Understanding Contributors to Racial Disparities in Blood Pressure Control

Nancy R. Kressin, PhD; Michelle B. Orner, MPH; Meredith Manze, MPH; Mark E. Glickman, PhD; Dan Berlowitz, MD, MPH

Background—Racial disparities in blood pressure (BP) control are well documented but poorly understood; prior studies have only included a limited range of potential explanatory factors. We examined a comprehensive set of putative factors related to blood pressure control, including patient clinical and sociodemographic characteristics, beliefs about BP and BP medications, medication adherence, and experiences of discrimination, to determine if the impact of race on BP control remains after accounting for such factors.

Methods and Results—We recruited 806 white and black patients with hypertension from an urban safety-net hospital. From a questionnaire administered to patients after their clinic visits, electronic medical record and BP data, we assessed an array of patient factors. We then examined the association of patient factors with BP control by modeling it as a function of the covariates using random-effects logistic regression. Blacks indicated worse medication adherence, more discrimination, and more concerns about high BP and BP medications, compared with whites. After accounting for all factors, race was no longer a significant predictor of BP control.

Conclusions—Results suggest that equalizing patients’ health beliefs, medication adherence, and experiences with care could ameliorate disparities in BP control. Additional attention must focus on the factors associated with race to identify, and ultimately intervene on, the causes of racial disparities in BP outcomes. (Circ Cardiovasc Qual Outcomes. 2010; 3:00-00.)

Key Words: blood pressure ■ hypertension ■ race ■ disparities
WHAT IS KNOWN

- Racial disparities in blood pressure (BP) control are well documented but poorly understood, and prior studies have only included a limited range of potential explanatory factors.

WHAT THE STUDY ADDS

- Blacks reported more experiences of discrimination, worse medication adherence, and more concerns about BP.
- Patient beliefs about hypertension can affect their BP control.
- Comorbid conditions, whose prevalence varies by race/ethnicity, can also affect BP control and thus are important to account for.
- We suggest an enhanced model of factors leading to disparities in BP control.

Methods

Sample
We identified all white and black patients ages 21 and older with 3 separate outpatient diagnoses of hypertension in 2004 in the primary care practices of a northeastern academically affiliated urban safety net tertiary care hospital. We use the term “black” to refer to patients of African or Caribbean descent. The study was approved by the institutional review board, and all subjects gave informed consent. Study staff tracked clinic visits of these 10,125 patients over 19 months (October 2004 to June 2006), and, as they presented for care, approached 3526 of them to request study participation. Those willing were asked a series of questions and administered a 6-item cognitive screen to determine eligibility. However, 654 patients (19% of 3526) overtly refused to participate and 920 patients (26%) did not have time to participate that day, indicated willingness to participate in the future, but staff were unable to enroll them at a future visit.

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Figure 1. Flow chart of patient recruitment.

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next year?” (all scored on a scale of 1 to 5: extremely serious to not at all serious for the former 2 questions; very likely to very unlikely for the latter 2). We also included 10 individual items from the “cause” dimension of the “Illness Perception Questionnaire” to assess illness identity, cause, timeline, consequences, and cure control to examine patients’ subjective beliefs about the etiology of their high BP (responses on a 5-point scale; range, strongly agree to strongly disagree).19

Perceived Discrimination in Health Care
We included 3 measures to assess patient perceptions of race-based discrimination in the health care setting. We used 5 questions that were a subset of the Commonwealth Fund 2001 Health Care Quality survey, focusing specifically on the patient perception of his/her provider and of encountering discrimination while receiving medical care, to generate a single item pertaining to the extent of the patient’s perception of his/her provider’s understanding of the patient’s cultural background and how it affects his/her health; each item was examined individually. We also included 7 dichotomous items from a measure of patient perceptions of discrimination in accessing health care,21 counting the number of experiences reported and creating a continuous variable (higher score indicates more experiences of discrimination21; α = 0.90).

