UNDERSTANDING RACIAL DISPARITIES IN HYPERTENSION CONTROL: INTENSITY OF HYPERTENSION MEDICATION TREATMENT IN THE REGARDS STUDY

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Objectives: African Americans (AA) suffer excess hypertension-related health outcomes and their blood pressures (BPs) are widely reported to be less controlled than European Americans (EA). Intensity of hypertension treatment may play a role. We examined whether AA with treated hypertension received less-intense medication regimens than EA, as reflected in the number of antihypertensive medication classes.

Design: Cross-sectional observation of baseline information from the REasons for Geographic And Racial Differences in Stroke cohort. Participants were recruited by telephone in 2003–2005, completed a telephone survey, and had BP measured and medications recorded during an in-home visit. The study's outcome was the number of classes of antihypertensive medications.

Setting: US national cohort study with oversampling from high stroke mortality regions. Participants were self-identified AA or EA, ≥45 years old, living in the community, and balanced on AA race and sex by design.

Participants: 8960 individuals with treated hypertension.

Results: Mean age was 68.0 ± 8.6 years. AA were poorer and less educated than EA, and had worse BP control (63.5% BP<140/90 mm Hg for AA, 74.0% for EA, $P<.01$), yet they were on more classes of BP medication (24.1% on ≥3 classes, vs 16.9%, $P<.01$). AA were taking an average of 0.138 more antihypertensive medication classes than otherwise similar EA ($P<.01$). More intense treatment persisted across all age, sex, education, income and BP groups.

Conclusions: AA were more intensely treated for hypertension than EA. Further study to identify action strategies to eliminate racial differences in hypertension outcomes is warranted. (*Ethn Dis*. 2007;17:421–426)

Key Words: Hypertension, Ethnicity, Epidemiology

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INTRODUCTION

African Americans (AA) have among the highest rates of hypertension in the world, with disproportionate rates of stroke, cardiovascular mortality and end-stage renal disease.[1] Among hypertensive individuals, AA consistently have worse blood pressure (BP) control than European Americans (EA).[1,2] An important public health objective is to eliminate this difference,[3] a goal that can only be accomplished by understanding the root causes leading to higher BP among AA.

The first step in hypertension control is awareness. Several national studies suggest that public health programs designed to raise awareness of hypertension have been particularly effective among AA. In the National Health and Nutrition Examination Survey, AA have had higher hypertension awareness than EA since 1988.[4] Among 1500 participants in a national telephone survey, AA were more familiar than EA with the definition of hypertension as well as its association with kidney failure.[5] In the REasons for Geographic And Racial Differences in Stroke (REGARDS) Study, a large national biracial cohort study evaluating the causes of racial and regional variations in stroke mortality, AA had higher hypertension awareness than EA did.[6]

African Americans have had higher hypertension awareness than European Americans since 1988.[4]

Once aware of hypertension, the next step to achieving control is treatment. If AA were less likely to be treated, it could contribute to worse control. However, we and others have demonstrated that AA were more likely to be treated for hypertension, yet less likely to achieve systolic BP <140 mm Hg and diastolic BP <90 mm Hg.[4,7]

Once in treatment, sufficiently intense medication regimens must be used to achieve control, as stressed in national guidelines.[2] Clinical trials demonstrate that hypertension control is achievable in 60% of AA and more than 67% of EA in real-life settings using widely available blood pressure (BP) medications.[8] In practice, worse BP control among treated AA could stem from differential treatment intensity. AA have been reported to receive fewer medical interventions, as well as fewer medications, to control BP in some settings.[9–13] As a potential contributor to differences in BP control among AA and EA, we hypothesized that, among treated hypertensive REGARDS participants, AA would receive less intense medication regimens compared with EA. We defined intensity of

treatment as the number of BP medications in the regimen, both as a simple sum and as the number of distinct classes of antihypertensive medication.

METHODS

The REGARDS cohort includes 30,000 participants from across the United States and recruited to study geographic and ethnic variations in stroke mortality. Methods for REGARDS recruitment and data collection have been described.[7] Briefly, starting in 2003, mail and telephone contact was used to recruit English-speaking community-dwelling adults ages ≥45 years from commercially available lists. The goal was to recruit half women and half AA, with half from the stroke belt (North and South Carolina and parts of Georgia not in the "Buckle," and the states of Tennessee, Alabama, Mississippi, Louisiana, and Arkansas) and Buckle (the coastal plain region of North and South Carolina and parts of Georgia), and the remainder from the rest of the continental United States.

