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Cardiovascular Function, Cognition, and Everyday Activities in Older Adults

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CARDIOVASCULAR FUNCTION, COGNITION, AND EVERYDAY ACTIVITIES IN OLDER ADULTS

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ABSTRACT

Research regarding hypertension and heart disease in older adults has indicated that these cardiovascular diseases are often associated with cognitive decline beyond that which is typically observed with normal aging. However, far less research has evaluated the relationship between non-diseased cardiovascular function and cognitive performance in older adults, and no studies have specifically addressed the intersection of non-diseased cardiovascular function, cognition, and everyday activities (i.e., instrumental activities of daily living, life space mobility). This study recruited community-dwelling adults (N = 197) age 65 and over and sought to evaluate these associations using structural equation modeling (i.e., SEM), as well as individual multiple regression analyses. Overall, cardiovascular function, as measured by systolic and diastolic blood pressures, was not significantly associated with cognition or everyday activities.

Participants reported no history of hypertension or reported pharmacologically controlled hypertension. However, a substantial portion of the sample was found to have blood pressure measurements in the hypertensive range (n = 84). Group comparisons based on hypertension status were conducted to evaluate whether cognitive or functional differences existed. No differences were found. In sum, among this select sample of generally healthy community-dwelling older adults, cardiovascular health did not affect cognition, life space mobility, or instrumental activities of daily living.

DEDICATION

This dissertation is dedicated to my family. To my amazing husband Louis, thank you for your encouragement and suggestions. This year has been a challenge, but look how much we have accomplished! To my parents, thank you for supporting my dreams and helping me achieve them – I owe so much of my success to you both. And David, you are an incredible big little brother with a great sense of humor and a refreshing perspective. It *is* just a shave-kit.

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LIST OF ABBREVIATIONS

ADLs	activities of daily living
AHA	American Heart Association
CAMCOG	Cambridge Examination for Mental Disorders of the Elderly – Cognitive Section
CAMDEX	Cambridge Examination for Mental Disorders of the Elderly
COWAT	Controlled Oral Word Association Test
cm	centimeters
HVLT	Hopkins Verbal Learning Test
IADLs	instrumental activities of daily living
LSA™	Life Space Assessment™
MI	myocardial infarction
mmHg	millimeters of mercury
MMSE	Mini-Mental State Exam
ms	milliseconds
TIA	transient ischemic attack
UFOV®	Useful Field of View test
WAIS	Wechsler Adult Intelligence Scale
WASI	Wechsler Abbreviated Scale of Intelligence

INTRODUCTION

Among older adults, much research indicates that hypertension and heart disease are associated with poorer cognitive function, but far less research has investigated the cognitive effects of cardiovascular health among older adults without hypertension or heart disease. Understandably, cognitive decrements can affect everyday activities, such as shopping, managing finances, and traveling outside the home, and these potential declines are often studied in aging research. However, little to no research has exclusively examined the intersection of aging, cardiovascular health, cognition, and everyday functional activities. The primary objective of this study is to simultaneously evaluate cardiovascular health, cognitive performance, and everyday activities in order to determine the relationship(s) among these factors that are frequently studied in aging research.

Background

The proportion of adults aged 65 and older is increasing dramatically in the United States, and is projected to account for 20 percent of the population by 2030 (Federal Interagency Forum on Aging-Related Statistics, 2004). The prevalence of many diseases increases with age, and the most prevalent conditions among older adults involve pathology of the cardiovascular system (Martin, 1994; Wan, Sengupta, Velkoff, & DeBarros, 2005). Cardiovascular disease, which includes diseases of the heart (e.g., ischemic heart disease, coronary artery disease, and coronary heart disease; often used interchangeably), cerebrovascular accident (i.e., stroke), hypertension, congestive heart failure, congenital cardiovascular defects, hardening of the arteries, and other diseases of the cardiovascular system, is the leading cause of death in the United States and is responsible for 36% of all deaths annually (American Heart Association [AHA], 2006). Of those deaths, approximately 82% are age 65 or older (AHA, 2008).