Medication Adherence and Hypertension Management
To assess medication adherence, we used the Hill-Bone Compliance to High Blood Pressure Therapy Scale, comprising items scored on a 4-point scale (“none of the time” to “all of the time”).22 We included the 9-item adherence subscale, which has been validated against BP control, summing the items to create a scale score (range, 9 to 36; higher scores indicate less adherence; α = 0.74).

Outcome Assessment: BP Control
Research staff assessed patient BP using an automatic, portable machine (Omron HEM-907, Bannockburn, Ill), which was validated according to the international validation protocol and deemed an appropriate instrument for accurate BP measurement.23 We excluded the 7% of patients without a BP reading from study staff. We dichotomized the BP readings to indicate whether each patient’s BP was controlled or not, for example, when their systolic BP exceeded 140 mm Hg or their diastolic BP exceeded 90 mm Hg, according to the Joint National Committee on Hypertension 7 standards at the time of the study, which also specified that for patients with diabetes or renal insufficiency, BP should not exceed 130/80 mm Hg.15

Statistical Analyses
We first examined bivariate associations between race and each of the sociodemographic, clinical, attitudinal, experiential, and medical adherence variables, using χ² or t tests, as appropriate. Next, we performed bivariate analyses to determine whether this same set of variables was associated with BP control (yes/no). Finally, BP control was modeled as a function of the covariates using random-effects logistic regression. The random effects, which were assumed to be mean-zero gaussian additive errors on the logit scale, accounted for 2 levels of clustering: patients within providers and providers within clinics.

We fit 6 sets of models of increasing numbers of covariates, including only patients with complete data. In the first, we examined the effects of race alone on BP control. Next, we examined the effects of race on BP control, adjusting for age and other sociodemographic characteristics. The third model added medication adherence, the fourth added health beliefs, the fifth added experiences of discrimination, and the sixth added comorbid conditions. Within each model, we chose the subset of additional variables through an ordinary logistic regression stepwise selection procedure, forcing in provider indicators as fixed effects, keeping significant variables from the prior model, and including race in all models. This procedure prevents collinearity and overparameterization. We used a probability value of 0.05 for variables to enter or be removed from the model. c-Statistics and Hosmer-Lemeshow analyses were performed on the models resulting from the stepwise procedure. Each model was then rerun with the random effects terms. All analyses were conducted using SAS 9.1.3 (SAS Institute, Cary, NC) with the exception of the random-effects logistic regression, which was conducted using the statistics package R (version 2.8.0*).

Results
Sociodemographic Characteristics of the Sample
Most of the sample were black (57%) or female (65%), with an overall mean age of 59 years. White patients were older (61 versus 58 years), and more likely to have at least a high school education (90% versus 71%). Black patients were more likely to have insurance coverage through Medicaid or Free Care (42% versus 22%, 41% versus 25%, respectively), whereas white patients were more likely to have “other” (private) insurance (59% versus 35%). There were race differences in combined household family income, with a greater percentage of blacks earning low incomes of <$20 000 (58% versus 36% whites) and being less likely to have a literacy score of 9th grade or higher (48% versus 84%), (all P < 0.001; Table 1).

BP and Medical History by Race
A greater percentage of white patients had controlled BP (65% versus 53%), with lower systolic and diastolic BP than blacks (white systolic BP, 130 mm Hg versus 132 mm Hg; white diastolic BP 76 mm Hg versus 81 mm Hg). White patients were more likely to have hyperlipidemia (60% versus 47%), peripheral vascular disease (7% versus 4%), benign prostatic hypertrophy (6% versus 2%), coronary artery disease (19% versus 8%), and cerebrovascular disease (7% versus 4%). Black patients were more likely to have diabetes (40% versus 24%), renal insufficiency (7% versus 4%), congestive heart failure (5% versus 1%), and to be obese (65% versus 52%, all P < 0.05).

