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Cognition and Health in African American Men

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Abstract

Objective—Despite high rates of poor health outcomes, little attention has been focused on associations between prominent health factors and cognitive function in African American men, exclusively. The objective was to examine relationships between cardiovascular and pulmonary health, and cognitive function in African American men.

Method—Data from 257 men were pooled from two studies of African American aging. The mean age of participants was 58.15 and mean educational attainment was 11.78 years. Participants provided self-reported health and demographic information, completed cognitive measures, and had their blood pressure and peak expiratory flow assessed.

Results—After adjustment, significant relationships were found between average peak expiratory flow rate (APEFR) and cognitive performance measures.

Discussion—Results suggest that lung function is important to consider when examining cognitive function in African American men. Understanding the role of health in cognition and implications for quality of life in this population will be critical as life expectancies increase.

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Keywords

cognitive function; cardiovascular health; lung function; men; African American

Despite vast improvements in health care over the past several decades, African American men continue to exhibit the poorest health profiles in the United States. (National Center for Health Statistics, 2011, 2012, 2013). For example, African American men suffer from higher rates of hypertension (39.1% vs. 27.5%), diabetes (9.9% vs. 6.5%), and age-adjusted heart disease (302.4 per 100,000 vs. 231.1 per 100,000) as compared with their White male counterparts (Cutler et al., 2008; Kochanek, Xu, & Murphy, 2011). In addition, they experience earlier disease onset and present for treatment at later disease stages (Hertz, Unger, Cornell, & Saunders, 2005; Hoyert & Xu, 2012; Powell Hammond, Matthews, Mohottige, Agyemang, & Corbie-Smith, 2010; Thorpe, Wilson-Frederick, Bowie, Coa, Clay et al., 2013). Consequently, African American men die significantly earlier than African American women and men and women of any other racial/ethnic group (Hoyert & Xu, 2012). In 2010, the average life expectancy for African American men at age 65 was 15.9 years compared with 17.7 years for White men (Kochanek, Arias, & Anderson, 2013).

The disproportionately high burden of poor health for African American men is influenced by a number of socioeconomic and psychosocial factors. African American men often have lower socioeconomic status (SES), lesser access to quality and affordable health care, and engage in less preventive health care due to low SES (Agency for Healthcare Research and Quality, 2006). African American men are also more likely to be affected by unique psychosocial stressors such as perceived racism and discrimination that contribute to poor health outcomes. Moreover, these psychosocial stressors, can lead African American men to engage in coping styles such as “John Henryism” that have been shown to be deleterious to health (Clark, Anderson, Clark, & Williams, 1999; James, 1994; Steffen, McNeilly, Anderson, & Sherwood, 2003). In addition, there has been an increase in the prevalence of poor health behaviors such as tobacco use, physical inactivity, excessive alcohol use, and inadequate nutritional intake among African American men (Thorpe et al., 2013). Coping with psychosocial stressors unique to the African American population can indirectly lead to poor health through these negative health behaviors (Griffith & Johnson, 2008). These behaviors are disproportionately prevalent in many predominately African American and poverty-dense communities (Griffith & Johnson, 2008), and are major predictors of mortality (Danaei et al., 2009; Ferrucci et al., 1999; Mokdad, Marks, Stroup, & Gerberding, 2004; Thorpe et al., 2013).

The sum of the consequences of these factors for African American men likely extends beyond inflated morbidity and mortality rates to reduced quality of life. Optimal cognitive function is a major quality of life indicator (Hollenberg, Testa, & Williams, 1991; Levine & Croog, 2004) that has been ignored in the literature devoted to African American men’s health. A significant body of literature documents the relationship between suboptimal health and cognitive function, and is largely focused on chronic health conditions such as hypertension, diabetes, and poor lung function (Richards, Strachan, Hardy, Kuh, & Wadsworth, 2005; Ryan, 2005; Waldstein, Brown, Maier, & Katzel, 2005); however, we are

unaware of any studies that have solely focused on African American men's cognitive function in relation to cardiovascular and pulmonary health. Emerging evidence suggests poor health has a significant influence on cognitive function in African Americans in general, but because of the significantly higher burden of chronic disease affecting African American men, there is a need to examine how multiple indicators of health are associated with cognitive outcomes in this at-risk, but understudied group.

