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Influence of medical conditions on executive and memory functions in low socioeconomic status African Americans

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Abstract

We examined the association of total comorbid score and specific chronic conditions including cardiovascular diseases, musculoskeletal conditions, diabetes mellitus, stroke, hypertension, and cancer with several cognitive domains across four different age groups: young adults (ages 18–34), young middle-aged adults (ages 35–50), middle-aged adults (ages 51–64), and older adults (ages >64). Cognitive tests measuring global ability, executive function, memory function, and perceptual speed ability were administered to 384 African Americans. Total comorbid score was computed by summing up the number of chronic conditions. Results showed an inverse association between total comorbid scores and executive and memory functions in the total sample. With the exception of the youngest group, stroke was the only prominent predictor of poor performance for all age groups, but the impact was greater in the younger age groups compared with older adults. These results suggest that the impact of medical conditions on domain specific tasks may be modified by age.

Keywords: African Americans; Comorbidity; Chronic disease; Cognitive function

1. Introduction

Medical conditions including chronic cardiovascular, respiratory, and metabolic diseases that impair cognition have been the subject of increased clinical research (Larson, 1993). The precise contribution of vascular factors and other medical conditions to cognitive decline and dementia is unclear. In addition, the exact mechanisms of action are difficult to identify as coexisting conditions become more prevalent with increasing age (Backman, Jones, Small, Aguero-Torres, & Fratiglioni, 2003). The presence of physical comorbidity also raises problems in diagnosis, but studies have suggested that risk of cognitive impairment may decrease as these conditions may be preventable and treatable (Solfrizzi et al., 1999; Solfrizzi, Panza, & Capurso, 2003). For instance, a clinical trial study by Forette et al. (2002) found a decrease of 50% incident cases of both vascular dementia and Alzheimer's disease (AD) with treatment of systolic hypertension.

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The association between comorbid conditions and cognitive functioning has been the focus of several studies (Blaum, Ofstedal, & Liang, 2002; Haan & Weldon, 1996; Luchsinger et al., 2005). In a nationally representative study of chronic diseases and cognitive performance, Blaum et al. (2002) showed that poor cognitive performance was associated with the presence of multiple comorbid conditions including cardiovascular diseases, musculoskeletal conditions, and cancer. In a study of the impact of comorbid stroke, diabetes mellitus, and hypertension on cognitive function, Haan and Weldon (1996) found that individuals with diabetes and stroke had poorer cognitive functioning. Luchsinger et al. (2005) studied the association of vascular risk factors with AD and found that the risk of AD increased with increasing number of conditions. Further, diabetes, hypertension, and heart disease increased the risk of AD when analyzed separately, but only diabetes was significant if all conditions were analyzed in the same model.

Although chronic conditions are considered important determinants of age-associated cognitive impairment and decline, little is known about the association of comorbid conditions and cognitive performance in African American adults, despite greater prevalence of impairment among African Americans than non-Hispanic whites. For instance, incidence of dementia has been reported as 22% for African Americans compared with 13% for whites (Lopez et al., 2003). In studies of African Americans and whites matched on socio-demographic factors and other variables including age at onset and AD symptom duration, African Americans had higher rates of poor cognitive outcome than whites (Manly et al., 1998; Shadlen, Larson, Gibbons, McCormick, & Teri, 1999). Among the few studies examining medical comorbidity and cognitive impairment, Shadlen et al. (1999) and Zamrini et al. (2004) reported that African Americans with AD had higher rates of hypertension than white patients with AD. However, white patients with AD had higher rates of atrial fibrillation, cancer, coronary artery disease, and gastrointestinal disease (Zamrini et al., 2004). Gorelick et al. (1994) compared risk factors for AD and vascular dementia (VaD) in African Americans and found that hypertension, diabetes mellitus, and atrial fibrillation were more prevalent among VaD patients. For other conditions including cancer, hip fracture, arthritis, bronchitis, liver disease, hip fracture, gastric ulcer, and head injury, hip fracture was more prevalent among AD than VaD patients.

To our knowledge, no studies to date have evaluated whether the relationship between medical conditions and cognitive performance is the same across different age groups in African Americans. Previous studies have suggested that with increasing age the influence of chronic diseases, specifically vascular risk, on cognitive performance may change (Launer et al., 2000; Piguet et al., 2003). Noteworthy, it has been reported that African Americans develop hypertension earlier than non-Hispanic whites (American Heart Association, 2000), and that hypertension and diabetes mellitus that develop during mid-life are reported as most important cardiovascular risk factors for AD in the general population (Breteler, 2000; Launer et al., 2000; Peila, Rodriguez, & Launer, 2002).