Health Beliefs and Illness Perceptions
Blacks had significantly more concerns about their BP medications than whites (2.5 versus 2.1, P < 0.0001). White patients were significantly more likely to respond that their BP was less serious, given their current use of medications (3.3 versus 2.8, P < 0.0001).

When asked about the causality of high BP, blacks agreed more with the notion that it is caused by a germ or virus or that diet, pollution, or heredity played a major role in causing BP (Table 1). Blacks were more likely to indicate that it was just by chance that they became ill with hypertension, that other people played a large role in causing their BP, or that high BP was caused by poor medical care in the past.

Perceived Discrimination
When asked if there was ever a time they would have gotten better medical care if they belonged to a different race or ethnic group or if they ever felt that a doctor or medical staff judged them unfairly or treated them with disrespect because of how well they spoke English, blacks were more likely to respond “yes” than whites (19% versus 1% and 4% versus 0%, respectively). Although all patients generally agreed that their provider understood their background and values, black patients agreed less strongly (1.5 versus 1.4), and though all patients disagreed that their provider looks down on them and
Table 1. Sociodemographic, Clinical, Attitudinal, Belief, and Experience Variables by Race and BP Control

<table>
<thead>
<tr>
<th>Sociodemographic Characteristics and Medical History</th>
<th>Overall, %</th>
<th>White, %</th>
<th>Black, %</th>
<th>P Value for Race Differences</th>
<th>Controlled BP, %</th>
<th>Uncontrolled BP, %</th>
<th>P Value for Difference by BP Control</th>
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</thead>
<tbody>
<tr>
<td>% White</td>
<td>43</td>
<td>n/a</td>
<td>48</td>
<td>0.0009</td>
<td>59</td>
<td>48</td>
<td>0.0003</td>
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<tr>
<td>Mean age, y</td>
<td>59</td>
<td>61</td>
<td>58</td>
<td>0.0007</td>
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<td>59</td>
<td>0.0853</td>
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<tr>
<td>% Male</td>
<td>35</td>
<td>46</td>
<td>27</td>
<td>&lt;0.0001</td>
<td>34</td>
<td>38</td>
<td>0.2919</td>
</tr>
<tr>
<td>Education, % ≥12 y</td>
<td>79</td>
<td>90</td>
<td>71</td>
<td>&lt;0.0001</td>
<td>81</td>
<td>76</td>
<td>0.0521</td>
</tr>
<tr>
<td>% Income &lt; $20,000</td>
<td>48</td>
<td>36</td>
<td>58</td>
<td>&lt;0.0001</td>
<td>43</td>
<td>56</td>
<td>0.0003</td>
</tr>
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<td>Insurance status</td>
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<td>Medicare</td>
<td>39</td>
<td>39</td>
<td>40</td>
<td>0.6889</td>
<td>37</td>
<td>43</td>
<td>0.0984</td>
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<td>Medigap</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0.4991</td>
<td>2</td>
<td>4</td>
<td>0.2143</td>
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<tr>
<td>Medicaid</td>
<td>33</td>
<td>22</td>
<td>42</td>
<td>&lt;0.0001</td>
<td>29</td>
<td>40</td>
<td>0.0012</td>
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<tr>
<td>Other</td>
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<td>59</td>
<td>35</td>
<td>&lt;0.0001</td>
<td>51</td>
<td>38</td>
<td>0.0003</td>
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<td>Free care</td>
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<td>25</td>
<td>41</td>
<td>&lt;0.0001</td>
<td>32</td>
<td>37</td>
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<td></td>
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<td>≤3rd grade</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
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<tr>
<td>4th to 6th grade</td>
<td>9</td>
<td>2</td>
<td>14</td>
<td></td>
<td>8</td>
<td>11</td>
<td></td>
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<tr>
<td>7th to 8th grade</td>
