Racial Differences in Hypertension Knowledge: Effects of Differential Item Functioning

Brian J. Ayotte, PhD; Ranak Trivedi, PhD; Hayden B. Bosworth, PhD

Health-related knowledge is an important component in the self-management of chronic illnesses. The objective of this study was to more accurately assess racial differences in hypertension knowledge by using a latent variable modeling approach that controlled for sociodemographic factors and accounted for measurement issues in the assessment of hypertension knowledge. Cross-sectional data from 1,177 participants (45% African American; 35% female) were analyzed using a multiple indicator multiple causes (MIMIC) modeling approach. Available sociodemographic data included race, education, sex, financial status, and age. All participants completed six items on a hypertension knowledge questionnaire. Overall, the final model suggested that females, Whites, and patients with at least a high school diploma had higher latent knowledge scores than males, African Americans, and patients with less than a high school diploma, respectively. The model also detected differential item functioning (DIF) based on race for two of the items. Specifically, the error rate for African Americans was lower than would be expected given the lower level of latent knowledge on the items, on the questions related to: (a) the association between high blood pressure and kidney disease, and (b) the increased risk African Americans have for developing hypertension. Not accounting for DIF resulted in the difference between Whites and African Americans to be underestimated. These results are discussed in the context of the need for careful measurement of health-related constructs, and how measurement-related issues can result in an inaccurate estimation of racial differences in hypertension knowledge. (*Ethn Dis.* 2009;19:23–27)

Key Words: Hypertension Knowledge, Differential Item Functioning, Disparities

From the Center for Health Services Research in Primary Care, Durham VAMC (BJA, HBB); the Department of Medicine, Division of General Internal Medicine, Duke University (RT, HBB), and the Department of Psychiatry and Behavioral Sciences and Center for Aging and Human Development, Duke University (HBB).

Address correspondence to: Brian J. Ayotte, PhD; Center for Health Services Research in Primary Care; VA Medical Center (152); 508 Fulton St; Durham, NC 27705; 919-668-5519; brian.ayotte@duke.edu

Introduction

The prevalence of hypertension is increasing in the United States, particularly among African Americans.[1] Between 1988–1994 and 1999–2002, cardiovascular mortality has declined less for African Americans than for Whites and remains higher overall among African Americans.[2] Despite efforts, fewer than 30% of patients with hypertension have their blood pressure under control.[3]

Hypertension treatment requires a high level of self-management (eg, taking medications),[4] and knowledge is a component of the ability to successfully control blood pressure.[5–8] Research suggests that differences exist between African Americans and Whites in terms of hypertension knowledge. For example, one study that used data from the general population found that African Americans did not necessarily believe that hypertension could be treated with lifestyle changes, whereas Whites believed that lifestyle modifications and medications were effective in controlling blood pressure.[9] More African Americans, however, knew that hypertension could lead to renal failure and cognitive impairment. No differences between Whites and African Americans on overall knowledge (represented by a summed score) were found.

The purpose of this study was to extend previous research on racial differences in hypertension knowledge by using a latent variable approach to data analysis and focusing on people with high blood pressure. We used a multiple indicator multiple cause (MIMIC) model approach to examine hypertension knowledge and differential item functioning (DIF) in a sample of hypertensive patients. The MIMIC approach to data analysis simultaneously estimates the

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association between specified background variables and latent ability while also considering how the background variables might be related to specific items.[10]

Methods

We analyzed baseline data from two institutional review board–approved trials—a randomized, controlled intervention to improve blood pressure control conducted in the Durham Veterans Affairs Medical Center Primary Care Clinics and another trial conducted in two outpatient primary care clinics. We identified patients through a review of the facility's information system as having a diagnosis of hypertension and having had filled a prescription for hypertensive medication in the previous year. Overall, 1189 participants were enrolled in the trials. Twelve patients were excluded from the current study because of missing data, resulting in a final sample size of 1177 patients. More detailed descriptions of the two interventions and recruitment methods have been previously published.[11,12]

Data regarding sex, race, financial difficulty, education, and age were

collected at baseline for all of the enrolled patients. Men, Whites, people who reported no problems paying their bills, and people with less than a high school diploma were coded as the referent groups (ie, coded as 0). Women, African Americans, people who reported having problems paying their bills, and people with at least a high school diploma were coded as 1. Age was treated as a continuous variable.