Hypertension (i.e., high blood pressure) is one of the primary risk factors for heart disease (i.e., ischemic heart disease, coronary artery disease, or coronary heart disease) and is highly prevalent among older adults (Thom et al., 2006). Numerous researchers have estimated that over half of adults over the age of 65 are hypertensive (Beaglehole, 1991; Kane, Ouslander, & Abrass, 2004; Pennypacker & Taylor, 2000; Wenger, 1998). The AHA (2008) defines hypertension as having systolic blood pressure of 140 mmHg or higher or diastolic blood pressure of 90 mmHg or higher; taking antihypertensive medication; or having been informed twice by a physician of having high blood pressure. Using this definition, over two-thirds of adults aged 65 and over are considered to have hypertension (AHA).

Heart Disease and Cognition

Likely due to the magnitude of the problem, there is a wide range of studies investigating cardiovascular diseases and cognition. Although relevant, research pertaining to cerebrovascular accidents (i.e., stroke) is beyond the scope of this project and is not thoroughly addressed.

Research assessing global cognitive function using the Mini Mental State Exam (MMSE) has demonstrated that adults (N = 4,971) aged 55 – 94 with a history of myocardial infarction, carotid artery plaques, or peripheral atherosclerotic disease, perform more poorly than normal controls, even when accounting for age, gender, and education (Breteler, Claus, Grobbee & Hofman, 1994). Further, other research has demonstrated that left carotid artery stenosis is especially predictive of decreased Modified MMSE performance in adults (N = 4,006) aged 65 and over (M = 74.7 years) without cerebrovascular disease (Johnston et al., 2004).

More sensitive measures of neuropsychological function have revealed similar results. Excluding cases of stroke, Elwood and colleagues (2002) found that men (N = 1,048) aged 55 – 69 with a history of myocardial infarction, ischemic heart disease, or peripheral vascular disease performed comparably to each other, yet significantly worse than non-diseased controls. The impairments were of approximately equal magnitude on measures of verbal and mathematical reasoning; reaction time; and memory, attention, coordination, and orientation (as reported by the Cambridge Examination for Mental Disorders of the Elderly – Cognitive Section (CAMCOG), an index score representing performance in the domains of memory, language, orientation, attention/calculation, abstract thinking, praxis, perception). The level of impairment was consistent with the expected decline after about five years of aging.

Perhaps more informative are comparisons of cardiovascular disease severity, rather than comparing cases to healthy controls. In one study, adults (N = 515) aged 65 and older (M = 75.0, SD = 7.0) with congestive heart failure (i.e., a condition marked by an inability of the heart to efficiently pump blood to the other organs of the body, AHA

2008) performed significantly worse on measures of memory and attention than older adults with cardiovascular disease uncomplicated by congestive heart failure. Both groups had comparable rates of coronary artery disease and myocardial infarction. This study evaluated neuropsychological performance in the domains of attention, visual-spatial reasoning, verbal fluency, visual-spatial working memory, and immediate and delayed verbal memory, and found that over one-third of those with cardiovascular disease uncomplicated by congestive heart failure (i.e., the control group) performed abnormally on at least three neuropsychological tests, although the authors do not provide specific information regarding these impairments (Trojano et al., 2003). In another study, Verhagen and colleagues (2002) determined that among adults (N = 516) aged 70 – 103, congestive heart failure and coronary heart disease were associated with decreased perceptual speed and verbal fluency, but no association was found for significant episodic memory impairment in either condition.

Finally, a comparison of older adults with a history of myocardial infarction (MI) determined that those who had (n = 35) experienced cardiac arrest (i.e., a sudden, abrupt loss of heart function, usually due to a disruption of the normal electrical impulses) were more impaired on measures of episodic long term memory and spatial memory than those who had not (n = 35) experienced cardiac arrest. Using the Rivermead Behavioral Memory profile scores, mild memory impairment was found in 37% of the controls (MI-only), whereas 43% of those with cardiac arrest were classified as having mild memory impairment, 29% had moderate impairment, and 9% of cases were classified as severely impaired (Grubb, O'Carroll, Cobbe, Sirel, & Fox, 1996).

Hypertension and Cognition

The majority of research pertaining to cardiovascular disease and cognition focuses on blood pressure, and specifically hypertension. Using the WAIS, one of the earliest studies concluded that hypertension longitudinally affects performance scale scores, but has no significant effect on verbal scale scores in adults (N = 202) aged 60 – 79 years (Wilkie & Eisdorfer, 1971). More current research attempts to evaluate a broader range of cognitive domains, and although the results are variable, most researchers agree that blood pressure is associated with cognitive performance.