<td>24</td>
<td>12</td>
<td>33</td>
<td></td>
<td>22</td>
<td>27</td>
<td></td>
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<tr>
<td>≥9th grade</td>
<td>63</td>
<td>84</td>
<td>48</td>
<td>&lt;0.0001</td>
<td>67</td>
<td>58</td>
<td>0.0884</td>
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<tr>
<td>% With controlled BP</td>
<td>58</td>
<td>65</td>
<td>53</td>
<td>0.0009</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>Mean systolic BP, mm Hg</td>
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<td>130</td>
<td>132</td>
<td>0.0277</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>Mean diastolic BP, mm Hg</td>
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<td>76</td>
<td>81</td>
<td>&lt;0.0001</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<td>Nicotine dependence</td>
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<td>5</td>
<td>9</td>
<td>0.0839</td>
<td>8</td>
<td>8</td>
<td>0.7303</td>
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<td>Hyperlipidemia</td>
<td>52</td>
<td>60</td>
<td>47</td>
<td>0.0002</td>
<td>52</td>
<td>33</td>
<td>0.9302</td>
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<tr>
<td>Diabetes</td>
<td>33</td>
<td>24</td>
<td>40</td>
<td>&lt;0.0001</td>
<td>25</td>
<td>45</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>0.0383</td>
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<td>5</td>
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<td>Renal insufficiency</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td>0.0470</td>
<td>3</td>
<td>10</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Benign prostatic hypertrophy</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>0.0003</td>
<td>4</td>
<td>2</td>
<td>0.1107</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>13</td>
<td>19</td>
<td>8</td>
<td>&lt;0.0001</td>
<td>14</td>
<td>11</td>
<td>0.2151</td>
</tr>
<tr>
<td>Obesity</td>
<td>59</td>
<td>52</td>
<td>66</td>
<td>0.0004</td>
<td>56</td>
<td>62</td>
<td>0.2373</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>0.0091</td>
<td>2</td>
<td>5</td>
<td>0.0635</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>0.0382</td>
<td>4</td>
<td>6</td>
<td>0.2162</td>
</tr>
<tr>
<td>Health Beliefs and Illness Perceptions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMQ: Mean necessity of medications, mean score</td>
<td>3.7</td>
<td>3.7</td>
<td>3.7</td>
<td>0.1542</td>
<td>3.7</td>
<td>3.7</td>
<td>0.9739</td>
</tr>
<tr>
<td>BMQ: Mean concerns about medications, mean score</td>
<td>2.3</td>
<td>2.1</td>
<td>2.5</td>
<td>&lt;0.0001</td>
<td>2.3</td>
<td>2.4</td>
<td>0.0407</td>
</tr>
<tr>
<td>How serious do you think high BP is, in general*</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>0.4607</td>
<td>1.5</td>
<td>1.6</td>
<td>0.1147</td>
</tr>
<tr>
<td>How serious do you think your high BP is, given your current use of medication?*</td>
<td>3.0</td>
<td>3.3</td>
<td>2.8</td>
<td>&lt;0.0001</td>
<td>3.1</td>
<td>2.9</td>
<td>0.0010</td>
</tr>
<tr>
<td>If you did not take BP meds, likelihood that BP would get worse w/in a year†</td>
<td>1.5</td>
<td>1.4</td>
<td>1.5</td>
<td>0.1284</td>
<td>1.5</td>
<td>1.4</td>
<td>0.1348</td>
</tr>
<tr>
<td>If you did not take BP meds, likelihood that you would develop other health problems w/in a year†</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>0.2307</td>
<td>1.7</td>
<td>1.7</td>
<td>0.4281</td>
</tr>
<tr>
<td>Illness Perceptions Questionnaire Items‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A germ or virus caused my high BP</td>
<td>3.9</td>
<td>4.2</td>
<td>3.7</td>
<td>&lt;0.0001</td>
<td>3.9</td>
<td>3.8</td>
<td>0.1208</td>
</tr>
<tr>
<td>Diet played a major role in causing my high BP</td>
<td>2.3</td>
<td>2.4</td>
<td>2.1</td>
<td>0.0017</td>
<td>2.2</td>
<td>2.3</td>
<td>0.6715</td>
</tr>
<tr>
<td>Pollution caused my high BP</td>
<td>3.7</td>
<td>3.8</td>
<td>3.5</td>
<td>0.0002</td>
<td>3.7</td>
<td>3.7</td>
<td>0.7546</td>
</tr>
</tbody>
</table>