Hypertension knowledge was measured by using six items. Specifically, patients were asked if 1) 160/100 mm Hg reflected high, low, or normal blood pressure; 2) hypertension usually lasts for a few years, for 5–10 years, or for the rest of a person's life; 3) losing weight and exercising increases, decreases, or does not affect blood pressure; 4) a person who has high blood pressure experiences dizziness or headaches; 5) high blood pressure can cause kidney problems; and 6) African Americans are at a higher risk for high blood pressure. Responses were coded as correct or incorrect.

Statistical Analysis

Previous research examining racial differences in hypertension knowledge compared the proportion of correct responses between groups.[9,13] However, this approach ignores the role of underlying ability.[14] Differential error rates might not reflect different levels of knowledge on specific items as much as a difference in the underlying latent ability of the groups. Additionally, using the proportion of correct responses to compare groups might simply reflect how discriminating the items are for persons with different levels of underlying ability.

Taking an item response theory approach addresses these possible measurement issues by identifying items that behave differently between groups.[15–17] An item that functions differently across groups (ie, demonstrates DIF) is either more difficult for one group, measures ability differently

for one group, or both. One approach to examining DIF is the MIMIC model, which is essentially a confirmatory factor analysis with covariates.[14,18] The MIMIC model involves two primary components: direct paths and indirect paths. Indirect paths refer to the regression paths from the covariates to the latent trait. Direct paths refer to the regression paths from the covariates to the indicators and, if significant, reflect a group difference in measurement intercepts for a specific item after controlling for latent ability (ie, DIF).

The process of building a MIMIC model to detect DIF involves three steps.[19] First, a measurement model is specified. Second, a model that estimates the indirect effects is estimated while holding all direct paths to zero. Third, a forward-stepwise procedure with modification indices is used to identify direct effects. If the added path significantly improves model fit (ie, a significant χ^2 difference test), the path is retained. This process continues until no further improvement in model fit can be made. All models were estimated using the weighted least squares estimator in Mplus version 4.1 (Muthén & Muthén, Los Angeles, California). Model fit was assessed with the χ^2 goodness-of-fit statistic, the root mean square error of approximation (RMSEA),[20] and the comparative fit index (CFI).[21] The RMSEA approaches 0 as model fit improves, with values close to .06 or less indicating adequate model fit.[21] The CFI ranges between 0 and 1; values greater than .95 generally indicate adequate model fit.[22]

RESULTS

Sample Characteristics

Approximately 46% of the sample was African American. Overall, the patients were approximately 62 years old and ranged in age from 21 to 92 years (Table 1). African Americans were younger, fewer had at least a high school

diploma, fewer reported having financial difficulty, and more were men compared with Whites.

Item-level Performance

In general, participants responded correctly to the items (Table 2). African Americans were more likely to err on all of the items, as were people with low education. We also observed differences in performance based on sex, financial stability, and age, but these differences were not present for all of the items. However, as noted previously, differential error prevalence is not necessarily evidence of DIF.

MIMIC Model Results

The baseline model that estimated all of the indirect effects and constrained all direct paths to zero fit the data poorly ($\chi^2[31] = 123.85$, $P < .001$, CFI = .623, RMSE = .050). The factor loadings indicated that all of the items were significantly related to the underlying latent trait (Table 3). In this baseline model, those with less than a high school diploma had significantly lower hypertension knowledge than those with a high school diploma, and women had significantly higher hypertension knowledge than did men. Race, age, and financial stability were not related to hypertension knowledge.

Evidence of DIF

The final model that estimated the direct effects and indirect effects fit the data well ($\chi^2[24] = 32.98$, $P = .132$, CFI = .968, RMSEA = .016). With regard to indirect effects, women, Whites, and people with at least a high school diploma had higher hypertension knowledge than did men, African Americans, and people with less than a high school diploma, respectively. Note that the indirect effect of race was significant in this model and not in the baseline model.