Budge and colleagues (2002) evaluated global cognitive function, as assessed by the MMSE and the CAMCOG, in adults (N = 158) aged 60 – 91 years without history of stroke or transient ischemic attack (TIA). The authors controlled for depression and other vascular risk factors (e.g., smoking history) and evaluated systolic blood pressure as a continuous variable. The results indicated that elevated systolic blood pressure (M = 153.2, SD = 20 mmHg) was associated with decreased performance on the MMSE and the CAMCOG. There was no association between cognitive performance and diastolic blood pressure (M = 81.6, SD = 9.1 mmHg).

The Framingham Study was one of the earliest large-scale studies to evaluate blood pressure and cognition in adults (N = 1,695) aged 55 – 88. Participants had no history of stroke. Systolic blood pressure (range: 92.2 mmHg – 208.5 mmHg) and diastolic blood pressure (range: 56.4 mmHg – 119.6 mmHg) were analyzed continuously. Higher systolic and diastolic blood pressure and the chronicity of hypertension were inversely related to cognitive function, particularly measures of attention and verbal and visual memory (Elias, D'Agostino, Elias, & Wolf, 1995[a]; Elias, D'Agostino, Elias, &

Wolf, 1995[b]; Elias, Wolf, D'Agostino, Cobb, & White, 1993). Similarly, Waldstein and colleagues (2005) evaluated adults (N = 101) aged 53 – 84 and concluded that those with high blood pressure (i.e., average resting systolic blood pressure reading ≥ 140 mmHg or an average diastolic blood pressure reading ≥ 90 mmHg; M = 152.8, SD = 10.8) demonstrated more impairments in immediate and delayed nonverbal memory as compared to those without hypertension (i.e., average resting systolic blood pressure reading < 140 mmHg and an average diastolic blood pressure reading of < 90 mmHg; M = 122.2, SD = 11.0).

Between group comparisons of untreated hypertensive adults (n = 107; range: 138 to 179/68 to 99 mmHg) and normotensive adults (n = 116; range: 108 to 149/60 to 89 mmHg) aged 70 – 89 has indicated that elevated blood pressure is also associated with significantly slower and less accurate responses on measures of reaction time, spatial scanning, and visual memory (Harrington, Saxby, McKeith, Wesnes, & Ford, 2000). Slower performance has also been noted on a measure of motor speed and manual dexterity (Waldstein, Brown, Maier, & Katzel, 2005).

There are clearly variations in study design (e.g., cross-sectional vs. longitudinal) and data analysis (e.g., continuous vs. categorical analysis of blood pressure data), but most research regarding blood pressure and cognition has focused on the effect(s) of hypertension. In the interest of evaluating the cross-sectional relationship of blood pressure (i.e., not solely hypertension) and cognitive performance, Elias and colleagues (1990) used blood pressure as a continuous variable to predict cognitive dysfunction. Participants (N = 301) aged 20 – 72 were withdrawn from anti-hypertensive medications, when applicable, and evaluated across various cognitive domains. Systolic blood pressure (M = 135.0, SD = 26.14, range: 83 – 242 mmHg) and diastolic blood pressure (M = 88.0, SD = 15.5, range: 58 – 144 mmHg) predicted varying degrees of cognitive impairment, even in normotensives, on tests of processing speed, memory, fine motor speed, and cognitive flexibility. However, diastolic blood pressure was a stronger predictor of cognitive performance after controlling for age, gender, education, previous hypertensive medication use, and the interaction of age and blood pressure.

Similarly, Starr and colleagues (1993) evaluated a medication-free and disease-free sample of nearly 600 adults aged 70 and older. In this study, average systolic blood pressure (M = 160 mmHg; 95% confidence intervals 114 – 206 mmHg) was negatively associated with performance on a common measure of mental status (MMSE) but no significant correlation was observed for average diastolic blood pressure (M = 86 mmHg; 95% confidence intervals 66 – 106 mmHg).