(Continued)
the way they live their life, white patients disagreed more strongly (4.5 versus 4.3). Blacks reported more experiences of discrimination when receiving health care than did whites (1.1 versus 0.2, all \( P < 0.05 \)).

**Medication Adherence**

White patients reported better medication adherence than did black patients (9.9 versus 11.0, \( P < 0.0001 \)).

**Covariates by BP Control**

A greater proportion of patients with controlled BP were white compared with patients with uncontrolled BP (48% versus 36%). Patients with uncontrolled BP were more likely to have a household income of < $20,000 (56% versus 43%), were more likely to have Medicaid (40% versus 29%), and were less likely to have “other” insurance (38% versus 51%). Patients with uncontrolled BP were more likely to have
diabetes (45% versus 25%) and renal insufficiency (10% versus 3%) and concerns about their BP medications (2.4 versus 2.3). Patients with controlled BP were more likely to disagree that their own BP was serious, given their current use of medication (10.4 versus 10.7, all P<0.05).

### Multivariate Results

The first model, only adjusted for race, accounting for physician and clinic, indicated that white patients had higher odds of having controlled BP than blacks (model 1, b=0.42, \( P=0.0068 \); Table 2; c-statistic (c)=0.661; Hosmer and Lemeshow goodness-of-fit test (HL) \( P=0.4226 \). The effect of race on BP control persisted in the second model, after adjustment for income (other sociodemographic variables were excluded through the ordinary logistic regression stepwise procedure). The third model added a measure of adherence, which was not significantly related to BP control, so these 2 latter models had the same results, with race continuing to be a significant predictor of BP control (models 2 and 3, b=0.37, \( P=0.0238 \); model 2, c=0.691, HL \( P=0.7127 \); model 3, c=0.670, HL \( P=0.9260 \). In the fourth model, an item assessing patients’ beliefs that high BP is largely due to one’s own behavior was added, as well as 2 items assessing the degree of seriousness with which patients perceive hypertension (all other attitudinal and experiential factors were excluded through the stepwise procedure). In this model, race was no longer significantly associated with odds of BP control (model 4, b=0.33, \( P=0.0531 \), c=0.713, HL \( P=0.3932 \)).

In the fifth model, 1 item assessing experiences with perceived discrimination in health care was added, specifically, perceptions about whether they would have ever gotten better medical care if they belonged to a different race or ethnic group (other items assessing discrimination were excluded through the stepwise procedure). Race was significant in this model (model 5, b=0.48, \( P=0.0074 \), c=0.708, HL \( P=0.8660 \)).

In the final model, diabetes, renal insufficiency, and benign prostatic hypertrophy were added (other comorbid conditions were excluded during the stepwise procedure in SAS). Here, race was no longer a significant predictor of BP control (model 6, b=0.32, \( P=0.0876 \), c=0.740, HL \( P=0.4274 \)).

