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Cognitive Function and Vascular Risk Factors Among Older African American Adults

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Abstract

To evaluate the association between vascular risk factors and cognitive impairment among older African American (AA) adults in a primary care clinic. Participants included 96 AA adults aged 60 years or older who were evaluated for global and domain-specific cognition. Participants were interviewed using the Computerized Assessment of Memory and Cognitive Impairment (CAMCI). The relationship between CAMCI cognitive domain scores and vascular risk factors were examined using hierarchical regression models. Patients who smoked, those with higher SBP/DBP values had lower accuracy rates on CAMCI cognitive domains (attention, executive, memory). Those with higher BMI had better attention scores. Patients with higher HbA1C values had worse verbal memory. Patients with higher blood pressure were significantly faster in responding to tasks in the executive domain. Primary care providers working with older AA adults with these VRFs could implement cognitive screening earlier into their practice to reduce barriers of seeking treatment.

Keywords

Cognitive impairment; Computerized assessment; Primary care; African American

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Compliance with Ethical Standards

Conflict of interest The authors declared that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study. IRB# 16156.

Introduction

Prevalence of dementia increases exponentially with increasing age [1]. Within the U.S., prevalence is higher among African Americans (AAs) compared to white non-Hispanics [2]. To further understand the progressive decline in cognitive function, examination has focused on vascular risks. Vascular risk factors (i.e., diabetes, hyperlipidemia, hypertension, smoking, heart disease, and obesity), which are more prevalent among older adults, appear to increase the risk of Alzheimer's Disease (AD) [3]. AAs experience higher risk of AD as well as a higher prevalence of vascular risk factors [4]. Furthermore, among medicare recipients, the risk of AD increases with increasing number of vascular risk factors [3].

Among older Americans, cardiovascular disease (CVD) has increased dramatically during the past two decades, with especially large increases in the AA population [5]; in addition, complications among AAs have increased, as well [5, 6]. The emerging relationship between these dementia and CVD raises particular concerns for the overall health of aging AAs.

More specifically, research has shown that diabetes [7], hyperlipidemia [8], hypertension [9], heart disease [10], smoking [11, 12], and obesity [13] are associated with higher risk of AD. Possible explanations for the relationship between CVD and AD include the coexistence of common disorders among older individuals, shared etiology of vascular factors and AD, and unclear definitions of AD [14]. However, the mechanisms linking vascular risk factors (VRFs) to AD remain unclear. While the relationship is likely complex, there are clear linkages between cerebrovascular disease and dementia [15].

Despite research on the relationship between VRFs and AD, there has been relatively little research focusing on that relationship among AAs, [16–18] although older African Americans and those with lower levels of education are known to have a higher prevalence of vascular risk factors [3] and risk of AD [4]. It is critical to understand this relationship in AAs since many VRFs are potentially modifiable, and prevention focused on these factors may reduce the risk of cognitive impairment and the course of the disease [19, 20]. Therefore, this study investigates the relationship between VRFs and cognitive impairment in older AAs.

Methods

Participants

Participants were AAs age 60 years or older, who were primary care patients from a mid-Atlantic University Medical Center clinic whose patients typically receive financial assistance. Recruitment employed multiple strategies: nurse/physician referral, posted flyers, and research assistant (RA) identification in waiting rooms. Potential participants were screened for reading eligibility, then informed consent was conducted and patients had the option to meet with the RA before or after their appointment. Total assessment time was less than 1 h.

Participants came to the clinic for reasons other than cognitive complaints. According to medical records, no participants had a prior dementia or mild cognitive impairment

diagnosis, although three participants' records mentioned subjective memory complaints, and these patients were excluded. Those with a lifetime history of schizophrenia, manic depressive disorder, or depressive disorder ($n = 3$) were also eliminated from the sample.