Baseline data collection included telephone surveys and in-home exams. Telephone surveys included demographics and measures of socioeconomic status, access to care, health status, medical history, and health behaviors. Socioeconomic indicators included household income and maximal personal education attainment. Health insurance status reflected access to care. Health status was assessed using the Physical Component Summary (PCS-12) and Mental Component Summary (MCS-12) scores from the Medical Outcomes Study Short Form-12 (SF-12).[14] SF-12 scores range from 0–100, where lower scores indicate worse functioning and 50 indicates average functioning. Medical history included questions about whether participants ever had been told by a doctor that they had had a stroke or heart attack, congestive heart failure, diabetes or high blood pressure. Health behaviors included cigarette smoking (smoked at least 100 cigarettes in their lifetime, categorized as never smoked, smoked in the past, or smoke currently); alcohol consumption (whether they currently drank alcohol, and if so, how many average-sized drinks per day, categorized into nondrinkers, 1–7 drinks per week, and >7 drinks per week); and exercise (how often each week they exercised enough to work up a sweat, categorized as never, 1–3 times per week, or ≥4 per week).

Trained, certified health professionals performed in-home visits. After obtaining written informed consent, they assessed BP levels using aneroid sphygmomanometers, using the appropriate cuff size, after participants were seated in a chair with both feet on the floor for 3 minutes. BPs were repeated twice and averaged for analysis, categorized into <140/90, 140–160/90–100, or >160/100 mm Hg. Height and weight were recorded using standardized methods and used to calculate body mass index (BMI), categorized into normal (<25 kg/m^2), overweight (25–30 kg/m^2), or obese (>30 kg/m^2).

During the in-home visit, participants were asked to produce the bottles for all medications taken in the past two weeks, and names were recorded and subsequently coded into drug classes. Only .3% of individuals who reported taking medications were unable to produce them for recording. Medication adherence was assessed based on a validated short scale (Do you ever forget to take medications? Are you ever careless in taking your medications? Do you ever miss taking your medications when you are feeling better? Do you ever miss taking any of your medications because you are feeling sick? Do you ever miss taking your medication for any reasons?).[15] The simple sum of 'yes' responses for each participant was entered into the models as an index of medication adherence.

Blood samples were taken at the in-home visits and serum creatinine was measured in a central laboratory. Because of a skewed distribution, creatinine was categorized into <1.5, 1.5–2.0 and >2.0 mg/dL.

For this analysis we included REGARDS participants who met three criteria: 1) enrolled as of March 2005 (N=16,720); 2) had been told by a doctor that they had hypertension or had BP ≥140/90 mm Hg at the in-home visit; and 3) on a BP medication (diuretic, beta blocker, angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB), calcium channel blocker, alpha blocker, vasodilator, or other hypertensive agent). These 7 categories defined the classes of BP medication used in analysis. Combination medications containing 2 different classes were counted as 2 classes, but if they contained 2 medications within the same class (eg, hydrochlorothiazide and triamterene) were counted as a single class. We excluded individuals not taking BP medications because an earlier REGARDS report already addressed predictors of being treated among those aware of their hypertension.[6]

The primary outcome was intensity of BP medication regimen, defined as the number of classes of BP medications. We also calculated the simple sum of BP medications, regardless of class, as an alternative outcome. Results were remarkably similar, thus we only report the results for the outcome of the number of classes of antihypertensive medications.

We developed a multivariable linear regression model to adjust for patient characteristics that might influence prescribing patterns. Covariates included demographics, socioeconomic factors, access to health care, health status (PCS-12 and MCS-12 scores), medical history, health behaviors, and physiologic measures (BMI, serum creatinine). We also included in a separate model the BP level itself. Because results were similar and BP was strongly associated

with intensity of treatment, we report results including BP in the model. Last, we tested 2-way interaction terms to examine whether the observed relationships were consistent for each race by region, sex, age, education, income and BP groups. Analyses were performed using SAS version 9 (Cary, North Carolina). Our institutional review board approved the study.

RESULTS

This report included 8,960 treated hypertensive individuals (Table 1). AA were younger, less educated, and had lower income than EA. This older population was highly insured, although slightly fewer AA reported having healthcare coverage. Fewer AA reported a previous stroke or heart attack, but more reported diabetes and heart failure. AA had higher creatinine, with AA men having more than twice the rate of creatinine > 2.0 mg/dL than any other group. More than four times as many AA women had creatinine > 2.0 mg/dL as EA women. Obesity was common, with greater prevalence among AA, especially women. Fewer AA than EA with treated hypertension had controlled BP (<140/90 mm Hg): 64% of both AA women and men were controlled, 76% of EA women, and 73% of EA men.