With regard to direct effects, older adults were less likely to know that African Americans are at a higher risk of

Table 1. Characteristics for 1177 African Americans and Whites with hypertension from 2 controlled clinical trials

Variable	Total (*N*=1177)	African American (*n*=537)	White (*n*=640)	Test of significance
Age, years	M=62.32 (SD=11.81)	M=60.23 (SD=12.16)	M=64.08 (SD=11.22)	*t*=5.64 (*P*<.001)
	Range=21–92	Range=28–92	Range=21–87	
Sex				χ^2=24.22 (*P*<.001)
Male	761 (65%)	454 (71%)	307 (57%)	
Female	416 (35%)	186 (29%)	230 (43%)	
Education				χ^2=18.87 (*P*<.001)
Less than high school diploma	509 (43%)	400 (63%)	268 (50%)	
At least high school diploma	668 (57%)	240 (37%)	269 (50%)	
Financial difficulty				χ^2=25.21 (*P*<.001)
No problems paying bills	943 (80%)	547 (85%)	396 (74%)	
Some problems paying bills	234 (20%)	93 (15%)	141 (26%)	
Hypertension knowledge	M=4.90 (SD=.98)	M=4.88 (SD=.95)	M=4.97 (SD=1.01)	*t*=1.51 (*P*=.13)
	Range=0–6	Range=2–6	Range=0–6	

hypertension and more likely to know that hypertension usually does not involve dizziness or headaches. These findings were consistent with the preliminary analyses reported in Table 2. The negative indirect effect of education and the positive direct effect suggests that participants with less than a high school diploma were more likely to err on the item related to how long high blood pressure normally lasts but this error rate was lower than what would be expected given the lower mean level of hypertension knowledge. In other words, the model-implied mean level of hypertension knowledge overestimates the likelihood of error on this item for people with less than a high school diploma. Likewise, the error rate for the items related to whether African Americans are at a higher risk for high blood pressure and the relation between high blood pressure and kidney disease were lower than would be expected

given the lower hypertension knowledge of African Americans.

In addition, we observed a negative direct effect from sex to the item related to how long high blood pressure lasts. Note that this effect is consistent with the error rates reported in Table 2 in that this was the single item that women erred more on than men. Therefore, model-implied mean level of hypertension knowledge underestimates the likelihood of error on this item for women. Finally, people who reported having trouble paying their bills were more likely to err on the item related to the symptoms of high blood pressure.

Hypertension Knowledge and DIF

Accounting for direct effects influenced the strength of the indirect effects. The indirect effect of race was not significant in the baseline model, but was significant in the final model.

To examine the influence of DIF on these estimates, a purposely misspecified model was estimated that held all of the direct effects of each covariate, in turn, to zero. For example, the standardized regression coefficient for education in the purposely misspecified model was −.73, and in the final model that accounted for DIF, this estimate was −.83. This finding suggests that people with less than a high school diploma had less hypertension knowledge than did people with at least a high school diploma in both models, but that the model not accounting for DIF underestimated the mean standardized difference between these two groups by approximately 12%.

For sex, the model accounting for DIF indicated that women had hypertension knowledge levels of approximately one half of a standard deviation higher than did men. In the model ignoring DIF, this difference was .39

Table 2. Item-level response data (proportion responding incorrectly, *N*=1177)

| | | | | | Education | | Financial Stability | | |
| | | Sex | | Race | | | | | |
Hypertension Knowledge Item		Male	Female	White	Black	High school diploma	No high school diploma	No problem with bills	Problem paying bills	Total
160/100 mm Hg is high blood pressure		.082	.045	.059	.081	.042	.103	.057	.111	.069
High blood pressure usually lasts for the rest of their life		.141	.164	.123	.180	.139	.161	.146	.157	.149
Losing weight and exercising usually makes blood pressure decrease		.086	.059	.061	.095	.043	.120	.076	.077	.077
When someone's blood pressure is too high they usually feel fine		.601	.489	.507	.626	.470	.680	.516	.728	.561
Decreasing blood pressure reduces the risk of kidney problems		.156	.126	.176	.110	.122	.177	.152	.111	.146
African Americans are at a higher risk for high blood pressure		.102	.036	.109	.042	.052	.113	.077	.081	.078

Table 3. Results of differential item functioning analysis using MIMIC model (*N*=1177)

		Indirect and Direct Effects				
	Item Loading	Age	Race	Sex	Education	Financial Status
Indirect effects						
Latent knowledge		−.01 (.01)	−.48 (.13)*	.61 (.14)*	−.99 (.14)*	.07 (.15)
Direct effects						
160/100 mm Hg is high BP	.52			−.34 (.12)*		
High BP lasts for lifetime	.56				.38 (.14)*	
Weight loss and exercise reduce BP	.61					
High BP has no symptoms	.50	.01 (.00)*				−.45 (.11)*
High BP is related to kidney disease	.40		.46 (.11)*			
African Americans are at higher risk	.59		.72 (.14)*			

Note: Item loadings are standardized with respect to the variance of the dependent variable; all other estimates are unstandardized with standard errors in parentheses; *P<.05.