Cardiovascular Health, Lung Function, and Cognitive Function in African Americans

Mounting evidence suggests poor cardiovascular health is associated with subtle, yet detectable changes in cognitive function (Ryan, 2005; Singh-Manoux & Marmot, 2005; Waldstein, Brown et al., 2005). Much of the research in this area has examined the association between blood pressure and cognitive function and utilized neuropsychological tests (Waldstein, 1995). Blood pressure is a significant predictor of performance on measures of executive function, working memory, attention, verbal learning, mental status, visual tracking, speed of information processing, and reasoning (Saxby, Harrington, McKeith, Wesnes, & Ford, 2003; Waldstein, Brown et al., 2005). The association between blood pressure and cognitive function is typically inverse, in that elevated blood pressure (i.e., hypertension) is associated with poorer performance on cognitive measures (Elias, Elias, Sullivan, Wolf, & D'Agostino, 2003; Waldstein, 1995; Whitfield, Allaire, Gamaldo, et al., 2008). Mounting evidence also suggests the potential for a nonlinear, u-shaped relationship among these variables, such that hypotension (blood pressure values <90/60 mmHg) is also associated with poorer performance (Bohannon, Fillenbaum, Pieper, Hanlon, & Blazer, 2002; Hebert et al., 2004; Waldstein, Giggey, Thayer, & Zonderman, 2005). Similarly, a preponderance of evidence suggests individuals with diabetes perform more poorly than individuals without diabetes on neuropsychological tests, and glucose levels are inversely associated with cognitive performance (Awad, Gagnon, & Messier, 2004; Elias, Elias, D'Agostino, Cupples, Wilson et al., 1997; Hiltunen, Keinanen-Kiukaanniemi, & Laara, 2001; Ryan, 2005). Observations of the role of cardiovascular health in variability in cognitive function among African Americans remain scarce; nonetheless, existing data suggest there is a significant association. For example, everyday cognition in older African Americans was partially explained by self-reported chronic illnesses and self-rated health after controlling for a number of demographic variables (Whitfield, Allaire, & Wiggins, 2004). Similarly, Aiken-Morgan and colleagues found that self-reported cardiovascular health status was a significant predictor of general intelligence and verbal learning performance in older African Americans (Aiken-Morgan, Sims, & Whitfield, 2010). Additional studies of African American samples have documented an inverse association between self-reported cardiovascular health, blood pressure, and performance on cognitive tests (Aiken-Morgan et al., 2010; Izquierdo-Porrera & Waldstein, 2002; Sims, Madhere, Campbell, & Callender, 2008; Sims, Madhere, Gordon, Clark, Abayomi et al., 2008).

Cardiovascular health has been linked to cognitive function through a number of vascular mechanisms. For example, hypertension has been associated with a greater prevalence of silent brain infarction and white matter disease (Liao, Cooper, Cai, Toole, Bryan et al.,

1996; Vermeer, Koudstaal, Oudkerk, Hofman, & Breteler, 2002). Similarly, diabetes is associated with a number of vascular changes that may precipitate cognitive dysfunction, including pathological changes in the arteries, increased blood–brain barrier permeability, and development of advanced glycosylated end products that are commonly associated with Alzheimer's disease pathology (Huber, 2008; Kurl, Laukkanen, Niskanen, Laaksonen, Sivenius et al., 2006; Ryan, 2001).

In addition to cardiovascular health findings, several reports have documented an association between pulmonary health and cognitive function, including cognitive decline and dementia (Emery & Pedersen, 1998; Giltay, Nissinen, Giampaoli, & Kromhout, 2009; Guo, Waern, Sjogren, Lissner, Bengtsson et al., 2007). Prior research has shown an inverse association between lung function and performance on cognitive tests of memory, reasoning, verbal fluency, psychomotor speed, visuospatial ability, and general cognition (Richards et al., 2005; Singh-Manoux & Marmot, 2005; Weuve et al., 2011). Relations among lung function and cognitive function have been largely unexplored in African Americans. We are aware of only one study that examined this association in a sample composed exclusively of African Americans. The study showed that lung function, as measured by average peak expiratory flow rate (APEFR) was a significant predictor of individual differences in general cognitive status after controlling for age, education, and smoking history. Poorer lung function was associated with poorer cognitive performance among African American older adults (Allaire, Tamez, & Whitfield, 2007). Similarly, a mixed racial/ethnic analysis of Atherosclerosis Risk in Communities Study (ARIC) data revealed that the inverse association between lung function and cognitive performance was more pronounced among African Americans as compared with Whites (Pathan et al., 2011).

Lung function has been associated with cognitive decrements, cognitive decline, and dementia through a number of mechanisms including subclinical cerebrovascular disease caused by inflammation, and changes in neurotransmitter metabolism induced by chronic hypoxia (Engstrom et al., 2002; Liao et al., 1999; Peers et al., 2009). Indeed, there is a need to further explore the influence of lung function on cognitive function in African Americans.

In addition to direct associations between cardiovascular health, lung function, and cognitive function, the association among these variables may be moderated by vulnerability and resilience factors including age and education. Given that greater age is a leading risk factor for hypertension, diabetes, and reduced lung function (Cowie, Rust, Byrd-Holt, Eberhardt, Flegal et al., 2006; Go, Mozaffarian, Roger, Benjamin, Berry et al., 2014; Mannino & Buist, 2007), it is plausible that age may interact with these health factors to yield reduced cognitive function. Conversely, educational attainment may serve as an important resilience factor. According to the brain-reserve hypothesis, greater educational attainment may afford individuals a degree of protection against cognitive decrements that is greater than their counterparts with less education, including enhanced protection against cognitive symptoms (Satz, 1993). Consistent with this hypothesis, relations among cardiovascular and pulmonary health outcomes may vary as a function of educational attainment, such that individuals with more education have more favorable cognitive performance.