Intensity of hypertension treatment was similar across regions (Table 2). More AA than EA were treated with ≥3 classes. Intensity of treatment was greater in the lower income and education strata, a difference more pronounced for AA than EA. Greater intensity of treatment was also evident among participants with higher BPs, more so for AA.

After adjusting for patient characteristics, AA were likely to receive .138 more classes of BP medication than EA (Table 3). Those reporting a history of stroke or heart attack were likely to be on .200 more classes of medications, and those with diabetes on .189 more. Lower physical functioning, drinking >7 alcoholic drinks per week, overweight, obesity, higher creatinine and BP>160/100 mm Hg were also independently associated with more intense treatment. The other covariates in the multivariable model were not independently associated with the number of classes of medications prescribed (ie, $P > .05$).

We evaluated intensity of treatment by race across age, sex, region, income, education and BP categories as well as levels of systolic (and, separately, diastolic) BP. None of these 2-way interaction terms with race were significant ($P > .05$), indicating that AA were more intensely treated regardless of age, sex, region, socioeconomic status or BP.

Table 1. Characteristics of 8960 treated hypertensive REGARDS participants

Pt characteristic	African Americans		European Americans	
	Women *n*=2383	Men *n*=1906	Women *n*=1646	Men *n*=3009
Age,%				
<65 years	45.9	43.1	36.2	34.7
65–74 years	35.8	37.6	35.7	39.5
≥75 years	18.3	19.3	28.1	25.8
Annual household income, %				
<$20,000	46.2	24.3	30.3	10.0
$20,000–35,000	29.9	31.3	34.5	28.1
$35,000–75,000	19.7	32.6	25.8	40.2
≥$75,000	4.2	11.7	9.4	21.8
Education, %				
Some High School	25.9	23.4	11.6	8.9
High School graduate	28.9	27.6	31.1	24.6
Some College	24.5	24.3	29.1	24.6
College graduate	20.7	24.6	28.3	42.0
Health insurance, %	91.5	94.5	96.3	97.3
Health status*				
PCS-12 score ± SD	42.4±11.1	45.1±10.1	43.4±11.5	46.1±10.2
MCS-12 score ± SD	50.9±8.9	52.7±7.2	51.8±8.0	53.4±6.4
Medical conditions, %				
Stroke or heart attack	17.2	24.5	16.2	27.9
Congestive heart failure	8.2	4.7	5.7	3.8
Diabetes	35.4	40.7	22.3	27.2
Health behaviors, %				
Current smoker	16.6	17.2	12.4	9.8
Never exerciser	44.3	33.2	44.6	29.3
Non-Drinker	67.0	56.0	52.1	41.1
Most adherent †	50.7	57.2	47.1	58.3
Physiologic measures, %				
Creatinine >2.0 mg/dL	3.3	7.1	0.6	2.9
BMI‡ >30 kg/m^2	56.9	40.1	38.6	35.4
BP§<140/90 mm Hg	63.5	63.5	75.7	72.9
BP 140–160/90–100 mm Hg	26.2	26.8	19.4	21.3
BP >160/100 mm Hg	10.3	9.7	4.8	5.8

* Health status measures: PCS-12 = Physical Component Summary score from the Short Form-12. MCS = Mental Component Summary score from the Short Form-12.

† Adherence as measured using a 5-item scale; only the proportion reporting being the most adherent are shown, see text.

‡ BMI = body mass index.

§ BP = blood pressure. All differences between African Americans and European Americans are significant at $P<.01$ except: history of stroke or MI for women, exercise for women, and history of heart failure for men.

Table 2. Percent* of African Americans and European Americans on 1, 2 or 3 or more antihypertensive medication classes