### Discussion

Understanding and ameliorating racial disparities in BP control is a major public health and clinical concern. We hypothesized that after adjusting for an extensive set of potential confounders, race would no longer be significantly associated with BP control, and the results generally supported this notion. Although the effects of race persisted after accounting for sociodemographic factors, the inclusion of BP-related attitudes and beliefs rendered race insignificant. However, the introduction of the discrimination variables made race significant again, in a counterintuitive fashion, although in the final model, with the inclusion of comorbid conditions, race was no longer significant. The finding that
patients who agreed with the statement that there was “ever a time when they would have gotten better medical care if they had belonged to a different race/ethnic group” had better BP control is puzzling. We carefully explored this dynamic, ruling out the possibility that race-discrimination interactions were driving it, and finding that even if we removed this variable, another discrimination variable became significant in the same counterintuitive direction (not shown). The variable was limited by its reference point (eg, was there ever a time . . .), so it is possible that patients who felt they were getting bad care in the past had changed clinicians and are now getting good care, leading to better current BP care and control. It is also possible that another, unmeasured, confounder caused these results.

The study findings are different than the Bosworth study,11 which indicated that after controlling for a similar range of factors (not including discrimination or comorbid conditions), race remained a significant predictor of BP control, among VA patients in one Southern city. They speculated that the results they obtained in that setting, where access to care is assured, might be different than those found elsewhere, and our results in a northeastern urban safety net hospital setting support this notion. Several other studies also controlled for subsets of the factors we included here, but race remained significant.6,25,26 Thus, although our findings support Bosworth’s proposed framework as a descriptive model, the notion that numerous psychosocial, behavioral, and experiential factors mediate the relationship between race and BP control,11 they indicate that comorbid conditions, whose prevalence varies by race/ethnicity, are also important to account for in models of disparities in BP control.

Several findings have clinical implications. Blacks reported more experiences of discrimination, and such experiences may erode overall trust in physicians, their diagnoses, and the therapies they prescribe. Experiences of discrimination in the community setting are generally associated with higher BP27,29,30 with less use of chronic disease care28 and may negatively affect patients’ acceptance of their diagnosis and beliefs in the necessity of or concerns about the associated therapy, which are foundational to patient adherence to prescribed medications.29 Unequal treatment, documented by us and others,30,31 may also contribute to disparities in BP outcomes.

Blacks indicated worse medication adherence and more concerns about BP. Each of these is potentially ameliorable through educational or counseling interventions, and our results suggest that addressing these will help address disparities in BP control.

This study was limited by its focus on patients in a single setting and its inclusion of only black (albeit both African-American and Caribbean-born) and white patients. Although we required that participants have 3 separate outpatient diagnoses of hypertension, our inability to contact or enroll many eligible patients may have biased our sample toward more frequent users. The observational nature of these data limits our ability to form causal inferences because we were not able to randomize by attitudinal characteristics or ascertain that certain attitudes or experiences preceded BP outcomes in time. Further, our measure of adherence, although internally consistent and previously validated against BP outcomes, was obtained by self-report. However, the large sample, which included women and detailed assessments of the richest array of putative factors examined to date, offsets the limitations.

Among the potential causes of disparities in BP control, the etiologic factors could arise from the patient (health beliefs and experiences, medication adherence or self-care behaviors, clinical or biological factors), the provider (practice style, communication skills, attitudes), the doctor-patient interaction, or the environment. Although the Bosworth model provided an excellent summary of the psychosocial and cultural factors that might be associated with BP control, we propose that a model for racial disparities in BP control should include a wider array of factors and include hypothesized associations (Figure 2). The present results help to demonstrate the effects of a variety of factors on race differences in BP, but we lacked data on other self-care behaviors important to hypertension management (eg, diet, exercise) to fully address this question. Nor are we able to rule out biological differences, such as race-linked nitric oxide deficiencies associated with cardiovascular disease52 or differences in the process of care. Our future work will also examine the effects of racial differences in providers’ therapeutic intensification, which varies by race,33 on BP outcomes. Similar to our prior suggestions for future directions in research on racial differences in invasive cardiac procedure
use,\textsuperscript{31} here we propose additional careful attention by clinicians, researchers, and, ultimately, policymakers, to a comprehensive array of factors associated with race to identify and intervene on the causes of racial disparities in BP outcomes.

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Disclosures
None.

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