Contrarily, there is also evidence that abnormally low blood pressure is related to impaired cognitive performance, as well (Qui, von Strauss, Winbald, & Fratiglioni, 2004). This U-shaped relationship underscores the importance of 1) obtaining an objective measure of blood pressure, rather than relying only on the participant's self-report regarding hypertensive status, and 2) using blood pressure as a continuous variable, rather than categorizing participants into groups.

Significance

Most social and behavioral research regarding cardiovascular health and cognitive function has focused primarily on cardiovascular pathology. Individuals without heart disease (e.g., coronary artery disease, myocardial infarction), but who have positive cardiovascular risk factors (e.g., increased blood pressure or cigarette use), are hypothesized to have impairments in similar cognitive domains, but to a lesser magnitude, than those with cardiovascular pathology (e.g., heart disease, uncontrolled hypertension). The cognitive domains of interest for this study are consistent with previous findings in the literature and include speed of processing/divided attention (Elias et al., 1990; Elias et al., 1995[a]; Elias et al., 1995[b];Elias, Wolf et al., 1993; Elwood et al., 2002; Harrington et al., 2000; Trojano et al., 2003; Verhagen et al., 2002;), verbal memory (Elias et al., 1995[a]; Elias et al., 1995[b]; Elias, Wolf et al., 1993; Elwood et al., 2002; Trojano et al., 2003;), non-verbal reasoning (Trojano et al., 2003), and executive function (Trojano et al., 2003; Verhagen et al., 2002). Decreased performance in these domains is also associated with impairments in activities of everyday life (Kelly-Hayes, Jette, Wolf, D'Agostino, & Odell, 1992; Royall, Palmer, Chiodo, & Polk, 2005; Stuck et al., 1999).

Instead of focusing solely on cognition, the proposed research seeks to expand the outcomes of interest to include measures of life space mobility and instrumental activities of daily living (IADLs). These outcomes are frequently addressed in the fields of both aging and cardiovascular disease, but have not been addressed in relation to normal aging and non-diseased cardiovascular function. Poor performance on measures of IADLs has been associated with decreased quality of life, and increased need for nursing home care, hospitalization, and even mortality (Donaldson, Clayton, & Clarke, 1980; Ettinger, 1994; Kovar & Lawton, 1994).

Life Space Mobility

The first measure of everyday function, life space mobility, is the ability to move through one's environment in order to complete a task or achieve a goal (Owsley et al., 2000; Parker, Baker, & Allman, 2001). The conceptualization of life space mobility extends beyond physical capacity and encompasses sociodemographic factors, health factors, and personal and environmental influences (Allman, Sawyer, & Roseman, 2006; Parker et al.) There are some reports that lower life space mobility is associated with increasing age, lower self-rated health, number of medications, number of diseases, and having more health-related complaints (Allman et al.), and also that life space is lower for females and African-Americans (as compared to whites; Peel et al., 2005). Reductions in life space mobility have been associated with decreases in independent living, personal autonomy, and decreased quality of life (Ettinger, 1994). Additionally, reduced mobility in older adults can result in decreased health, cognitive decline, increased risk for disability and decreased longevity (Hubert, Bloch, & Fries, 1993; Mor et al., 1989; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Slattery, Jacobs, & Nichaman, 1989).

There are two main advantages of including an assessment of life space mobility when evaluating everyday activities in older adults. First, assessment of life space mobility focuses on where an individual has actually gone within a discrete period of time. This is in contrast to traditional questionnaires assessing activities of daily living (ADLs) and IADLs which typically measure potential ability or difficulty experienced, but not what is actually done (Allman et al., 2006). The second advantage of measuring life space mobility is that it appears to be more sensitive at detecting functional decline in older adults. For example, declines in life space mobility are typically detected before declines in IADLs or ADLs are evident (Baker, Bodner, & Allman, 2003).

Timed IADLs

The second measure of everyday function involves a standardized assessment of how effectively and efficiently one can manage IADLs, such as finding a telephone number, making change, and reading instructions on a medicine container (i.e., Timed IADL Test). This laboratory-based assessment requires each participant to complete identical tasks under timed conditions, rather than relying on self-report of everyday IADL function (Di Carlo et al., 2000; Wang, van Belle, Kukull, & Larson, 2002). Slower and inaccurate performances on this measure have been associated with impairments in numerous cognitive domains (Ball, Wadley, Vance, & Edwards, 2004; Owsley, McGwin, Sloane, Stalvey, & Wells, 2001; Owsley, Sloane, McGwin, & Ball, 2002). Conversely, Ball and colleagues (2002) determined that speed of processing training reliably improves Timed IADL performance.