Purpose of the Study

Although a growing number of researchers are exploring the role of health in the cognitive function of African Americans, there is a critical need to target the association between health and cognitive function among African American men specifically due to the burden of chronic disease morbidity and early mortality that plagues this understudied population (Thorpe et al., 2013). Some large studies of cognitive aging have previously examined race moderation in the association of health and cognitive function among African Americans; however, it is with within-group analyses that we can move toward a fuller understanding of factors that influence minority aging, including cognitive aging among African American men. Within-group analysis may provide critical information about factors underlying specific cognitive outcomes that are lost with between-group analysis (Whitfield, Allaire, Belue, & Edwards, 2008). Investigating the relationship between health and cognitive function in African American men is a necessary step toward more fully characterizing the cognitive aging process in this at-risk population. Furthermore, understanding the role that specific demographic vulnerability and resilience factors play is necessary to more fully characterize these relations Therefore, the purpose of the study was to examine the relationship between cardiovascular health, pulmonary health, and cognitive function. Second, we sought to examine the role of age and education as moderators of these relationships. It was hypothesized that higher systolic blood pressure, greater self-reported diabetes, and poorer lung function among African American men would be associated with poorer performance on cognitive measures. We also hypothesized that these relationships would vary such that greater age reflects a vulnerability factor and greater educational attainment reflects a resilience factor.

Method

Description of Samples

Data were derived from two samples: the Carolina African American Twin Study of Aging (CAATSA) and the Baltimore Study of Black Aging (BSBA). CAATSA was designed to examine the contribution of genetic and environmental influences on the physical and mental health of adult African American twins (Whitfield, Brandon, Wiggins, Vogler, & McClearn, 2003). Merged data from these studies have previously been published (see Heard, Whitfield, Edwards, Bruce, & Beech, 2011). Our rationale for combining samples was to create a sample size that would be sufficient for complex analysis given the absence of existing data sets that sampled African American men exclusively and included sufficient cognitive assessment. Measures included assessments of chronic illness (e.g., hypertension, arthritis, and cardiovascular disease [CVD]), health behaviors, well-being, personality, stress, and memory. Participants 22 years and older were identified from birth records between the years of 1913 and 1975 from 23 vital statistics offices in North Carolina counties. CAATSA twin registry participants were contacted for possible participation in the study. On the day of the interview, participants read and signed an informed consent and completed all study measures on the same day. A two-and-a-half hour interview battery was administered by trained personnel (see Whitfield et al., 2003; Whitfield, Kiddoe, Gamaldo, Andel, & Edwards, 2009 for recruitment and study procedures). This procedure was

approved by the Pennsylvania State University Institutional Review Board (IRB). The total *N* for CAATSA was 706. After excluding women and randomly excluding one twin from each remaining male twin pair to eliminate the violation of the assumption of independent observations for the analyses, 155 men from CAATSA were included in the current sample.

The second sample was from the BSBA–Patterns of Cognitive Aging (BSBA-PCA), which was designed to examine patterns and individual factors that contribute to individual differences in cognitive function in older African Americans (see Allaire, Gamaldo, Ayotte, Sims, & Whitfield, 2009; Gamaldo, Allaire, Sims, & Whitfield, 2010; Sims et al., 2011, for detailed methods). The sample consisted of 602 participants aged 48 years and older who were recruited from 29 predominantly African American senior apartment complexes in the city of Baltimore, Maryland. In BSBA-PCA, participants completed a battery of cognitive measures as well as measures that assessed demographic and other health-related factors. The testing session occurred on a single day and lasted approximately two and a half hours. Data collection lasted 18 months and took place between 2006 and 2008. The BSBA-PCA study was approved by the Duke University IRB. After women were excluded, the final BSBA-PCA sample size for the analysis was 102. The final analytic sample for the entire study included 257 African American men.

Measures

Scores for four cognitive measures that overlapped between the studies were extracted for the analysis. Cognitive status was assessed with the Short Portable Mental Status Questionnaire (SPMSQ), a brief assessment of cognitive status in older adults. The specific constructs assessed include orientation, memory function related to capacity for self-care, remote memory, and capacity to perform several mental operations. Test–retest reliability of the SPMSQ is 0.82 (Pfeiffer, 1975).

The Digit Symbol Substitution Test measured general psychomotor speed and attention and required participants to reproduce, within 90 s, as many coded symbols as possible in blank boxes beneath randomly generated digits, according to a coding scheme for pairing digits with symbols. Test–retest reliability for the test is 0.82 (Wechsler, 1981).

Backward Digit Span (BWD) measured working memory and executive function and required participants to repeat backwards a series of digits that were orally presented (Wechsler, 1981). Participants were given 20 s to produce responses. Digit strings ranged from four to nine digits. The number of correct and incorrect responses was recorded as pass or fail. If the participant failed two consecutive trials of the same digit string, the test was ended. Test–retest reliability for this measure ranges from 0.80 to 0.89 (Strauss, Sherman, & Spreen, 2006).