We examined the impact of chronic conditions including cardiovascular conditions, musculoskeletal conditions, diabetes mellitus, stroke, hypertension, and cancer on cognitive performance among nondemented African Americans with low socioeconomic status (SES). While the burden of comorbidities upon the likelihood of poor performance should not depend on race, dementia among minorities, particularly among African Americans, may be highly associated with socioeconomic status and higher comorbid illness (Gurland et al., 1999; Heyman et al., 1991). Hence, we hypothesized that medical conditions would be associated with poor cognitive function, as early as middle age, and argued that hypertension, diabetes mellitus, and stroke are independent risk factors for poor performance. We studied the association of comorbid disease and specific chronic conditions with several cognitive domains including global ability, executive function, memory function, and perceptual speed ability. More specifically, we focused on two domains (executive and memory functions) because existing evidence suggested that they overlap substantially, particularly poor executive functioning which is related to greater deficits in verbal and visual memory function (Cunningham, Pliskin, Cassisi, Tsang, & Rao, 1997; Vanderploeg, Schinka, & Retzlaff, 1994). We also examined these associations across four different age groups because of the large effect of age on cognitive function.

2. Methods

2.1. Participants

Participants were from the Healthy Aging in Nationally Diverse Longitudinal Samples study (HANDLS), a cross-sectional pilot study consisting of 442 community-living African American subjects, from Baltimore, Maryland. The study used a sample of convenience to evaluate the feasibility of using mobile medical research vehicles as field-based research platforms, tested recruitment and retention techniques, assessed the various research instruments, and focused on several scientific and clinical domains among participants with diverse socioeconomic backgrounds. Participants were recruited between 2000 and 2001. This study was approved by the institutional review board at the National Institutes of Health, and all participants gave informed consent. The study included a significant percentage of low SES participants, with 80% having a mean total household income of $20 k or less, and the mean education of the total sample was 12 years.

Of the total sample, 12 participants were excluded from the analyses due to missing data on several cognitive tests or medical conditions. We also excluded another 46 participants because they had evidence of dementia, illiteracy, and physical and sensory impairment including hearing and vision. Those excluded were not significantly different in terms of age, education level, and depressive symptoms compared to those who were included in the analyses. Thus, the final sample consisted of 384 subjects with complete data on both cognitive tests and medical conditions. The mean educational level for the final sample was 12.46 ± 2.7, with 84% having a mean total household income of $23 k or less, and the group was predominately women (58%). To examine the influence of age differences in the association of cognitive function and medical condition, participants were categorized into four birth cohorts: young adults (ages 18–34, $n = 61$), young middle-aged adults (ages 35–50, $n = 183$), middle-aged adults (ages 51–64, $n = 75$), and older adults (ages >64, $n = 65$).

2.2. Neuropsychological tests

In order to demonstrate the effect of medical comorbidity on various cognitive abilities, we selected nine neuropsychological tests to represent cognitive domains of interest: global ability, executive function, memory function, and perceptual speed ability. We selected more than one task to fully represent the executive and memory domains, but given the logistical aspects and practicality of the study, the global ability and perceptual speed domains involved only one target test. Therefore, in choosing tests for the domains, particularly for global ability and perceptual speed domains, consideration was given to tests that are relatively robust and are widely used in the general population. Tests selected were also based upon prior evidence indicating that they distinguish typical changes in performance associated with aging from changes in performance which may be associated with disease when combined with neurological and neuropsychological outcomes and clinical diagnoses of AD (Kawas, Gray, Brookmeyer, Fozard, & Zonderman, 2000; National Institute on Aging, 2007). The tests were administered to participants by a highly trained research staff.

2.2.1. Global ability

The Mini Mental State Examination (MMSE) assesses global cognitive ability (Folstein, Folstein, & McHugh, 1975) and is among the most frequently used cognitive screening measures in studies of older adults. This test involves standardized questions that measure a range of cognitive abilities, including orientation for place and time, memory and attention, language skills, and visuospatial abilities. The participant gets one point for each correct response. The maximum total score on the MMSE is 30.