Data Collection and Measures

A total of 96 participants (37 men, 59 female) were included. Participants had an average of 10.2 years of education ($SD = 4.2$) and a mean age of 69 ($SD = 6.9$), with no significant differences between gender. The assessment took place in a private room in the primary care clinic. After reviewing the participant's history, a RA administered the Computer-based Assessment of Mild Cognitive Impairment (CAMCI) to assess cognitive functioning [21]. The CAMCI is a self-administered test, taking approximately 20 min that runs on a light-weight and portable tablet computer, presenting information visually and orally to assist low literacy participants [21]. The test includes a series of traditional tests, modified from pencil and paper format, to allow computer administration. One test requires participants to move through a virtual environment on a shopping trip, resembling an everyday experience. The CAMCI assesses seven domain-specific functions: attention, executive function, processing speed, verbal memory, non-verbal memory, functional memory, and incidental memory. Attention was assessed with a digit span forward task for accuracy; reaction time for attention was assessed with a simple reaction time task. Executive function was assessed with digit span reverse, Go/No Go and virtual environment "Choice Points" tasks for accuracy rates; executive function speed was also assessed with digit span reverse, and Go/No Go. Processing speed was assessed by reaction time in the Go/No Go, verbal recognition, and recurring pictures tasks. Accuracy for verbal memory was assessed with a word recall task. Reaction time for verbal memory was measured for the word recognition task. Reaction time for non-verbal memory was assessed using the recurring pictures task. Functional and incidental memory was assessed with participants' accuracy rates in the virtual environment tasks (i.e., grocery shopping, using an ATM bank teller, following directions), itemized recall and incidental recall, respectively. Participants' cognitive performance on the CAMCI was derived by averaging accuracy rates and reaction times for correct responses across tasks in the corresponding domains.

Demographic factors used as covariates included age, gender and education level. VRFs included body mass index (BMI), hypertension, diabetes mellitus, dyslipidemia, stroke and smoking. BMI (weight in kilograms divided by height in meters squared) >30 indicated obesity. Lab values of SBP/DBP and HbA1C (glycated hemoglobin A1C), most recent within the past year, were indicative of hypertension and diabetes mellitus. Dyslipidemia (high cholesterol value: $200+$ mg/dL) was confirmed using medical chart reviews. Stroke was defined using the ICD 9 (International Classification of Diseases 9th Revision) code for stroke including ischemic or hemorrhagic stroke. Smokers were categorized as current smokers (currently smoking/quit fewer than 10 years ago), or former smokers (quit more than 10 years ago). These parameters were selected because after more than 10–15 years of smoking cessation, risk of coronary heart disease is reportedly similar to individuals who have never smoked [22].

Statistical Analysis

Categorical variables were represented as frequencies and percentages. Continuous variables were represented as mean $\pm$ SD. Three of the VRFs (dyslipidemia, stroke, and smoke) were treated as dichotomous variables, indicating presence or absence of the risk factor. The remaining VRFs (obesity, hypertension, and diabetes mellitus) reported continuous lab values.

Cognitive functioning, as measured by the CAMCI, was analyzed for attention, executive function, processing speed, verbal memory, nonverbal memory, functional memory, and incidental memory. Patients' reaction time and accuracy rates on the relevant tasks indicate cognitive functioning in the corresponding domains. Reaction times of participants' correct responses are available for the attention domain, executive functioning, processing speed, verbal memory, and nonverbal memory tasks. For domains consisting of more than one task, the corresponding reaction time was averaged across the relevant tasks. For ease of interpretation, patients' average speed (in milliseconds) was computed as the reciprocal of reaction time, where higher values represent faster speed (i.e. shorter reaction time). Accuracy rates are available for the attention domain, executive functioning, verbal memory, functional memory, and incidental memory tasks. Accuracy rates are the percentage of correct responses for the corresponding tasks; higher accuracy rates indicate more correct responses. For domains that consist of more than one task, accuracy rates were averaged across the relevant tasks.

First, the relationship between patients' demographic characteristics and VRFs was examined. Continuous variables were compared using linear regression models, and categorical variables were compared using χ^2 tests. Next, we examined the associations between VRFs and cognitive functioning (CAMCI domains) in linear regression models, controlling for patients' demographic characteristics (age, gender, and education level). Analyses were performed using R version 3.1.1 [23]. Statistical significance was set at $p < 0.05$. The study was approved by the University Institutional Review Board (IRB-HSR# 16156).

Results

Descriptive Statistics

Descriptive statistics of VRFs are in Table 1. Most participants in this study meet the classification of obesity (BMI >30) (GHO, 2015). Of the 96 participants, 19 have hyperlipidemia, 13 have history of stroke, and six are current smokers. Bivariate comparisons showed that patients' age, gender, and education level were not associated with BMI, diabetes mellitus, dyslipidemia, or smoking. Older participants have higher SBP/DBP lab values ($p = 0.008$) and are more likely to have histories of stroke ($p = 0.010$).