The Alpha Span (AS) task also measured working memory and executive function. Participants were read a list of words that ranged from two to eight words (Craik, 1989). After each list was read, participants were asked to repeat the list in alphabetical order. Responses were recorded as pass or fail. If a participant failed two consecutive attempts, the test was ended. Test– retest reliability for the AS task is 0.74 (Waters & Caplan, 2003).

A composite of the four cognitive measures was created to reflect global cognitive performance. Each cognitive measure's raw scores were transformed to *T*-scores with a mean of 50 and a standard deviation of 10 (see Gamaldo, Allaire, & Whitfield, 2012, for an example). The four resulting *T*-scores were then aggregated to form a single global cognitive composite score.

The health status variables included blood pressure, diabetes, and lung function. Blood pressure measurements were taken immediately after a 5-min rest period to reduce effects of stress following the other assessments. Blood pressure was measured using an oscillometric, automated device (A & D model UA-767; Milpitas, California), and the average blood pressure across three seated measurements was used in the analyses. Diabetic status was based on self-reported diagnosis by a physician. Lung function was measured using the Mini-Wright peak flow meter, which assessed participants' peak expiratory flow. Participants stood and covered the end of the tube of the peak flow meter with their lips and blew as hard as possible after taking a deep breath for 1 s. Lung function was operationalized as APEFR, calculated as the average of the three trials. There was at least a 30-s interval between each measurement.

Demographic variables, smoking behavior, blood pressure medication usage, and depressive symptomatology were included as covariates in the analyses due to their known association with cognitive performance (Anstey, von Sanden, Salim, & O'Kearney, 2007; Lichtenberg, Ross, Millis, & Manning, 1995.). Demographic variables included age (in years), education (in formal years attained), and marital status (married/unmarried). Smoking behavior was included as a dichotomized variable: "former or current smoker" and "never smoked." Blood pressure medication usage was included as a dichotomized variable. Depressive symptomatology was assessed using the Center for Epidemiological Studies Depression Scale (CES-D), a self-report scale that measures depressive symptomatology in the general population (Radloff, 1977). The CES-D has high internal consistency with Cronbach's alpha coefficients ranging from .85 to .90 across studies (Radloff, 1977). The 11-item version was administered (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993). A physical functioning variable that indicated participants' difficulties with instrumental activities of daily living (IADLs) was also added as a covariate. Finally, due to heterogeneity between the two samples, a variable was created that indicated which study was participated in to adjust for this variability in the analyses.

Statistical analysis

Statistical analyses were conducted using SPSS version 21.0 software (SPSS, Inc. Chicago, IL). Descriptive statistics were calculated to describe the combined sample as well as the individual samples. Intercorrelations were then run to assess initial associations between self-reported diabetes, average systolic blood pressure, APEFR, covariates, and cognitive scores. Hierarchical regressions were then conducted to determine linear relations between self-reported diabetes, average systolic blood pressure, APEFR, and each cognitive outcome. Moderation was tested through the creation of interaction terms. To create interaction terms, age was split at the median at age less than 60 years and age less than or equal to 60 years. This cutoff also represents the dichotomy between middle age adulthood

and young–old adulthood and older. In addition, education was dichotomized as less than 12 years of education and greater than or equal to 12 years. This cutoff was near the median and represented the important distinction between having completed high school or not. The following interaction terms were then created: self-reported diabetes X age, self-reported diabetes X education, average systolic blood pressure X age, average systolic blood pressure X education, APEFR X age, and APEFR X education. For each cognitive outcome, the first model included age, education, marital status, smoking status, blood pressure medication usage, depressive symptomatology, and study participated in. The second model included variables in Model 1 as well as self-reported diabetes, average systolic blood pressure, and APEFR. The third model included all variables in Model 2 and included the six interaction terms. The *p* values that were less than .05 were considered to be statistically significant.

Results

Sample Characteristics

All sample characteristics and mean performance for the four cognitive measures for the total sample and each subsample can be found in Table 1. The final sample included 257 men. The mean age of the total sample was 58.15 years (*SD* = 16.15) and ranged from 22 to 84 years. The mean educational attainment was 11.78 years (*SD* = 3.47). Forty-four percent of the total sample was married. More than half of men reported a diagnosis of hypertension and more than 20% of participants reported a diagnosis of diabetes. The mean APEFR was 338.54 (152.54). BSBA-PCA men were significantly older than CAATSA men due to the difference in age inclusion criteria for the studies. CAATSA men were more likely to be married (61.3% vs. 17.6%) and had attained more formal education (12.25 vs. 11.08 years) than BSBA-PCA men. BSBA-PCA men were more likely to have hypertension and diabetes, but had a lower APEFR than CAATSA men. Nearly all BSBA-PCA men reported former or current smoking (91.2%), whereas only 62.6% of the CAATSA sample reported past or current smoking. Nearly half (47.6%) of men reported taking blood pressure medication, and BSBA-PCA men were significantly more likely to report this usage. Depressive symptomatology was low within both samples, but greater among CAATSA men. Performance on the SPMSQ (mental status) was better for BSBA-PCA men; CAATSA men had better performance on the Digit Symbol Substitution Test.

