Blood Pressure and Memory in Older African Americans

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The rates of high blood pressure among African Americans, as a group, are the highest in the world. The implications for higher average blood pressure include complications for many major chronic conditions, such as cardiovascular disease and diabetes. Less well studied is the effect of blood pressure on the cognitive functioning of African Americans. The purpose of this study was to examine the effect of blood pressure on memory measures in a sample of adult African Americans. Analyses were conducted on a sample of 361 African American adults (mean age 61.50 years, standard deviation 9.39 years). We found significant correlations between systolic blood pressure and most cognitive measures but only for one of the measures and diastolic blood pressure. Regressions revealed significant effects for systolic blood pressure on Digit Symbol, Telephone Interview of Cognitive Status, and Immediate Recall on the Wechsler Logical Memory test. These findings suggest that blood pressure is a source of individual variability in cognitive aging among African Americans. (*Ethn Dis*. 2008;18:181–186)

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Introduction

Several lines of research (studies examining self-rated health, cardiovascular disease, hypertension, and mortality) suggest relationships between cognition and health. One chronic disease that appears to play a central role in lower cognitive functioning is hypertension. Research indicates that increases in blood pressure and chronicity and duration of hypertension are associated with lower levels of cognitive performance on several measures, particularly those assessing memory.[1] Much of this work has focused on neuropsychological assessments of cognition.[2–7] Inconsistencies have been observed with regard to the various neuropsychological domains most affected by high blood pressure; for instance, some studies find relationships between memory or attention and blood pressure, while others do not.[8,9] In addition, studies have found various patterns of neuropsychological and cognitive deficits, such that relative effects of blood pressure on neuropsychological domains are difficult to discern.[10] Research suggests high blood pressure negatively affects cognitive function, with the effects of hypertension exacerbated by other factors, including ApoE4 allele status, obesity, and hyperglycemia.[10–15]

Several possible explanations exist for the influence of hypertension on cognitive decline. One explanation posits that chronic hypertension can cause structural changes of the cerebral vessels (ie, thickening of vessel walls), increased vascular resistance, and impairment of cerebral autoregulation followed by a significant drop in blood pressure. As a result, oxygen supply to the brain is diminished, which produces infarcts or white matter lesions and subsequent cognitive decline.[16,17]

The prevalence of hypertension among African Americans is one of the highest in the world, twice as high as in European Americans.[18–20] However, few studies have investigated the association between blood pressure and cognitive impairment among African Americans.

The relative importance of an identifiable association between blood pressure and cognitive decline in African Americans is often illustrated by differential rates of cognitive impairment in African Americans as compared to European Americans. For example, African Americans 71 to 80 years of age show mild cognitive impairment at twice the rate in European Americans, and African Americans age ≥76 years show moderate-to-severe impairment at nearly three times the rate in European Americans.[22] Investigations of health in elderly African Americans indicate cognitive functioning is an essential variable to understand aging.[23,24] Investigating the contribution of specific chronic conditions as the link between cognition and physical health indices is a step toward understanding cognitive aging in African Americans.[25]

Given the greater prevalence, severity, and earlier onset of hypertension in African Americans and the role of hypertension as a predisposing factor

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for several conditions that are often fatal, cognitive declines associated with hypertension should exist and may be related to the higher rates of premature mortality observed in this population. Previous research in a small sample of African Americans has found that the greater the number of antihypertensive medications and the higher the diastolic blood pressure, the poorer executive functioning and delayed verbal memory.[26]

In summary, previous studies have shown that persons with high blood pressure perform more poorly on tasks involving memory, executive cognitive functions, and processing speed. However, virtually all previous studies have been conducted in Caucasian samples, and the blood pressure threshold associated with impaired cognitive function in African Americans is currently unknown. Epidemiologic studies have consistently shown that African Americans have a higher incidence of hypertension-related mortality, including a higher prevalence of end-stage renal disease at comparable ages. Cognitive impairment may appear at lower blood pressure levels in African Americans because of earlier (at younger ages) onset and greater severity of these conditions. In addition, evidence is increasing of low availability and utilization of health care and previous findings of high chronic illness rates (hypertension, diabetes mellitus, and coronary heart disease) in this population.[27–30] These conditions may be principal contributors for increased susceptibility to the development of vascular dementia and hypothesized accelerated age-normative declines in cognition among African Americans.[31–33] The purpose of this article is to examine the cross-sectional relationships between hypertensive status and cognitive functioning among older African Americans.

