ (36.9)	28.3 (22.9)	34.7† (26.5)

Abbreviations as in Table 1.

HTN+ compared to normotensives in each ethnic group.

Hypertension defined as self-reported treatment with one of classes of antihypertensive medications (thiazide diuretics, β-blockers, calcium channel blockers, angiotensin converting enzyme inhibitors angiotensin-2 receptor blockers, and α blockers) or a SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg.

* Values shown as mean (standard deviation); † Household income was collected as a categorical variable. To estimate mean income, the midpoint of the range for each category was used. For the highest category income (100k and higher), 120k was assigned; ‡ $P < .0001$; § $P < .001$; || $P < .01$.

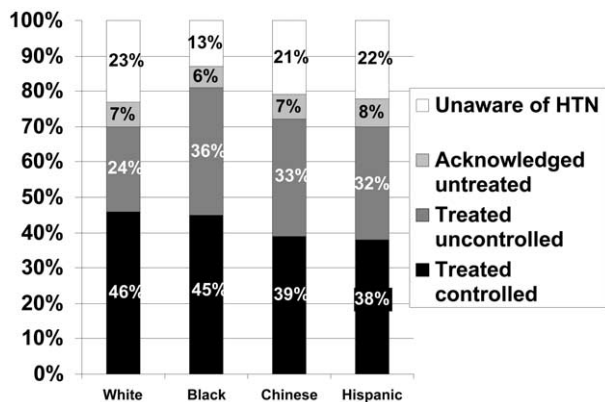


FIG. 1. Treatment and control of hypertension (HTN) among hypertensive MESA participants by race and ethnicity. Hypertension defined as self-reported treatment with one of six classes of antihypertensive medications (thiazide diuretics, β -blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, angiotensin-2 receptor blockers, and α -blockers) or a systolic BP \geq 140 mm Hg or diastolic BP \geq 90 mm Hg. ¹ $P < .0001$ compared with whites, ² $P < .001$ compared with whites, ³ $P < .01$ compared with whites. Treated and controlled hypertension: whites > Hispanics³. Treated and uncontrolled hypertension: African Americans > whites¹; Hispanics > whites²; and Chinese > whites³. Unaware of hypertension: whites > African Americans¹.

therapy in parentheses. Compared with whites, use of diuretics was significantly lower in the Chinese (22% v 47%; $P < .0001$) and Hispanic participants (32% v 47%; $P < .0001$). Among African Americans, β -blocker use was significantly lower (18% v 28%; $P < .0001$) and calcium channel blocker use was significantly higher (40% v 25%; $P < .0001$) compared with whites. Use of β -blockers among the Chinese and Hispanic participants did not differ significantly from whites. Use of calcium channel blockers was higher among Hispanics than whites (33% v 25% $P = .0025$), but differences in calcium channel blocker use between Chinese and white participants did

not reach statistical significance ($P = .049$). The ACEI/ARB use was similar across the white, African American, and Hispanic racial/ethnic groups, whereas among Chinese MESA participants, use (40%) was significantly lower than whites (52%; $P = .002$). Use of ACEI/ARB surpassed use of all other classes of antihypertensives among the racial/ethnic groups except among African Americans where use of ACEI/ARB and diuretics was similar.

Table 4 lists the results of the logistic regression models examining the association between racial/ethnic group and presence of hypertension (use of antihypertensives or BP \geq 140/90 mm Hg). In all models, African American race/ethnicity was associated with more than a twofold higher odds of hypertension compared with whites. The age- and sex-adjusted odds ratio (OR) was 2.72 (95% confidence interval [95% CI] 2.38–3.10) and adjustment for all the covariates including income and financial strain reduced the OR to 2.21 (95% CI 1.91–2.56). The Chinese racial/ethnic group was not associated with presence of hypertension in the age- and sex-adjusted model compared with whites. After the addition of demographic factors including BMI (model 2), Chinese race/ethnicity was associated with a 42% (95% CI 1.17–1.71) higher odds of hypertension compared with whites. Adjustment for education, income, and financial strain reduced the OR to 1.30 (95% CI 1.07–1.56). In contrast, Hispanic race/ethnicity was associated with the presence of hypertension in the age- and sex-adjusted model (1.31; 95% CI 1.14–1.50) but this association was no longer significant after adjustment for the other covariates. No significant interaction was observed between race/ethnicity and sex, education, income, and financial strain on odds of hypertension in the regression model that included all of the covariates (model 3).