Intercorrelations

Intercorrelations among variables are shown in Table 2. Self-reported diabetic status was inversely associated with performance on the Digit Symbol Substitution Test ($r = -.261$, $p < .01$) and the cognitive composite score ($r = -.163$, $p < .01$).

Systolic blood pressure was inversely associated with Digit Symbol Substitution Test performance ($r = -.370$, $p < .01$), BWD performance ($r = .245$, $p < .01$), AS performance ($r = -.127$, $p < .05$), and global cognitive performance ($r = -.290$, $p < .01$).

APEFR was positively associated with SPMSQ performance ($r = .140$, $p < .05$), Digit Symbol Substitution Test performance ($r = .568$, $p < .01$), BWD performance ($r = .142$, $p <$.

01), AS performance (r = .169, p < .01), and the cognitive composite score (r = .432, p < .01). Thus poorer lung function was associated with poorer performance on all measures.

Hierarchical Regression Findings

Findings from the hierarchical regression models are displayed in Table 3.

SPMSQ (mental status)—In the first model age, education, marital status, smoking status, blood pressure medication usage, CES-D, and study participated in were entered. This model was significant, $F(8, 133) = 2.733$, $p < .01$, and explained 9% of the variance in SPMSQ scores. The second model added self-reported diabetes, systolic blood pressure (BP), and APEFR. This model was also significant, $F(11, 130) = 2.880$, $p < .01$, and explained an additional 3.8% of the variance in SPMSQ scores. Within the second model, APEFR was a significant predictor. Lower APEFR was associated with poorer performance (b = .243, p < .01). The third model included the six age and education interaction terms. This model was significant, $F(17, 124) = 1.843$, $p < .01$; however, none of the age and education interaction terms were significantly associated with SPMSQ performance.

Digit Symbol Substitution Test (psychomotor speed and attention)—The first model of the regression that included covariates only was significant, $F(8, 132) = 16.475$, $p < .01$, and explained 46.9% of the variance in Digit Symbol scores. The second model was also significant, $F(11, 129) = 15.307$, $p < .01$, and explained an additional 6% of the variance in Digit Symbol scores. Within the second model, APEFR was a significant predictor of Digit Symbol scores. Lower APEFR was associated with poorer performance on this cognitive measure (b = .290, p < .01). The third model was also significant, $F(17, 123) = 9.827$, $p < .01$; however, none of the age and education interaction terms were significantly associated with Digit Symbol Substitution Test performance.

BWD (working memory and executive function)—The first model that predicted BWD scores from covariates was significant and predicted 9% of the variance, $F(8, 133) = 2.733$, $p < .01$. The second model that included health variables, was also significant and predicted an additional 3.8% of the variance in BWD scores, $F(11, 130) = 2.880$, $p < .01$. Within this model, APEFR was a significant predictor of BWD scores. Lower APEFR was associated with poorer performance (b = .243, p < .01). The third model that contained the interaction terms was significant; however, no age and education interactions were significant, $F(17,124) = 1.834$, $p < .05$.

AS (working memory and executive function)—The first model that predicted AS performance from covariates was significant, $F(8, 127) = 8.449$, $p < .01$, and explained 30.6% of the variance in scores. After adding health status variables, the second model was also significant, $F(11, 124) = 6.073$, $p < .01$, and explained an additional 1.4% of the variance in AS scores; however, no health status variables were significantly associated with AS performance in this model. The third model that contained the interaction terms was significant; however, no age and education interactions were significant, $F(17, 118) = 4.474$, $p < .01$.

Cognitive composite score—The first step in the model predicting cognitive composite scores was significant, $F(8, 133) = 9.054$, $p < .01$, and explained 31.4% of the variance in cognitive composite scores. The second model was also significant, $F(11, 130) = 8.090$, $p < .01$, and explained an additional 4.2% of the variance in cognitive composite scores. Within the model, APEFR was a significant predictor of cognitive performance ($b = .254$, $p < .01$). Lower APEFR was associated with poorer global cognitive performance. The third model was significant, but yielded no significant interactions, $F(17,124) = 5.258$, $p < .01$.

Discussion

African American men represent an at-risk and understudied population in the health and cognitive function literature. The disproportionate burden of disease morbidity faced by African American men confers an unknown influence on cognitive function, yet few researchers have attempted to describe this association. The current study sought to examine the relations between cardiovascular health, pulmonary health, and cognitive function among African American men. It further sought to examine whether age and education moderate these relationships. Findings demonstrated that poorer lung function was associated with poorer cognitive performance in the domains of cognitive status, working memory and attention, psychomotor speed and attention, and global cognitive function. Results further showed that age was not a significant vulnerability factor nor education a significant resilience factor for any health and cognitive function relationship.