METHODS

Data for these analyses were obtained from the Carolina African American Twin Study of Aging (CAATSA).[34] CAATSA was designed to examine the health status, cognitive functioning, and physical and psychosocial functioning of adult African American twins. The final sample resulted in 706 interviews with 286 pairs of twins, 31 pairs of siblings, and 72 surviving members of non-intact twin pairs.

In this analysis, only participants >50 years of age were included because of the higher prevalence of hypertension in this age group. This resulted in a subsample of 361 African Americans 50–92 years of age (mean 61.50 years, standard deviation [SD] 9.39 years). The sample was 38%, with an average education of 12.00 years (SD 3.94) and an average monthly income of $1150.

Measures

From the available data, cognitive and blood pressure assessments were included in the analyses.

Blood Pressure

Blood pressure was taken by using an oscillometric automated device (A & D model UA-767; Milpitas, Calif). A blood pressure cuff of appropriate size was placed on participants' bare arms to record blood pressure while the participant was sitting and standing.[35] The assessments took place immediately after a five-minute rest period to reduce the effect of stress that may have arisen from performing the other assessments in the battery. The score for each participant is the average systolic and diastolic values of the three sitting blood pressure measures. Sample average for systolic was 141.32 (SD 22.10) and 82.33 (SD 12.13) for diastolic.

TICS

The Telephone Interview of Cognitive Status (TICS) is a cognitive screening test that can be administered over the telephone.[36] It is highly related to the Mini Mental Status Examination (MMSE) (r=+.94), which is the most commonly used measure of mental status. The TICS has a sensitively of 94% and a specificity of 100%, is shorter in length, and avoids some of the pitfalls of the MMSE. The sample average was 29.06 (SD 5.52).

Digit Span

This task is a measure of attention (forward) and auditory working memory (backward) that requires participants to repeat a series of digits that have been orally presented (in the case of the backward portion of the test, in reverse order). Participants were given 20 seconds to produce their answers. Digit strings ranged from four to nine digits. The number of correct and incorrect responses was recorded as pass or fail. If the subject failed two consecutive trials of the same digit string, the test was ended. The test-retest correlation is .92.[37] Sample average was 7.18 (SD 2.49) for forward and 4.39 (SD 2.09) for backward.

Alpha Span

This is a task of auditory working memory, in which participants were read a list of words (from two to eight words). After each list was read, participants were asked to repeat the list in alphabetical order. Responses were recorded as pass or fail. If a subject failed two consecutive attempts, the test was ended.[38] Sample average was 4.01 (SD 2.11).

Wechsler Logical Memory Scale

This task required participants to listen to a short story read to them aloud.[39] The participants were then asked to recall as much of the story verbatim as possible, immediately after it was read (immediate) and then 10 minutes later (delayed). Sample average was 13.14 (SD 6.85) for immediate and 6.78 (SD 5.97) for delayed.

Digit Symbol Substitution

This task measured general psychomotor speed and required participants to reproduce, within 90 seconds, as

Table 1. Correlations between cognitive variables, demographics, and blood pressure

	Age	Sex (F)	Education	Income	Systolic BP	Diastolic BP
Forward Digit Span	−.23*	.13*	.37*	.25*	−.03	.13*
Backward Digit Span	−.28*	.06	.44*	.30*	−.11*	.04
Digit Symbol Substitution	−.57*	.11*	.61*	.45*	−.29*	.02
Alpha Span	−.41*	.12*	.53*	.40*	−.19*	.03
Immediate Recall	−.36*	−.001	.48*	.42*	−.20*	.02
Delayed Recall	−.37*	.03	.41*	.33*	−.19*	.05
TICS	−.43*	−.02	.67*	.54*	−.21*	.03

BP = blood pressure, TICS = telephone interview of cognitive status.

many coded symbols as possible in blank boxes beneath randomly generated digits, according to a coding scheme for pairing digits with symbols. The test-retest correlation is .82.[39] Sample average was 37.35 (SD 19.19).