Results of the regression models for treated but uncontrolled hypertension (BP \geq 140/90 mm Hg) are listed in

Table 3. Use of antihypertensive class by race/ethnicity among treated hypertensives (% using class as monotherapy)*

	White <i>n</i> = 690	African-American <i>n</i> = 914	Chinese <i>n</i> = 223	Hispanic <i>n</i> = 440
Diuretic	47% (9%)	51% (11%)	22%‡ (6%)	32%‡ (6%)
β -blocker	28% (9%)	18%‡ (4%)	34% (10%)	25% (9%)
Calcium channel blocker	25% (7%)	40%‡ (13%)	32% (15%)	33% (13%)
ACEI/ARB	52% (21%)	49% (13%)	40% (17%)	53% (21%)
Other†	8% (1%)	10% (1%)	9% (0.5%)	8% (1%)
Taking 3 or more of the above classes of drugs	13%	17%	9%	14%

ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin-2 receptor blocker.

All ethnic groups compared to whites.

§ $P < .001$ compared to whites;

* Data are shown as percentage of treated hypertensives using an antihypertensive class with percentage using the antihypertensive class as monotherapy in parentheses. Monotherapy drug use was not compared among the four ethnic groups; † Other class includes peripheral vasodilators, α -blockers; ‡ $P < .0001$ compared to whites; || $P < .01$ compared to whites.

Table 4. Odds ratio (OR) of hypertension by race/ethnicity among all MESA participants

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
White	1.00 (reference)	1.00 (reference)	1.0 (reference)
African-American	2.72 (2.38–3.10)	2.33 (2.01–2.69)	2.21 (1.91–2.56)
Chinese	1.03 (0.87–1.22)	1.42 (1.17–1.71)	1.30 (1.07–1.56)
Hispanic	1.31 (1.14–1.50)	1.12 (0.97–1.30)	0.92 (0.81–1.14)

95% CI = 95% confidence interval.

Model 1 includes age and sex.

Model 2 includes model 1 and BMI, waist circumference, presence of DM, and current smoking status.

Model 3 includes model 2 and education level, income and financial strain to model 2.

Hypertension (use of antihypertensive medications or BP >140/90 mm Hg).

Table 5. African American, Chinese, and Hispanic race/ethnicity were all associated with increased odds of treated but uncontrolled hypertension in model 1 (sex and age) and model 2 (model 1 and BMI, waist circumference, presence of DM, smoking, and alcohol consumption) compared with whites. After the addition of education level, income, and financial strain to the regression model, the association between Chinese and Hispanic race/ethnicity and treated but uncontrolled hypertension was no longer statistically significant. However, African-American race/ethnicity remained significantly associated with treated but uncontrolled hypertension in all the regression models, including model 4, which added use of emergency room for primary care services, lack of health insurance, and use of diuretics (OR 1.35; 95% CI 1.07–1.71). No significant interactions were noted between race/ethnicity and diuretic use, sex, education, income, and financial strain on odds of treated but uncontrolled hypertension.

Discussion

In this cross-sectional analysis of adults without established cardiovascular disease, we noted a significantly higher prevalence of hypertension among African Americans compared with whites, but no significant difference in the prevalence of hypertension between white and Hispanic or white and Chinese racial/ethnic groups. The

higher prevalence of hypertension among African-American MESA participants compared with white participants is similar to reports in the general U.S. population.¹⁷ The most recent National Health and Nutrition Examination Survey (NHANES), conducted in 1999 to 2000 also showed a significantly higher prevalence of hypertension among non-Hispanic African American adults (34% v 29%; $P < .01$) compared with whites. The older age of the MESA participants probably accounts for the higher prevalence of hypertension compared with the NHANES survey, which included adults ≥ 18 years of age.

The frequency of hypertension was higher among Hispanics compared with whites but the difference did not reach statistical significance after accounting for multiple comparisons ($P = .026$). The higher frequency of hypertension among Hispanics compared with whites contrasts with the most recent NHANES results, which noted a significantly lower prevalence of hypertension among Mexican Americans (21% v 29%; $P < .001$) compared with whites.¹⁷ It is important to note that more than half of the Hispanic MESA participants were not born in Mexico. In addition, mean BMI and prevalence of DM were significantly higher among the Hispanic MESA participants compared with white participants, and this could account for the excess hypertension noted among the Hispanics. Moreover, the association between Hispanic ethnicity and

Table 5. Odds ratio (OR) of treated but uncontrolled hypertension among MESA participants with treated hypertension

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
White	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
African-American	1.49 (1.19–1.84)	1.44 (1.15–1.80)	1.35 (1.07–1.70)	1.35 (1.07–1.71)
Chinese	1.58 (1.15–2.17)	1.55 (1.11–2.17)	1.32 (0.93–1.87)	1.27 (0.89–1.82)
Hispanic	1.64 (1.27–2.11)	1.58 (1.22–2.05)	1.22 (0.91–1.63)	1.19 (0.89–1.60)

CI = confidence interval; other abbreviations as in Tables 1 and 4.