2.2.2. Executive function

Though there are various components of executive functions such as initiation, perseveration, disinhibition, adaptation, goal-directed tasks, abstraction, fluency, and reasoning, and planning (Stern & Prohaska, 1996), we used short-term memory and working memory, verbal fluency, and auditory attention to measure the components of executive functioning. The Digit Span Forward and Digit Span Backward tests from the Wechsler Memory Scale-III (Wechsler, 1981) were used to access short-term memory and working memory (Baddeley, 1992). In Digit Span, the examiner reads a series of numbers. After the full series was read, the participant repeated them in the order in which they were given (Forward) or repeated them in the reverse order of presentation (Backward). Each level (i.e., number of digits) has two trials with different series of numbers. If the participant fails both trials at a given level, the test is discontinued. The participant receives one point for each trail he/she passes. The maximum score on each subtask (Digit Forward and Digit Backward) is 14 (two trials for each of seven levels). Verbal fluency was assessed by asking the participants to name as many animals as they could think of in 60 s (Newcombe, 1969). One point is awarded for every correct response. The Brief Attention Test measures auditory divided attention. This measure requires the examiner to read a list of letters and numbers, and the participant must keep track of how many numbers are read (Schretlen, 1997). The participant's score is the total number correct.

2.2.3. *Memory function*

Three types of memory function including visual, verbal, and everyday memory were assessed. Visual memory was measured using the Benton Visual Retention Test (Benton). Participants were presented with card depicting of one or more geometric designs. The card was exposed for 10 s. Immediately after its removal, participants attempted to reproduce the designs from memory on a blank sheet of paper (Sivan, 1992). Using standard criteria, two examiners independently scored the participant's drawings for accuracy and the total number of errors was used for analyses. The California Verbal Learning Test (CVLT) (Delis, Kramer, Kaplan, & Ober, 1987) was used to measure verbal memory. In CVLT, a list of 16 semantically related shopping items was verbally presented for three trials. An additional 16-item shopping list was administered once after the third learning trial to assess interference effects. Free and cued recall was assessed immediately after presentation of the interference list as well as after a 15–20-min delay. The total number of correct across all learning trials was used for analyses. Prospective (everyday) memory, adapted from the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1991), was used to assess incidental memory and simulate everyday memory situations in which the individuals must recall items and tasks. Two points were awarded for each spontaneous correct response and one point for correct responses following a prompt.

2.2.4. *Perceptual speed ability*

The Identical Picture Test measures the ability to find figures, make comparisons, and carry out simple tasks involving visual perception with speed and accuracy (Ekstrom, French, Harman, & Dermen, 1976). Participants were asked to select (from five possible responses) the picture that was identical to a target. The participant's score was calculated as the number of items marked correctly minus the number marked incorrectly divided by 4.

In this study, executive function comprises the Digit Span, verbal fluency, and the Brief Attention tests. Memory function includes the Benton, CVLT, and prospective everyday memory tests. To give each test equal weight, the raw ability score of each test was transformed and standardized into z-scores (z-score = (participant's score − mean test score)/standard deviation of test), which then were averaged to produce composite scores of each domain.

2.3. *Medical information*

Data regarding medical conditions were based on a self-report medical history questionnaire administered by a nurse practitioner, supplemented by a standardized review of systems questionnaire performed by HANDLS physicians. Disease variables were derived using diagnostic information from the International Classification of Diseases, Ninth Revision (ICD-9). Because the way in which medical conditions were categorized could influence results, we chose to follow Blaum et al.'s (2002) grouping of conditions to be consistent with previous studies that have examined medical comorbidity and cognitive impairment. We combined myocardial infarction, congestive heart failure, and chronic obstructive pulmonary diseases into the cardiovascular (CVD) group. Hip fracture, back problems, and arthritis formed the musculoskeletal group. We studied hypertension, diabetes, and stroke as separate indicators to be consistent with Blaum et al. but also to evaluate the hypothesis that these conditions would be independent risk factors for poor performance. Cancer was also considered separately. In addition, we computed a total comorbid disease score by summing up the number of chronic conditions and used that as a total risk score in the analysis.