Procedures

As described above, participants were identified from birth records and contacted by phone. Upon agreement to participate, they were scheduled an interview time and place that was convenient to them. After providing informed consent, they completed the interview, which lasted on average 2.5 hours. At the end of the interview, subjects were compensated $40 for their participation.

RESULTS

Correlations were computed to identify covariation among the measures, and regression analysis was used to determine if blood pressure was uniquely associated with cognitive functioning after controlling for demographic characteristics.

Correlations

We found significant negative effects by age for all of the cognitive variables (Table 1). Women in the sample performed better, on average, on the Forward Digit Span, Digit Symbol Substitution, and Alpha Span tasks than did men. Years of education and income were significantly positively correlated with all of the cognitive measures, indicating that higher levels of education and income were associated with better cognitive performance. All of the cognitive variables included in the test battery were significantly correlated with systolic blood pressure, except for forward digit symbol, which was associated with diastolic blood pressure.

Regressions

Regression models examined the utility of systolic blood pressure to predict individual differences in performance on each of the cognitive measures included in the study. Only systolic pressure was used because no relationship was found between diastolic blood pressure and the cognitive measures (with only one exception, Forward Digit Span). Because the sample consisted of adult twin pairs, standard regression procedures were inappropriate, given that the independence of observations assumption was violated. Consequently, to control for twin-pair dependency both in the outcomes and predictors, multilevel models using Proc Mixed (SAS, SAS Institute, Inc, Cary, NC) were used in the analyses. A multilevel approach assumes that each participant is nested within a twin-pair and allows for a varying degree of covariation among twins depending on their twin status (ie, monozygotic, dizygotic, same-sex dizygotic, or sibling).

All of the cognitive variables included in the test battery were significantly correlated with systolic blood pressure, except for forward digit symbol, which was associated with diastolic blood pressure.

Analysis began by examining the extent to which systolic blood pressure predicted individual differences in performance on each of the cognitive tests. Similar to the pattern of results for the correlations among measures, systolic blood pressure was negatively and significantly related to each cognitive test (Table 2). This finding indicates that higher systolic blood pressure was associated with poorer performance on seven of the eight measures of cognition. Next, analyses examined whether the effect of systolic blood pressure on cognitive performance remained significant after controlling for demographic characteristics (ie, age, sex, education, and income), which were significantly correlated with performance on each of the cognitive measures. Systolic blood pressure remained a unique and negative predictor of performance on the Digit Symbol Substitution task and the TICS, indicating that higher systolic blood pressure was related to poorer performance on these cognitive measures, even after controlling for sociodemographic characteristics. Systolic blood pressure was also uniquely predictive of performance on the Immediate Recall task (P=.08), but it did not meet statistical significance. Given that diastolic blood pressure was significantly correlated with performance on the Digit Span forward task, an additional model that included diastolic instead of systolic blood pressure was estimated. Results indicated that after including the covariates, diastolic blood pressure was not a significant predictor.

Table 2. Regression results: systolic blood pressure predicting performance on cognitive measures

	Digit Span Forward		Digit Span Backward		Digit Symbol		Alpha Span		Immediate Recall		Delayed Recall		TICS	
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Step 1														
Systolic BP	−.01	.02	−.05^{+}	.02	−.09*	.02	−.06*	.02	−.06*	.02	−.05*	.02	−.07*	.02
Step 2														
Systolic BP	.06	.04	−.02	.02	−.05*	.02	−.03	.04	−.04^{+}	.02	−.03	.02	−.04*	.02
Age	−.02	.07	−.09	.07	−.35*	.05	−.26*	.06	−.13*	.06	−.20*	.07	−.12*	.05
Sex	2.52*	1.15	.87	1.11	2.28*	.85	1.93	1.03	.44	1.05	1.03	1.08	1.09	.86
Education	.69*	.16	.82*	.16	.92*	.13	.85*	.15	.70*	.14	.62*	.15	1.22*	.12
Income	.34*	.14	.28	.14	.47*	.11	.38*	.13	.61*	.13	.40*	.14	.59*	.11
BP Medication	−.34	.35	−.38	.35	.03	.26	.10	.31	.07	.32	−.24	.33	.33	.26