	African American (*n*=4289)			European American (*n*=4655)		
Number of Classes:	**1**	**2**	**≥ 3**	**1**	**2**	**≥ 3**
Patient Characteristic						
All	37.7	38.2	24.1	46.8	36.3	16.9
Region						
Stroke belt	36.6	40.7	22.8	46.3	37.0	16.8
Stroke buckle	39.6	37.0	23.4	47.6	35.3	17.0
Remainder of US	38.0	37.1	25.0	47.0	36.1	16.9
Age						
<65 years	38.8	38.0	23.3	50.1	34.4	15.5
65–74 years	36.9	38.1	25.0	45.2	36.8	18.0
≥75 years	36.6	39.0	24.3	44.7	38.1	17.2
Sex						
Women	38.7	39.1	22.2	48.7	36.3	15.0
Men	36.4	37.1	26.5	45.8	36.3	17.9
Annual household income						
<$20,000	36.0	39.4	24.7	43.1	38.5	18.4
$20,000–35,000	36.6	38.9	24.5	44.6	37.3	18.1
$35,001–74,999	39.9	36.0	24.1	49.0	35.2	15.8
≥$75,000	44.9	36.6	18.5	52.8	32.2	15.0
Education						
Some high school	36.3	38.3	25.5	43.5	37.2	19.3
High school graduate	35.6	39.4	25.0	44.6	38.4	17.0
Some college	39.5	36.4	24.1	44.7	36.6	18.7
College graduate	39.8	38.7	21.5	50.8	34.2	15.0
Blood pressure						
<140/90 mm Hg	39.0	38.8	22.1	47.1	36.6	16.3
140–160/90–100 mm Hg	36.5	36.4	27.1	47.1	35.2	17.8
>160/100 mm Hg	33.2	38.1	28.7	41.0	38.6	20.3

* Percentages reflect the proportion of each racial/ethnic group in any given patient characteristic and treatment category; for example, for African Americans with blood pressure <140/90 mm Hg, 39% were on 1 class, 38.8% were on 2, and 22.1% were on 3 or more; whereas for European Americans, 47.1% were on 1, 36.6% were on 2, and 16.3% were on 3. All χ-square tests of differences between African Americans and European Americans within each characteristic and treatment category had $P<.001$.

DISCUSSION

Contrary to our hypothesis, we found no evidence of AA receiving less intense hypertension treatment. In fact, these middle-aged and older AA from across the United States were prescribed *more* intense hypertension treatment than otherwise similar EA. More intense treatment in AA was observed across all age, sex, regional (Stroke Belt or Buckle residence or not), and income and education categories. Our hypothesis of less intense medication treatment among AAs does not seem likely to be a major contributor to lower hypertension control rates among AA that we and others have observed.[4,6]

While this report is the first examining racial differences in the intensity of BP management at the national level, our findings are concordant with observations in other smaller studies and in study populations with restricted membership (eg, veterans). Sheats reported that more than 7000 AA and EA had similar treatment prevalence in a clinic for under-served populations in South Carolina (83.4% vs 81.6% treated for hypertension, respectively, $P>.05$).[16] AA were on 1.44 antihypertensive medications, compared with 1.40 for EA ($P>.05$). Among nearly 8000 hypertensive veterans in South Carolina, AA

Table 3. Significant predictors of relative number of classes of antihypertensive medications used to treat hypertension*

Category of variable	Comparison	Relative number of classes†	{95% CI}	*P* value
Race	African Americans vs European Americans	.138	{.115,.161,}	<.01
Health status	Physical functioning score	−.006	{−.007,−.005}	<.01
Medical conditions	Stroke or heart attack vs neither	.200	{.174,.225}	<.01
	Diabetes vs no diabetes	.189	{.166,.212}	<.01
Health behavior	Heavy drinkers vs nondrinkers	.114	{.071,.157}	<.01
	Moderate drinkers vs nondrinkers	.016	{−.007,.039}	.48
Physiologic measures	Creatinine 1.5–2.0 vs ≤ 1.5 mg/dL	.242	{.209,.275}	<.01
	Creatinine > 2.0 vs ≤ 1.5 mg/dL	.456	{.402,.509}	<.01
	Body mass index 25–30 vs <25 kg/m^2	.099	{.070,.128}	<.01
	Body mass index >30 vs <25 kg/m^2	.200	{.171,.229}	<.01
	BP <140/90 vs >160/100 mm Hg	−.129	{−.169,−.089}	<.01
	BP 140–160/90–100 vs >160/100 mm Hg	−.092	{−.136,−.050}	.03

* Significant predictors in a multivariable linear regression model predicting the number of antihypertensive medication classes prescribed (see text). Variables included in the model but without significant independent association with number of drug classes prescribed: region, sex, age, education, income, health insurance, mental component summary score, congestive heart failure, smoking, exercise and medication adherence.