2.4. *Covariates*

In addition to socio-demographic characteristics including age, gender, and education level, participants were also assessed for the presence of self-reported depressive symptoms using the Center for Epidemiological Studies Depression (CES-D) scale (Radloff, 1977). Although the contribution of these variables has varied in different studies, they were adjusted in all of our models due to their well-known association with cognitive functioning (Johnson & Wolinsky, 1994; Mehta et al., 2003).

2.5. *Statistical analysis*

Multiple linear regression models, adjusted for demographic variables and depressive symptoms, were used to examine the association of chronic conditions and cognitive performance. Four regression models were performed with each of the cognitive domain as the continuous dependent variable and total comorbid score as the independent variable. All models were adjusted for age, gender, education level, and depressive symptoms. Subsequent regression models were also performed to determine which medical conditions (i.e., CVD, musculoskeletal, diabetes mellitus, stroke, hypertension, and cancer) contributed the most to the primary effects seen within each age group.

3. Results

Table 1 presents selected sample characteristics, mean cognitive test scores, and the distribution of participants according to medical conditions for the entire final sample. The mean age of the sample was 48.85 (S.D. = 14.45). The average number of medical conditions was 0.62, 1.18, 2.08 and 2.52 from youngest to oldest. Overall, the oldest group reported highest prevalent CVD conditions (32.31%), musculoskeletal conditions (66.67%), and hypertension (77.78%), followed by middle-aged, young middle-aged, and young adult groups. However, a higher proportion of the middle-aged groups reported having stroke (12.50%) and diabetes (23.61%) compared with other age groups. Table 2 shows that poor cognitive performance was associated with increasing age, less education, and a higher level of depressive symptoms. Total comorbid score showed a significant statistical relationship with only executive function and memory function, adjusting for age, education, gender, and depressive symptoms. Participants with greater total comorbid score were more likely to have poorer executive and memory function performance. There were no significant

Table 1
Selected characteristics, cognitive test scores, and the distribution of participants according to medical conditions

	Mean ± S.D. ($n = 384$)
CES-D	16.15 ± 11.06
Global ability (0–30)	26.71 ± 2.53
Executive function	
Digit forward (0–12)	6.57 ± 2.16
Digit backward (0–12)	5.02 ± 2.07
Verbal fluency (5–36)	16.09 ± 5.00
Brief attention (1–10)	6.20 ± 2.12
Memory function	
Benton (0–26)	16.91 ± 5.22
CVLT (0–43)	22.57 ± 7.17
Prospective everyday memory (0–6)	4.57 ± 1.32
Perceptual speed ability (1–46)	21.25 ± 7.15
Medical conditions (%)	
Cardiovascular conditions	25.78
Musculoskeletal conditions	36.03
Stroke	4.19
Diabetes mellitus	11.45
Hypertension	37.15
Cancer	2.79
Total comorbid score (mean ± S.D.)	1.22 ± 1.22

Table 2
Multiple regression analyses of predictors on domain-specific cognitive performance

	Global ability	Executive function	Memory function	Perceptual speed ability
Sex	−0.19*	0.12	−0.03	−0.05
Age (years)	−0.03*	−0.01*	−0.03*	−0.04*
Education (years)	0.07*	0.06*	0.05*	0.07*
Depressive symptoms	−0.01*	−0.01*	0.01*	−0.01*
Total comorbid score	−0.04	−0.06*	−0.09*	−0.01

* $p < .05$.

Table 3
Regression coefficients between medical conditions and cognitive domains by age group

	Global ability	Executive function	Memory function	Perceptual speed ability
Aged <35				
CVD conditions	0.04	−0.21	0.09	−0.24
Musculoskeletal conditions	0.01	0.92*	0.31	0.22
Stroke	–	–	–	–
Diabetes mellitus	0.04	0.32	0.05	−0.54
Hypertension	−0.22	−0.02	0.12	−0.25
Cancer	–	–	–	–
Aged 35–50				
CVD conditions	0.23	0.01	−0.03	0.20
Musculoskeletal conditions	−0.04	0.12	0.21	0.13
Stroke	−2.09**	−1.84**	−1.62*	−1.87*
Diabetes mellitus	−0.05	−0.08	0.06	−0.24
Hypertension	0.10	0.01	0.09	−0.42**
Cancer	0.31	0.16	0.59	−0.30
Aged 51–64				
CVD conditions	−0.09	0.02	0.14	0.08
Musculoskeletal conditions	−0.20	0.19	−0.02	0.14
Stroke	−0.81*	−0.41*	−0.50*	−0.37
Diabetes mellitus	0.12	−0.05	0.19	−0.21
Hypertension	0.05	0.07	0.07	0.27
Cancer	0.27	0.46	0.01	0.45
Aged >64				
CVD conditions	−0.05	−0.06	0.08	−0.21
Musculoskeletal conditions	−0.21	0.31	0.21	0.35
Stroke	0.41	−0.63*	−0.04	−0.13
Diabetes mellitus	0.12	−0.26	0.03	−0.28
Hypertension	−0.10	0.14	0.03	0.17
Cancer	−0.12	0.45	0.15	0.11