Lung function is a less widely studied correlate of cognitive function (Singh-Manoux et al., 2011; Weuve, Glymour, Hu, Sparrow, Spiro et al., 2011). Consistent with specific cognitive domains assessed in our study, prior research has shown an inverse association between lung function and performance on cognitive tests of memory, psychomotor speed, attention, and global cognitive function (Strachan, Hardy, Kuh, & Wadsworth, 2005; Weuve et al., 2011). Prior to this analysis, we were aware of only one study that examined the association between lung function and cognitive function in African Americans (Allaire et al., 2007). Similar to findings in that study, results demonstrated that poorer lung function was associated with poorer cognitive function. Whereas Allaire and colleagues (2007) found that APEFR accounted for 2% of the variance in a measure of mental status among older African Americans in their sample, our findings showed that a model where APEFR was the only significant predictor accounted for 3.8% of the variance in mental status. Thus, African American men show a slightly higher tendency for poorer lung function to be associated with poorer cognitive function than older African Americans in general. Cross-sectional studies examining lung function and cognitive function among predominately White samples have generally included forced expiratory volume (FEV) as a predictor (Richards et al., 2005; Singh-Manoux et al., 2011; Weuve et al., 2011); however, comparison of standardized coefficients between our study and these studies suggest stronger patterns of inverse associations among our sample of African American men. Thus, African American men appear to have poorer cognitive outcomes associated with reduced lung function than their White counterparts.

Prior research has shown that reduced lung function is a salient biomarker of aging and a strong predictor of premature death (Cook et al., 1991; Kannel & Hubert, 1982). As a

traditional index of general health, lung function is second only to age in predicting mortality (Cook et al., 1995; Kannel & Hubert, 1982). Although African American men do not have the highest rates of lung disease (e.g., chronic obstructive pulmonary diseases) in the United States (Centers for Disease Control and Prevention, 2012), because of lung function's prominent role in health, it remains necessary to fully understand how suboptimal lung function affects cognitive function in African American men. Our findings underscore the importance of optimal lung function for cognitive outcomes in African American men.

Whereas lung function was associated with cognitive performance in the sample, blood pressure and self-reported diabetes were not. This finding was unexpected given that higher systolic blood pressure has been reliably associated with poorer cognitive performance in both African American and White samples (Izquierdo-Porrera & Waldstein, 2002; Saxby et al., 2003; Sims et al., 2008; Waldstein, 1995; Waldstein, Brown, et al., 2005; Whitfield, Allaire, Gamaldo et al., 2008) and that participants, on average, were hypertensive. Although education interactions were nonsignificant, greater education was a significant predictor of better performance for all of cognitive outcomes. It is plausible that education and underlying factors that were not measured are acting to promote cognitive function in the sample. Importantly, because African American men have the highest rates of hypertension in the United States (Cutler et al., 2008; Kochanek et al., 2011), our findings should not discourage future exploration of blood pressure and cognitive function associations among African American men, including additional indices of blood pressure and other cognitive domains. Blood pressure remains an important health variable to consider in understanding cognitive outcomes in this population. One plausible explanation for nonsignificant findings for diabetes is the possibility that participant self-reports underestimated the prevalence of diabetes within the sample, thus masking the influence of diabetes on cognitive function.

Age and education did not emerge as significant moderators in the study. Interactions were nonsignificant despite the role of age as a leading risk factor for hypertension, diabetes, reduced lung function and cognitive decline (Cowie et al., 2006; Go et al., 2014; Mannino & Buist, 2007), and the role of educational attainment as a protective factor against cognitive decrements (Satz, 1993). The absence of significant interactive associations between health, age, education, and cognitive function for several cognitive outcomes may suggest the presence of a selective survival effect, such that older men who participated in the study were more fit than older African American men in general by virtue of surviving into old age. In addition, heterogeneity in educational attainment, such as regional differences in quality of education, may have reduced the likelihood of significant education interactions.

Although the current study makes a unique contribution to the extant literature on the relationship between health and cognitive function by highlighting this issue in African American men, the findings should be presented within the following context. The cross-sectional nature of the design does not allow us to examine directionality of the health–cognitive function relationship; a longitudinal design is needed to confirm the temporal relationship among variables. Another limitation is our subjective measurement of diabetes. By using a self-report measure of health, we were unable to determine men's exact health status.

This study has some aspects that make its contribution to the cognitive aging literature unique. While a large number of studies in the cardiovascular health and cognition literature have been dedicated to examining blood pressure and cognitive function relations, our findings suggest that lung function is an important biomarker that deserves greater focus in the cognitive aging literature, particularly for African American men. Indeed, improving lung function may lead to better cognitive performance, which could subsequently reduce disparities in cognitive performance.