CAMCI and Demographic Characteristics

Overall, higher education levels were associated with higher accuracy rates and faster reaction times both p 's < 0.0001 . For the domain-specific CAMCI tasks, older patients showed slower reaction time in attention, non-verbal memory tasks, and overall processing

speed (p 's = 0.036, 0.019, and 0.003, respectively), and were less accurate on tasks related to incidental memory (p = 0.016). On verbal memory tasks, women had faster reaction times (p = 0.018) and higher accuracy rates (p = 0.012) than men. Patients with higher education level showed faster reaction times on processing speed, verbal, and non-verbal memory related tasks (p 's = 0.026, 0.018, 0.020, respectively). In addition, they showed higher accuracy rates on attention, executive functioning, verbal, and functional memory tasks (p 's = 0.010, 0.001, 0.006, 0.006, respectively).

CAMCI Domains

Attention Domain—After controlling for demographic characteristics, current smokers had statistically significantly lower accuracy rates than former smokers (p = 0.018). The following trends, though not statistically significant, may have clinical significance. Patients with high BMI rates had higher accuracy rates (p = 0.065), whereas patients with high hypertension and those with a history of stroke had lower accuracy (p 's = 0.055 and 0.056, respectively).

Executive Domain—VRFs were not statistically significantly associated with accuracy scores.

Verbal Memory Domain—Patients with higher HbA1c values showed lower accuracy rates in verbal memory than those with lower HbA1c values (p = 0.081), albeit not statistically significant. No VRFs were associated with functional or incidental memory (Table 2).

Reaction times (speed) for patients' correct responses were also measured in each domain. Patients' speed was not associated with any VRFs in the attention, processing speed, or non-verbal memory domains (Table 3). However, in the Executive domain, patients with higher SBP/DBP values had faster reaction times than those with lower SBP/DBP values (p = 0.009).

Discussion

This study evaluated the association between VRFs and cognitive function in older AAs using the CAMCI. Demographic risk factors for dementia found in non-AAs (2, 7), such as age and education, were also present in this sample of older AAs. As participants got older in this study they had poorer cognitive performance, as evident with slower reaction times and slower accuracy rates. Such results are not surprising, considering that age is a well-known risk factor for dementia [24] and among non-dementia patients. AA adults with higher levels of education performed better on cognitive assessments, with higher accuracy rates and faster reaction times, than those with lower levels of education. This finding is consistent with the overwhelming evidence that increased level of education (in terms of years of education or level of literacy) is associated with lower risk for dementia [25]. Our current findings support age and years of education being associated with risk of dementia among older AAs, a group not previously well studied [26].

Apart from age and education, gender has been established as a risk factor for dementia. However, whether the risk for women or men at a certain age remains unclear [27, 28]. Women in this study demonstrated better cognitive performance than men in verbal memory tasks; women were faster and more accurate when responding to tasks assessing verbal memory, even after adjusting for participants' age and education level. Such gender differences in cognitive performance were not observed in other CAMCI domains. This suggests that decline in cognitive functioning may vary among different cognitive domains for older men and women. At a given age, men and women with similar education may have similar risks to develop dementia, but vary in their risks of decline in a specific cognitive domain (e.g., verbal memory). Future studies should explore whether older men and women show differential decline in performance across varying cognitive domains.

After adjusting for patients' demographic risk factors, a number of VRFs were found to be associated with impaired cognitive functioning. Given the limited sample size in our study, we included trends of findings that are not statistically significant as these results may be important to understanding the association between VRFs and cognitive decline among older AAs. Current smokers had poorer cognition than former/non-smokers among our AA participants. This finding corroborates existing evidence that current smokers have higher risk of cognitive decline and dementia [29, 30], suggesting that the relationship may be generalized to older AAs as well. Compared with other VRFs, smoking may be the most modifiable risk factor of later-life dementia. For AAs, quitting smoking may effectively reduce the risk of cognitive decline and AD.

Hypertension was associated with performance in executive functioning and attention tasks. Participants with higher blood pressure had faster responses to executive functioning tasks, but were less accurate in attention tasks. It appears that different domains of cognitive functioning may be differentially influenced by hypertension. These mixed findings add to the inconsistent relationships between mid-to-later-life hypertension and cognitive decline [31]. While a consistent relation has sometimes been reported between high blood pressure and cognitive decline [32, 33], other studies suggest that later-life hypertension may protect against cognitive decline [34]. We speculate that the link between hypertension and risk of cognitive decline may change with age, and urge researchers to design longitudinal studies to explore whether the association changes over time.