BP = blood pressure, TICS = telephone interview of cognitive status.

DISCUSSION

The findings presented here confirm our hypothesis that cognitive functioning and, more specifically, dimensions of memory are affected by blood pressure. These results replicate findings in European American samples. More specifically, measures that assess cognitive impairment appear to be most susceptible to blood pressure as a source of individual variability. While universal effects were observed in the form of associations between systolic blood pressure and the various forms of memory, relationships were not found for memory measures and diastolic blood pressure. Furthermore, working memory, an executive cognitive function, does not appear to be influenced by systolic blood pressure in our results.

Our results also show that speed of processing is disrupted with elevated systolic blood pressure. The relationship between blood pressure and processing speed is an important finding based on the importance of speed as a source of individual differences in older adults. Since blood pressure tends to increase with age[40] and speed of processing decreases,[41] we propose that there may be central age-related processes that change with age rather than two systems at work independently. Alternatively, elevated blood pressure over time may decrease speed of processing in later life.

These findings are perhaps even more important in the study of aging African Americans because of the higher rates of hypertension in this population.[18–20] The results of the present study suggest that, as in research on European Americans, increases in blood pressure correspond to lower performance on measures of cognitive functioning. Blood pressure may not only account for variability observed in individual performance but may also account for race differences between African Americans and European Americans in cognitive performance. A small but growing literature suggests that health is a primary source of variation accounting for racial differences observed in cognitive functioning.[24]

As noted earlier, there is a greater prevalence, severity, and earlier onset of hypertension in African Americans. The effects of the earlier onset are captured to some degree in this sample because it contains participants as young as 50 years of age. The initial damage that elevated blood pressure can cause on cognitive functioning has yet to be examined, but it is likely that among African Americans the effects will be observed at younger adult ages. Conceptual models such as terminal decline and cognitive reserve have not been studied in African Americans.[33] However, the high prevalence of cardiovascular health problems among African Americans makes it likely that cognitive decline can be described using these explanatory models if the relationship between risk factors, such as elevated blood pressure, and cognitive functioning exist over time.

The growing interest in understanding the factors that affect cognition in African Americans will likely result in more studies of risk factors for poor performance and explanations for differences between ethnic groups. A perplexing question is why the rates of cognitive dysfunction observed among older African Americans are not higher, given the relationship between blood pressure and cognition and the higher rates of premature mortality observed in this population. Perhaps, in addition to factors like higher rates of blood pressure, there are also protective factors at work, such as social support.[42] This could also be due to the lack of culturally appropriate measures that could be creating floor effects such that decline is lower than change observed in other groups because scores have nowhere to go.[24] These sorts of issues need to be tested empirically.

Limitations

A limited number of cognitive measures were included in the CAATSA study for use in this analysis. One possible explanation for the lack of a relationship between blood pressure and

memory is that the measures used to examine working memory were not of sufficient difficulty. Measures of greater difficulty might have produced the expected decline.

The cross-sectional design of the study also limited the ability to assess changes in blood pressure and cognition. An analogous issue was the lack of data on the impact of severity of initial blood pressure level. For example, one study found that participants with hypertension performed significantly worse on measures of verbal ability, visuospatial ability, and memory than did participants with either stage 1 or stage 2 hypertension. In contrast, participants with stage 3 hypertension performed worse on these measures than did any other group.[43] Since those with hypertension in the current study were medicated, the participant's initial hypertension stage before being diagnosed could not be assessed.

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