The U.S. population is rapidly aging. By the year 2050, the number of Americans aged 65 years and older is projected to be 88.5 million, more than double its population of 40.2 million in 2010 (DeNavas-Walt, Proctor, & Smith, 2008). Among these, African American men, despite having the shortest life expectancies, will be living longer as well. Given that African American men will be more likely to survive into their 70s and 80s, and will be simultaneously managing chronic illnesses, it is imperative that we have a clear understanding of their cognitive function in old age. This understanding will be critical for intervening with African American men to reduce the risk of cognitive impairment and preserve quality of life.

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Table 1

Sample Characteristics and Mean Performance on Cognitive Measures for African American Men.

	Total (*N* = 257) *M* (*SD*)	**CAATSA (*n* = 155) *M* (*SD*)**	**PCA (*n* = 102) *M* (*SD*)**
Age (years)	58.15 (16.15)	50.85 (15.63)	69.24** (9.07)
	range = 22–84	range = 22–84	range = 51–91
Married, %	44	61.3	17.6**
Education (years completed)	11.78 (3.47)	12.25 (3.56)	11.08* (3.22)
Self-reported hypertension, %	54.9	41.3	75.5**
Self-reported diabetes, %	21.8	16.8	29.4*
Systolic blood pressure (mm/Hg)	140.93 (21.47)	137.79 (20.45)	145.66 (22.17)**
Diastolic blood pressure (mm/Hg)	83.76 (12.88)	82.13 (12.03)	86.23 (13.75)*
APEFR	338.54 (152.54)	380.19 (161.83)	275.65** (111.51)
Former or current smoker (%)	73.9	62.6	91.2**
Use of blood pressure medication (%)	47.5	33.6	71.6*
Difficulties with IADLs	0.20 (0.617)	0.22 (0.667)	0.18 (0.534)
Center for Epidemiological Studies Depression Scale	8.76 (3.70)	9.80** (4.06)	7.16 (2.29)
Short portable mental status questionnaire	8.84 (1.24)	8.54 (1.26)	9.31** (1.06)
Digit Symbol Substitution Test	39.31 (21.75)	46.20 (23.40)	29.24** (14.01)
Backward digit span	4.67 (2.15)	4.74 (2.27)	4.56 (1.98)
Alpha span	4.90 (2.32)	4.49 (2.31)	5.50* (2.21)

Note. CAATSA = Carolina African American Twin Study of Aging; PCA = patterns of cognitive aging; APEFR = average peak expiratory flow rate; IADLs = instrumental activities of daily living.

* Significantly different from CAATSA at $p < .01$.

** Significantly different from CAATSA at $p < .001$.

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Table 2

Intercorrelations Between Demographic Variables, Smoking Status, Health Variables, and Cognitive Outcome Variables Among African American Men (N = 257).

	Age	Marital status	Education	Diabetes	Systolic BP	Smoking status	APEFR	CES−D	SPMSQ	DS	BWD	AS	Cognitive composite
Age	1.00												
Marital status	−.175**	1.00											
Education	−.482**	.081	1.00										
Self-reported diabetes	.266**	−.092	−.127*	1.00									
Systolic BP	.455**	−.217**	−.167**	.288**	1.00								
Smoking status	.410**	−.287**	−.303**	.117	.248**	1.00							
APEFR	−.516**	.229**	.418**	−.100	−.301**	.172**	1.00						
CES-D	−.269**	.130*	−.056	−.108	−.185**	−.043	.048	1.00					
SPMSQ	−.136*	−.160**	.318**	−.025	−.064	.069	.140*	−.150*	1.00				
DS	−.746**	.033	.592**	−.261**	−.370**	.239**	.568**	.074	.276**	1.00			
BWD	−.321**	.358**	.358**	−.107	−.245**	.142*	.315**	−.005	.277**	.467**	1.00		
AS	−.187**	−.173**	.432**	−.033	−.127*	.046	.169**	−.114	.419**	.367**	.369**	1.00	
Cognitive composite	−.484**	−.043	.544**	−.163**	−.290	−.274**	.432**	−.028	.417**	.733**	.896**	.670**	1.00

Note. BP = blood pressure; APEFR = average peak expiratory flow rate; CES-D = Center for Epidemiological Studies Depression Scale; SPMSQ = Short Portable Mental Status Questionnaire; DS = Digit Symbol Substitution Test; BWD = Backward Digit Span; AS = Alpha Span.

* $p < .05$.

** $p < .01$.

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Table 3

Two-Step Regression Model: Self-Reported Hypertension, Self-Reported Diabetes, and Lung Function Predicting Cognitive Performance in African American Men After Adjustment for Covariates (N = 257).