SD, suggesting that ignoring DIF underestimated the difference between men and women by approximately 24%. The influence of DIF was most striking for race. In the purposefully misspecified model that ignored DIF, the standardized regression coefficient was −.14 (*P*=.15). However, after accounting for DIF, the standardized regression coefficient was −.40 (*z*=−3.69, *P*<.01). Ignoring DIF resulted in the difference between Whites and African Americans to be underestimated by 64.7%. The effects of DIF were not calculated for financial stability or age because the indirect paths were not significant in the baseline or the final model.

DISCUSSION

The primary purpose of this study was to examine racial differences in hypertension knowledge using a latent-variable approach. Overall, patients had a high level of hypertension-related knowledge. However, the final model indicated a difference between Whites and African Americans with regard to latent hypertension knowledge of approximately .4 SD. This contradicts previous findings that document a lack of racial differences in hypertension knowledge.[9] In addition, people with less than a high school diploma and men had lower levels of underlying knowledge than did people

> *…people with less than a high school diploma and men had lower levels of underlying knowledge than did people with a high school diploma and women, respectively.*

with a high school diploma and women, respectively.

A number of the items demonstrated DIF based on age, education, financial status, sex, and race. With regard to DIF based on race, the error rate for African Americans on the items related to the risk of kidney disease and the increased risk of high blood pressure in African Americans was lower than would be expected given the difference in latent hypertension knowledge. This is consistent with previous research, which found that African Americans tend to be more knowledgeable about the link between high blood pressure and kidney disease than do Whites.[9,13] This finding could be due to the increased prevalence of hypertension-related kidney disease in the African American population and the increased efforts to increase awareness of hypertension in African Americans.[3]

One of the most intriguing findings of this study was that the racial

difference in latent hypertension knowledge was underestimated (and statistically nonsignificant) if DIF was ignored (or if a simple mean comparison was performed). Previous research has reported no difference in hypertension knowledge between African Americans and Whites.[9] The results of the current study suggest that these null findings may have been due to measurement non-invariance. In other words, by not accounting for DIF, a difference between Whites and African Americans on a factor related to the self-management of high blood pressure may be missed.

Some limitations should be considered when interpreting these findings. First, the measure of hypertension knowledge was brief and did not assess dimensions of hypertension knowledge such as the relative importance of systolic and diastolic pressure and the role of medication in the treatment of high blood pressure.[9] Second, the factor loadings of the individual items, although significant, were not high, which indicates the latent factor left a substantial portion of the variance of the individual items unexplained. Finally, most of the sample was male (65%), thus limiting the generalizability of the results. The study did, however, include a high percentage of African Americans (45%) and patients who reported financial difficulty (20%).

Future research should further develop hypertension knowledge measures, as

well as attempt to identify the causes and consequences of the observed racial differences in knowledge related to high blood pressure. Research could also examine if hypertension knowledge among people with high blood pressure differs from knowledge among those who do not have hypertension. Taking this approach would help examine whether the racial differences detected in the current study exist only within patients of hypertension, or whether it represents a baseline difference between African Americans and Whites.

In terms of clinical implications, health care professionals should be aware of the relationships among patient characteristics and hypertension knowledge. For example, our model indicates that those who reported financial problems have difficulty with the item regarding symptoms of hypertension. Therefore, when caring for a patient who has hypertension and who may also be having financial difficulty, the healthcare professional might want to emphasize that aspect of hypertension. Likewise, the results indicate that African Americans, men, and those with less than a high school diploma have less hypertension knowledge in general. Practitioners should be aware of these relationships and ensure that these patients have adequate hypertension knowledge.

Conclusion

The prevalence of hypertension in the African American community underscores the need to understand correlates of self-management. Our study suggests that hypertensive patients overall have a high level of knowledge related to high blood pressure. The results also indicate that, contrary to previous research, differences between African Americans and Whites exist with regard to underlying knowledge. However, this difference is underestimated if item-level characteristics (DIF) are not considered. Our results do not necessarily suggest that the measure we used was psychometrically poor but that

caution should be used if one is interested in making group comparisons on the basis of items similar to the ones used in this study. If researchers seek to investigate group differences in hypertension knowledge, it might be appropriate to use a measure that uses multiple items to assess specific domains of knowledge such as risk factors, consequences, and the definition of hypertension. Alternatively, the heterogeneity could be modeled in the analyses by including paths between exogenous variables and specific indicators of a latent trait.

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