Treated but uncontrolled hypertension = SBP ≥ 140 or DBP ≥ 90 among treated hypertensives.

Model 1 includes age and sex.

Model 2 includes model 1 and BMI, waist circumference, presence of DM, and current smoking status.

Model 3 includes model 2 and education level, income, financial strain.

Model 4 includes model 3 and use of emergency room for primary care services, lack of health insurance, and use of diuretics.

hypertension was not significant after adjustment for BMI, waist circumference, and presence of DM.

In China, the prevalence of hypertension in the adult population age 35 to 74 years ranges from 34% among adults living in northern China to 27% in southern China.¹⁸ However, the majority of hypertensives in China are not treated and less than 30% receiving antihypertensive treatment are controlled (systolic BP <140 mm Hg and diastolic BP <90 mm Hg).¹⁸ Previous national surveys of hypertension in the United States did not include Chinese-Americans, a population with limited data on hypertension prevalence. Stroke rates in Asian countries such as China, Korea, and Japan are two- to fivefold higher compared with U.S. rates in large part due to undertreatment or no treatment for hypertension.^{18,19} It is likely that social factors, such as diet, continue to influence BP levels among Chinese-Americans, especially because the vast majority of Chinese MESA participants were born outside the United States.

Compared with whites, all non-white racial/ethnic groups were significantly associated with treated but uncontrolled hypertension. The NHANES noted significantly lower rates of hypertension control among both African American (45%; $P < .05$) and Mexican American adults (44%; $P < .05$) compared with whites (56%).¹⁷ A population-based survey of elderly men and women living in North Carolina noted that African Americans were 67% more likely than whites to have uncontrolled BP after adjustment for multiple covariates.²⁰ The association between Chinese and Hispanic race/ethnicity and treated but uncontrolled hypertension did not remain significant after the addition of socioeconomic factors including education level, income, and financial strain, which suggests that these factors influence hypertension control. In contrast, the association between African-American race/ethnicity and uncontrolled hypertension was attenuated after adjustment for multiple covariates but remained statistically significant, consistent with the interpretation that these factors as well as others indexed by African-American race/ethnicity influence hypertension control. One such factor is likely to be higher pretreatment BP levels. This hypothesis is supported by several previous large cohort studies such as the Multiple Risk Factor Introduction Trial and the Hypertension Detection and Follow-Up Program, which noted significantly higher pretreatment BPs in African Americans compared with whites.^{21,22} The majority of hypertensive MESA participants were receiving antihypertensive treatment; thus, this cross-sectional study cannot determine whether pretreatment BPs differ by racial/ethnic group. Regarding differential treatment, diuretic use was lowest among Chinese and Hispanic participants and highest among African Americans compared with whites. Mean household income was lowest among Chinese and Hispanic participants with hypertension, yet these two ethnic groups were least likely to be treated with diuretics, the lowest cost class of antihypertensives.

The MESA study was designed to investigate the prev-

alence and progression of subclinical cardiovascular disease in a large sample of men and women without known cardiovascular disease. Thus, the MESA participants are not representative of the U.S. population of people with hypertension, which includes those with known cardiovascular disease. However, many of our findings are supported by studies based on representative samples of the U.S. population.¹⁷ In addition, this multiracial cohort without established cardiovascular disease represents the patient population targeted for the primary prevention of cardiovascular disease, and the diversity of the MESA participants provides information on racial/ethnic groups not included in previous studies.

In conclusion, we noted an association between African-American and Chinese race/ethnicity and hypertension compared with whites after controlling for multiple covariates. In addition, the prevalence of treated but uncontrolled hypertension was significantly higher among African-American, Chinese, and Hispanic racial/ethnic groups compared with whites. Use of diuretics, the most affordable class of antihypertensives and first-line therapy for the treatment of uncomplicated hypertension,¹⁰ was lowest in groups with very limited monetary resources. These data indicate areas of health services research that deserve continued attention and research.

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