As mentioned, most research evaluating cardiovascular health, cognition, and functional abilities focuses on individuals who have been diagnosed with cardiovascular pathology (e.g., heart disease, hypertension). Such tertiary prevention studies involve evaluating and treating those who are already ill. Instead, the proposed research intends to demonstrate that associations between cardiovascular health (i.e., blood pressure, cigarette use) and everyday function exist even among older adults without heart disease. This approach would emphasize prevention and the importance of developing and maintaining positive cardiovascular-related health behaviors.

The objective of the proposed research is to establish that cardiovascular function in cognitively intact older adults without heart disease predicts life space mobility and independence with IADLs. Further, it is expected that this relationship will remain significant after controlling for demographic variables, health-related variables, and cognitive function. Among older adults, cognitive performance and physical ability are thought to mediate functional mobility and independence, and thus are often targeted for intervention (Ball et al., 2004; Hunter, McCarthy, & Bamman, 2004). By establishing that elevations in cardiovascular risk factors (e.g., blood pressure, cigarette use) affect functional mobility and independence, we can create another, separate pathway for intervention.

Specific Aims

Prior research has demonstrated that age-related declines in cognitive function contribute to poor performance on IADLs, such as medication management, financial management, and driving, among others (Ball et al., 2002; Jobe et al., 2001). Intuitively, it is understandable that impairments in attention, memory, reasoning, or planning would affect one's ability to shop for groceries, balance a checkbook, or prepare a meal. In healthy older adults without frank cardiovascular or neurological disease, it is possible that impairments in regional cerebral blood flow (i.e., cardiovascular function) contribute to declining cognitive function (Gur, Gur, Obrist, Skolnick, & Reivich, 1987; Martin, Friston, Colebatch, & Frackowiak, 1991). Although much research indicates that hypertension and heart disease are associated with poorer cognitive function (Viamonte, Ball, Vance, & Wadley, submitted; see above for others), it remains to be seen whether precursors of these conditions (e.g., increasing blood pressure) among those without heart disease, are associated with poorer cognition and performance on tasks of everyday living. Of special interest is whether elevated cardiovascular risk factors directly impact one's ability to function well in everyday life, or whether their impact on everyday function is mediated through declines in cognition. If the evidence indicates that elevated cardiovascular risk factors are linked to declines in cognition and/or everyday function, earlier interventions may be warranted to prevent further decline.

The overarching goal of this research is to determine whether or not cardiovascular function in cognitively intact older persons without heart disease predicts practical outcomes associated with daily function. The two outcomes of interest include (1) the extent of one's movement in their environment (i.e., life space mobility; Figure 1) and (2) the ability to efficiently perform instrumental activities of daily living (i.e., Timed IADLs; Figure 2).

The proposed research has three specific aims:

Aim 1: To investigate the effects of cardiovascular function (i.e., systolic and diastolic blood pressure) on two measures of everyday activities (i.e., life space mobility and Timed IADLs).

H1: It is expected that higher blood pressure will be associated with reduced life space mobility and slower performance on Timed IADLs.

Aim 2: To evaluate the relationship between cardiovascular function and four domains of cognitive function (i.e., speed of processing/divided attention, non-verbal reasoning, verbal memory, and executive function).

H2: It is expected that higher blood pressure will be associated with poorer cognitive function.

Aim 3: To determine whether the impact of cardiovascular function on everyday functioning is mediated by cognitive function while simultaneously controlling for other variables known to be associated with cardiovascular function, cognition, and everyday activities.

H3: Cardiovascular function will remain an independent predictor of everyday activities, as measured by life space mobility and Timed IADLs, even when age, gender, race, cigarette smoking, years of education, and cognitive function are included in the statistical model.