† For example, AA on average were on .138 more hypertension medication classes than otherwise similar EA.

received a comparable number of prescriptions for antihypertensive medications as EA, and among nearly 5000 non-veterans in the same region, AA received more prescriptions than EA; AA still achieved lower hypertension control in both settings.[18] Among 8000 diabetes patients in 10 managed care health plans across the United States, AA were also on more hypertension medications than EA, with worse control.[19]

We found that more intense treatment for AA compared with EA persisted across all strata of socioeconomic status, suggesting that observed racial differences are not attributable to socioeconomic status. It is notable that the marked gradient in intensity of prescribed treatment across income and education strata in the unadjusted comparisons was completely explained by physiologic and health-related patient characteristics. In multivariable analysis, neither income nor education were independently associated with treatment intensity. While it was reassuring to note the similar higher intensity of treatment for AA regardless of income or education in this population, we do note the small number without health insurance. Health insurance and any concomitant pharmacy benefits undoubtedly influence access to medications, but we could not examine this important question in our study.

Our study confirmed additional previously reported findings. First, the higher number of classes of medications prescribed for those with a history of stroke, myocardial infarction, diabetes or chronic kidney disease may reflect appropriate efforts at secondary prevention. Second, we found no evidence of less intense treatment based on age. Some studies have reported less intensity of hypertension treatment at older age,[17,20] but, similar to our findings, this was not observed in the Framingham Heart Study, which found no association of the number of antihypertensive medications at different ages (60% were on 1 agent, 30% on 2 and 10% on $\geq$3).[21] Similar to other reports, we found that overweight and obese individuals were treated more intensely.[20,22] This more intense treatment could reflect the widely reported association between BMI and hypertension, and appropriate efforts to control BP.[23]

The finding that AA were more intensely treated than EA but still had worse BP control suggests that additional study is warranted. We and others have reported that higher BPs in AA cannot be ascribed to less awareness among AA.[4,6] Further, we previously reported that AA who were aware of their hypertension had an odds ratio of 1.7 (95% CI 1.4, 2.0) for treatment compared with EA.[6] Our current study suggests that differential intensity of treatment may also not be a major contributor.

Nevertheless, more intense treatment of both EA and AA could lead to better control. In the Antihypertensive and Lipid Lowering Trial to prevent Heart Attack (ALLHAT) study, as many as 70% of AA and 63% of EA were on multidrug therapy by the end of the study.[8] In our study, only 62% of AA and 53% of EA were on multidrug regimens, well below ALLHAT levels.

Although systematic under-treatment may not be a major contributor, several avenues are worth pursuing to better understand potential mechanisms leading to sub-optimal BP control. Self-reported adherence was not associated with intensity of medication treatment in our study, but adherence could contribute to worse control despite more intensive treatment among AA. Lee, et al,[24] reported difficulty achieving target BP in an AA population; despite excellent visit adherence, participants had relatively poor medication compliance as assessed by pill counts. Among urban indigent patients, EA had higher pharmacy refill rates than other races.[25] Among veterans, although there were no racial differences in medication compliance at older ages, younger AAs refilled cardiovascular medications less often than EA.[26]

In addition, BP medication efficacy may differ for AA and EA, eg, in ALLHAT, BP control differed by treatment: 63% of AA in the chlorthalidone arm achieved control compared with 60% in the amlodipine arm and 54% in the lisinopril arm.[8] Other reports suggest that ACEI and BB may be less effective and CCB more effective among AA.[27–29] Regardless of the treatment, fewer AA tend to achieve control than EA, reported as far back as the Hypertension Detection and Follow-up Program, but still poorly understood.[30]

Several limitations are worth noting. Since we did not have pretreatment BPs or age at diagnosis available, we could not examine the possibility of *relative* under treatment. Several assessments of BP and medications would have been ideal. In addition to preventing assignment of causality, another limitation of cross-sectional observational studies is the possibility of residual confounding; some domains were incompletely captured, such as access to care (we only assessed health insurance status) and social position (we only assessed income and education). The medication inventory depended on the participant's producing medications, and some could have been omitted. Many variables were based on self-report, including the adherence measure; this scale does correlate with blood pressure and glycemic control.[15,31] Self-reported diabetes is widely used in epidemiologic studies, but self-reported stroke, heart attack and especially congestive heart failure may be less reliable.[32] These variables were not the central focus of this analysis, however. Although we did not have medication doses available, we note that recent guidelines recommend using submaximal doses of multiple medications to decrease side effects, thus our approach of determining intensity of treatment based on medication number is reasonable.[2]

In conclusion, less intense treatment for hypertension is unlikely to be a major contributor to differences in BP control

Less intense treatment for hypertension is unlikely to be a major contributor to differences in BP control among AA and EA

among AA and EA. In fact, AA were more intensely treated both overall and across all age, sex groups, income and education categories. However, both groups could have been treated more intensely to achieve better control. The poorer relative BP control rates among AA warrant further study in the search for strategies to eliminate disparities in hypertension outcomes.

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