	SPMSQ β (*SE*)			Digit symbol β (*SE*)			Backward digit span β (*SE*)			Alpha span β (*SE*)			Cognitive composite β (*SE*)		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Age	−.055 (0.077)	.054 (0.080)	.046 (0.089)	−.503** (0.056)	−.379** (0.056)	−.400* (0.062)	−.055 (0.077)	.054 (0.080)	.046 (0.089)	−.106 (0.084)	−.114 (0.089)	.158 (0.097)	−.214* (0.053)	−.112 (0.055)	−.153 (0.060)
Education	.304** (0.251)	.256* (0.251)	.225 (0.301)	.306** (0.183)	.252** (0.176)	.293** (0.209)	.304 (0.251)	.256* (0.251)	.225 (0.301)	.383** (0.276)	.376** (0.283)	.490** (0.330)	.423** (0.174)	.372** (0.172)	.404** (0.205)
Marital status	−.047 (0.571)	−.071 (0.561)	−.078 (0.588)	.045 (0.416)	.022 (0.393)	.038 (0.409)	−.047 (0.571)	−.071 (0.561)	−.078 (0.588)	−.109 (0.604)	−.108 (0.612)	−.058 (0.623)	−.039 (0.396)	−.062 (0.385)	−.045 (0.401)
Smoking status	−.077 (1.992)	−.110 (1.967)	−.105 (2.041)	.062 (1.451)	.023 (1.381)	.036 (1.418)	−.077 (1.992)	−.110 (1.967)	−.105 (2.041)	.017 (2.091)	.016 (2.133)	.016 (2.143)	−.034 (1.381)	−.066 (1.350)	−.053 (1.391)
Functional status	.051 (0.719)	.103 (0.723)	.108 (0.742)	−.113 (0.524)	−.065 (0.507)	−.061 (0.517)	.051 (0.719)	.103 (0.723)	.108 (0.742)	.079 (0.768)	.078 (0.796)	.068 (0.794)	.016 (0.499)	.062 (0.496)	.064 (0.506)
BP meds		−.007 (0.654)	−.013 (0.690)	−.079 (0.486)	−.072 (0.459)	−.083 (0.481)	−.010 (0.666)	−.007 (0.654)	−.013 (0.690)	−.042 (0.709)	−.046 (0.719)	−.048 (0.734)	−.052 (0.462)	−.050 (0.449)	−.058 (0.470)
CES-D	.051 (0.571)	.079 (0.219)	.076 (0.229)		−.046 (0.157)	−.029 (0.164)	.051 (0.571)	.079 (0.219)	.076 (0.229)	−.059 (0.242)	−.055 (0.247)	−.033 (0.253)	.015 (0.154)	.046 (0.150)	.059 (0.156)
Study	−.200 (0.097)	−.211 (2.055)	−.215 (0.080)		−.111 (1.451)	−.134 (1.497)	−.200 (2.097)	−.211 (2.055)	−.215 (0.080)	−.421** 2.246	−.425** 2.274	−.457** 2.308	−.335** (1.454)	−.348** (1.410)	−.373 (1.447)
Diabetes		−.019 (1.530)	−.077 (3.656)		−.081 (1.071)	−.087 (2.545)		−.019 (1.530)	−.077 (3.656)		.053 (1.676)	−.054 (3.853)		−.009 (1.050)	−.084 (2.492)
Systolic BP		−.116 (0.033)	−.139 (0.097)		−.062 (0.023)	.036 (0.069)		−.116 (0.033)	−.139 (0.097)		−.002 (0.037)	.329 (0.105)		−.084 (0.023)	.116 (0.066)
APEFR		.243** (0.006)	.342 (0.018)		.290** (0.004)	.321 (0.011)		.243** (0.006)	.342 (0.018)		.008 (0.007)	−.300 (0.016)		.254** (0.004)	.270 (0.010)
Diabetes × Age			.042 (3.470)			−.052 (2.411)			.042 (3.470)			.216 (3.647)			.122 (2.364)
Diabetes × Education			(0.024) 3.290			−.060 (2.290)			(0.024) 3.290			−.086 (3.483)			−.036 (2.242)
Systolic BP × Age			−.029 (0.095)			−.128 (0.067)			−.029 (0.095)			−.276 (0.102)			−.219 (1.064)
Systolic BP × Education			−.029 (0.095)			.038 (0.050)			−.029 (0.095)			−.084 (0.077)			.004 (0.049)
APEFR × Age			−.042 (0.013)			−.089 (0.010)			−.042 (0.013)			.149 (0.015)			−.046 (0.009)

	SPMSQ β (*SE*)			Digit symbol β (*SE*)			Backward digit span β (*SE*)			Alpha span β (*SE*)			Cognitive composite β (*SE*)		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
APEFR × Education			−.075 (0.013)			.043 (0.009)			−.075 (0.013)			.219 (0.014)			.011 (0.009)
F	2.733**	2.880**	1.843*	16.475**	15.307**	9.827**	2.733**	2.880**	1.843**	8.449**	6.073**	4.474**	9.054**	8.090**	5.258**
Adjusted R^2	.090	.128	.092	.469	.529	.517	.090	.128	.092	.306	.292	.304	.314	.356	.339

Note. SPMSQ = short portable mental status questionnaire; Digit Symbol = Digit Symbol Substitution Test; BP = blood pressure; CES-D = Center for Epidemiological Studies Depression Scale; APEFR = average peak expiratory flow rate.

* $p < .05$.

** $p < .01$.