(−) Not included in analysis due to low prevalence rate. Coefficients are adjusted for gender, education level, and depressive symptoms.
* $p < .05$.
** $p < .01$.

associations between total comorbid score and global and perceptual speed abilities. The age × total comorbid score interaction term was added to the analysis, but the effect was not statistical significant.

We next investigated patterns of association within each age group, and how those patterns differ across age groups. As such, cardiovascular group, musculoskeletal conditions, diabetes mellitus, stroke, hypertension, and cancer were examined as multivariate variables for each age group. These models were adjusted for education, gender, and depressive symptoms. Table 3 shows the performance of medical condition groups on cognitive domains across age groups. Our main hypothesis was that hypertension, diabetes mellitus, and stroke would be independent risk factors for poor performance. However, with the exception of the youngest group, stroke was the only prominent predictor of poor performance for all age groups. For both middle age groups, participants with prevalent stroke performed worse on global ability, executive and memory tasks. Older participants with a history of stroke also performed significantly worse on executive tasks, but no statistically significant differences were observed between stroke and other tasks. In general, the presence of CVD conditions, diabetes mellitus, hypertension, musculoskeletal conditions, or cancer was not statistically significant with cognitive performance.

4. Discussion

This study examined the effect of medical conditions on cognitive performance among African Americans with low socioeconomic status. Our findings are in agreement with previous research in the general population showing that the greatest risk seems to be among individuals with multiple illnesses, and that poor cognitive performance is possibly symptomatic of a range of comorbid conditions (Meyer, Xu, Thornby, Chowdhury, & Quach, 2002).

We found an association between total comorbid score and executive and memory functions, and these findings are compatible with other studies. Previous research has found that individuals with poor executive functioning also exhibit greater deficits in verbal and visual memory function (Cunningham et al., 1997; Vanderploeg et al., 1994). Duff et al. (2005) investigated the association between verbal/visual memory and executive functioning, and found the two domains overlapped substantially. The direction of influence is still a matter of debate, but there is more theoretical support at this time regarding the influence of executive abilities on memory performance as opposed to the alternative hypothesis of memory abilities influencing executive functioning (Duff et al., 2005). In fact, there appears to be more data supporting the view of frontal lobes as a central system that affects the hippocampal memory processes, particularly the effects of frontal brain damage on memory deficits including both short-term and long-term memory (Baddeley, 1990; Schacter, Curran, Galluccio, Milberg, & Bates, 1996; Stuss et al., 1994). Though we were not able to assess the direct causal associations between executive and memory functions, we did examine the relation between executive and memory functioning. In a supplementary multivariate analysis adjusting for demographic variables, depressive symptoms, and total comorbid score, we found that poor executive functioning was associated with poor memory performance ($p < .001$). Hence, our findings of an association between these two domains are consistent with previous data, suggesting deficits on executive functioning are also associated with impaired memory abilities.

With the exception of musculoskeletal conditions, we found the presence of individual chronic conditions had no statistically significant effect on cognitive performance in the youngest group. Because these medical conditions are a chronic process that has a long natural history, it is likely that the duration of each chronic condition was too short in this group to observe overt poor cognitive performance. The relations between stroke and global ability, executive and memory functions were found in both middle-aged groups. Though very few studies have included middle-aged adults, the pattern of poor cognitive performance among middle-aged participants with strokes in this study is in line with Seshadri et al. (2004) who found mid-life stroke as a risk factor of lower cognitive function. However, the relations found in our study appear to occur at an earlier age than the mean age reported in Seshadri et al. study. Our young middle-aged group had a mean age of 43.2 years (S.D. = 4.24) compared to the average age of 54 years (S.D. = 9) reported in Seshadri et al. study. Although previous studies mainly focused on elderly participants, our study is perhaps the first to single out which of the conditions was influencing lower cognitive performance in lower SES middle-aged African Americans, and stroke was prominently responsible. These results have important implications for the epidemiology of cognitive impairments in mid-life as previous studies have shown the association of stroke with both vascular dementia and Alzheimer's disease, in addition to a causal relation between stroke during mid-life and later-life dementia (Desmond, Moroney, Sano, & Stern, 2002; Kivipelto et al., 2001). Hence, our findings further provide a rationale for the identification and subsequent management of individuals with stroke risk factors.