Older AAs with higher BMI were more accurate in attention-related tasks than those with lower BMI. This appears to contradict the widely accepted hypothesis that obesity is associated with cognitive decline in later life; our findings raise questions of consistency in the relation between obesity and cognitive functioning among older individuals of different race/ethnicity. Since performance in other cognitive tasks did not differ by BMI, it's possible that mid- and late-life obesity may affect different aspects of cognitive functioning. The association between risk of dementia and obesity, like hypertension, may vary with age [35]. In light of a recent controversial finding that underweight individuals have higher risk for dementia [36], it is likely that the link between mid- to late-life obesity and cognitive decline may be complex, and further studies are warranted to explicate this association among different race/ethnic groups.

Other VRFs associated with poorer cognitive functioning among this sample of older AAs include stroke and diabetes. Patients with a history of stroke were less accurate in attention-related tasks, and those with elevated HbA1c had worse cognition related to verbal memory tasks. There exists strong evidence relating individuals with diabetes and/or history of stroke to an increase risk of cognitive impairment and dementia [37, 38]. Our results add to the strength of the association, finding similar associations among elderly AAs. With longitudinal studies, it is possible to examine the extent to which these VRFs contribute to decline in cognitive function/dementia over time among AAs.

In general, the clinical relationships between VRFs and cognitive impairment in AAs were complex. The associations between certain VRFs and risk of cognitive decline and dementia appeared to change with age, consistent with other findings [34, 36]. The mixed findings in our study suggested that the relations between VRFs and cognitive impairment among older AAs vary across different cognitive domains. VRFs were associated with patients' performance in attention, executive functioning, and verbal memory, but not with processing speed, nonverbal memory, or incidental memory. It is possible that certain tasks are more sensitive to cognitive decline than others, thus reflecting the link between VRFs and cognitive impairment among participants. Given that functional memory tasks are closely related to individuals' daily lives, one could suggest that different tasks assess different cognitive abilities and underlying neurocognitive systems that may be differentially affected by VRFs. Moreover, because some tasks may be less closely related to everyday lives, the effect of VRFs on cognitive impairment may be more attuned.

Even finding that patients with higher blood pressure were faster in their correct responses to tasks assessing executive function, we are hesitant to draw a conclusion for two reasons. First, reaction time is only available for participants' correct responses. Without information about participants' reaction time for all responses, we cannot determine whether this suggests high blood pressure is associated with faster correct responses or faster responses in general. Second, unlike traditional paper-and-pen neuropsychological tests, the CAMCI is computer-administered. Since the majority of our participants demonstrate financial need, it is unclear whether participants' reaction time might be due to unfamiliarity with tablet computers. Additionally, since poor people typically have less access to medical care, this, not race, may be responsible for increased risk factors.

Several limitations should be noted. First, this is a small cross-sectional study in which the assessment of cognitive impairment. However, it was based on a computer-based neuropsychological evaluation that improves accessibility in primary care. Additional cognitive tests providing diagnoses might have clarified the cognitive impairment; although the design necessitated the use of rapid portable measures. Longitudinal studies with a larger number of participants would be desirable to confirm the results of this study. Since only current information of VRFs were available for the present study, it is unclear whether participants' cognitive functioning was affected by the time of onset and changes in treatment of VRFs.

Second, although we collected data on whether participants were on medication for their hypertension, we did not distinguish the type or impact of those medications (e.g., the use of

statins, ACE-inhibitors, etc.), which could limit our findings. There have been many studies showing a relationship with hypertension and cognition. Johnson and colleagues [39] found that subjects with treated but uncontrolled hypertension had significantly lower MMSE scores than those without hypertension or from those with controlled hypertension. Cognitive impairment was also significantly associated with uncontrolled blood pressure and poor treatment compliance [40]. Both of these studies showed that cognitive impairment was associated with uncontrolled hypertension. In our study, almost all subjects (90%) had hypertension or uncontrolled hypertension, thus we chose to use the current blood pressure level, which is a limitation. Further research should be conducted to better understand the impact and influence of medications. Despite these limitations, the study provides strong support that early cognitive screening is imperative among older African American adults with vascular risk factors.