Significant associations were found between prevalent stroke and executive functioning in the oldest group, suggesting that the association between stroke and executive functioning is the same for the middle-aged groups and specifically the oldest group. Global ability and memory functioning, however, were not statistically significant with prevalent stroke. The findings are compatible with other studies showing the condition to predict executive dysfunction but not the MMSE or memory tasks (Aleman, Muller, de Haan, & van der Schouw, 2005; Muller, Grobbee, Aleman, Bots, & van der Schouw, 2007). Furthermore, our findings suggest that stroke has a larger impact on cognitive performance in younger age groups, but the impact is less in older adults due to the possibility of a longer interval between stroke and cognitive assessment. Previous studies have shown cognitive function to prevail over time in individuals with prevalent stroke; significant improvements across time were found for multiple domains including memory, visuospatial function, and attention (Hochstenbach, den Otter, & Mulder, 2003; Rasquin et al., 2004). We lack data on time between event and cognitive testing, and further studies will examine the extent of recovery of cognitive function in African Americans with prevalent stroke.

In contrast to the results found for stroke, we generally found no relationship between cognitive performances and diabetes mellitus and hypertension. Evidence linking diabetes mellitus and cognition has been inconsistent, though case–control studies from clinical samples have found negative associations (Perlmuter et al., 1984; Worrall, Moulton, & Briffett, 1993). The inconsistencies among studies may be due to the use of different cognitive measures or diagnosis of dementia, different samples as well as sample sizes, duration of disease, and number of control variables including hypertension and stroke. The lack of association between poor test performance and hypertension is of special interest because of the high prevalence of hypertension among African Americans (American Heart Association, 2000). Several longitudinal studies have reported lower cognitive scores and decline among persons with high blood pressure (Glynn et al., 1999; Tzourio, Dufouil, Ducimetiere, & Alperovitch, 1999). In cross-sectional studies such as the current study, however, high blood pressure is not consistently associated with cognitive impairment in persons who are not demented (Birkenhager, Forette, Seux, Wang, & Staessen, 2001; Davis, Massman, & Doody, 2003).

This study has several limitations. First, our findings are limited by the cross-sectional design and therefore lack the ability to determine causal associations. Longitudinal data would provide information on risks of cognitive impairment and decline even after adjustment for baseline risk factors. Second, although the forms were completed by nurse practitioners or physicians, the medical conditions are self-reports by subjects about their health history and we lack objective measures of disease. Because lower SES is related to a higher prevalence of diseases (Heyman et al., 1991; Luchsinger, Tang, Stern, Shea, & Mayeux, 2001), we may have underestimated the prevalence of disease in our study. Hence, our results may underestimate the associations between hypertension, diabetes mellitus, and CVD conditions and cognitive function. Third, we defined comorbidity as the number of diseases irrespective of severity. There is some evidence that both number of diseases and occurrence of very severe diseases are determinants of poor outcome (Rozzini et al., 2002), suggesting that severity of diseases should be taken into account to yield a more accurate relationship between comorbid illness and cognitive function. Our data are limited in this aspect but this hypothesis will be further tested by a full-scale population study currently in progress. Lastly, we lack data on duration of disease and results should be interpreted in this context. Despite these limitations, findings from the present study emphasize the importance of early identification of risk factors, as poor cognitive performance is possibly symptomatic of a range of comorbid conditions in low SES African Americans. Because health disparities are often explained along socioeconomic lines, the relative homogeneity in SES among the participants may have improved this study's ability to detect the effect of total comorbid conditions and the specific condition that is prominently responsible. Future research should focus on the factors associated with comorbid illness that predisposes African Americans to cognitive deficit. Also, better medical care and preventive interventions on factors associated comorbidity may have a substantial impact on reducing rates associated with cognitive function and decline among African Americans.

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