In conclusion, this study explored the relationship between common VRFs and cognitive function in older AAs. Because the maintenance of good cognitive function significantly influences quality of life in the elderly, understanding the influence of VRFs may help develop more comprehensive preventive strategies to prevent or reduce cognitive impairment in older AAs. The high prevalence of VRFs among AAs is consistent with existing studies, although examining cognition in conjunction with these VRFs in a primary care setting is unique. Among study participants, smoking, high blood pressure, BMI, diabetes, and history of stroke are associated with cognitive functioning. As most of these can be modified by individual lifestyle or medical intervention, this highlights the need for providers to be cognizant of the risk factors, and to implement interventions to reduce them. We also urge longitudinal research studies to examine the impact of VRFs on cognitive decline and dementia, as well as the effectiveness of interventions to address modifiable risk factors among older AAs.

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Table 1

Characteristics of vascular risk factors among participants

	Men ^a	Women ^b	Total ^c
BMI	30.8 (<i>SD</i> = 7.34)	34.1 (<i>SD</i> = 11.5)	32.9 (<i>SD</i> = 10.1)
SBP/DBP	1.91 (<i>SD</i> = 0.27)	1.90 (<i>SD</i> = 0.27)	1.91 (<i>SD</i> = 0.27)
Diabetes	6.59 (<i>SD</i> = 1.16)	6.93 (<i>SD</i> = 1.35)	6.8 (<i>SD</i> = 1.28)
	Presence		Absence
Hyperlipidemia	19 (21.6%)		69 (78.4%)
Stroke	13 (13.5%)		85 (86.5%)
Smoking	6 (6.3%)		90 (93.8%)

No significant difference in demographic age, gender, and education between patients with or without specific vascular risk factors, with the exception that older patients are likely to have higher sbp/dbp lab values ($p = 0.008$), and patients at risk for stroke are likely to be older than those not at risk for stroke ($p = 0.010$). *BMI* body mass index, computed by dividing weight in kilograms by height in meters squared. A BMI below 18.5 (shown in white) is considered underweight. A BMI of 18.5–24.9 (green) is considered healthy. A BMI of 25–29.9 (yellow) is considered overweight. A BMI of 30 or higher (red) is considered obese. *SBP/DBP* systolic blood pressure/diastolic blood pressure. Diabetes is represented by the Glycated hemoglobin A1c level (HbA1c). Hyperlipidemia: patients with lab cholesterol values 200 mg/dL or above. Stroke: ICD9. Smoking: smokers were those who were currently smoking and/or had quit for less than 10 years; non-smokers were those who had never smoked and/or had quit for at least 10 years

^a
n = 37

^b
n = 59

^c
n = 96

Table 2

Summary of regression models estimating accuracy rates of CAMCI domains

	Attention			Executive			Verbal memory			Functional memory			Incidental memory		
	β	<i>t</i>		β	<i>t</i>		β	<i>t</i>		B	<i>t</i>		β	<i>t</i>	
BMI	0.634	1.88		0.225	0.80		-0.378	-0.89		-0.001	0.00		-0.141	-0.43	
Hypertension	-21.727	-1.96		7.299	0.79		9.358	0.67		5.696	0.45		-8.390	-0.78	
Smoke	-25.293	-2.44*		2.440	0.28		-3.647	-0.28		13.094	1.10		-2.238	-0.22	
Diabetes	-1.922	-0.94		-1.937	-1.14		-4.566	-1.78		-0.584	-0.25		1.523	0.77	
Hyperlipidemia	6.778	1.05		0.232	0.04		1.426	0.17		5.249	0.71		4.307	0.69	
Stroke	-14.526	-1.95		-3.305	-0.53		15.549	1.65		-4.928	-0.58		5.706	0.79	

* $p < 0.05$. All models controlled for patients' age, gender, and education level

Table 3

Summary of regression models estimating reaction time of CAMCI domains

	Attention		Executive		Processing speed		Verbal memory		Nonverbal memory	
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
BMI	0.006	0.85	-0.001	-1.00	-0.001	-0.68	-0.0003	-0.19	-0.001	-0.48
Hypertension	-0.224	-1.00	0.125	2.68*	0.079	1.61	0.024	0.48	0.041	0.53
Smoke	0.055	0.27	0.025	0.58	-0.033	-0.71	-0.008	-0.16	-0.040	-0.54
Diabetes	-0.028	-0.63	-0.009	-1.03	-0.01	-1.14	-0.012	-1.25	-0.008	-0.53
Hyperlipidemia	0.015	0.12	-0.008	-0.30	0.010	0.34	0.050	1.70	-0.016	-0.36
Stroke	-0.124	-0.83	-0.002	-0.05	-0.028	-0.85	-0.007	-0.20	0.009	0.17

* $p < 0.01$