METHODS

The Parent Study

Participants were recruited from a large-scale intervention study (i.e., the parent study) conducted at The Center for Translational Research on Aging and Mobility, University of Alabama at Birmingham (projected N = 320). The basic design of this two-year longitudinal intervention study employs a 2x2 model to investigate the impact of cognitive training and exercise training on the cognition and mobility of older adults. The four cells consist of: (1) cognitive speed training only, (2) exercise training only, (3) both cognitive speed and exercise training, and (4) no contact control. The sample is limited to sedentary older adults (i.e., those who have not engaged in aerobic exercise more than one hour per week in the past year) because most research demonstrating cognitive and mobility-related training gains has been conducted in this population (Colcombe & Kramer, 2003). Further, the parent study sample only is limited to older adults with mild deficits in cognitive speed of processing (see below), because past research has determined that some level of decrement is necessary for training gains to be observed (Edwards et al., 2002). For the hypotheses tested in this paper, *the pre-intervention baseline data from the parent study are used*. In addition, in an attempt to increase the variability of the sample, other older adults were also recruited (see below).

Participant Recruitment

Participants were recruited from the following populations: (1) Previously screened older adults in Birmingham, Alabama. A number of older adults have participated in previous studies at the UAB Center for Translational Research on Aging and Mobility and have indicated a willingness to participate in future research. (2) A demographically diverse population of older adults in Birmingham, Alabama, whose names were obtained from a purchased Equifax list and presorted by zip code in order to yield a representative sample. These lists have been used successfully in prior large scale studies at the Center.

Contact letters were prepared and mailed out to those individuals identified from these populations who are aged 65 years and older. This letter described the nature and purpose of the research, the types of participants needed, duration and location of participation, and other study incentives such as no-cost physiologic assessments, free parking, and reimbursements for time and travel. This mailing also included a postcard that prospective participants could return if they were interested in learning more about the study. All individuals contacted by letter were assigned a code number for database purposes.

After the postcards were returned to the Center, a follow up telephone call was made by a member of the study team providing more information about the study and inviting the individual to participate. If the individual verbally consented to the telephone interview, certain basic inclusionary demographic data and information about functional capabilities were obtained, including: age (>64 years), living independently, no use of mobility-assistive devices (e.g., walkers and wheelchairs), ability to travel to the site (self-reported), be sedentary (i.e., has not engaged in aerobic exercise for more than one hour per week in the past year), and has no plans to move from the study area in the next two years.

Specific exclusionary criteria related to health conditions were also addressed in the phone call. Individuals who have experienced myocardial infarction (MI), coronary artery bypass graft (CABG) surgery, cerebral infarct or hemorrhage (stroke), or those with a pacemaker were excluded from participation. Individuals with conditions associated with actual or potential cognitive impairment, including Alzheimer's disease, diabetes mellitus (Gorelick, 2005), uncontrolled hypertension, or current chemotherapy or radiation treatment for cancer (Kvale et al., submitted; Tannock, Ahles, Ganz, & van Dam, 2004) were excluded. An in-person appointment to complete the screening process was scheduled for willing individuals who met the telephone inclusion criteria. A letter confirming the appointment date and time, along with directions to the testing center, was mailed immediately. On the day before the appointment, the participant received a reminder telephone call.

In-Person Screening

The objective of the in-person screening was to determine eligibility for the parent study. All participants provided IRB-approved written informed consent. Eligibility criteria are explained below; those who were ineligible were informed they did not meet inclusion criteria, but were invited to participate in a one-time assessment measuring variables related to cognition and cardiovascular function. As mentioned, this was an attempt to broaden the variability of the sample reported herein. It was clearly explained that they would not be participating in the intervention study (i.e., the parent study).

The in-person screening consisted of a brief battery of sensory and cognitive measures. In order to qualify for inclusion for the parent study, participants had: (1) intact mental status (an MMSE score greater than or equal to 24); (2) adequate vision (20/60 or better); and (3) reduced processing speed, as indicated by a UFOV® score on Subtest 2 greater than 150 ms or a combined score greater than 500 ms on Subtests 1, 2, and 3, as described below. Upon completion of the screening battery, participants were reimbursed for time and travel. Those participants who met all inclusion criteria were recruited to participate in the baseline assessment of the parent study. Participants who had adequate vision, but who failed to meet either or both of the other inclusion criteria (i.e., MMSE $\geq$ 24; reduced speed of processing) were recruited to participate in the one-time assessment measuring variables related to cognition and cardiovascular function. The one-time assessment protocol contained the same measures as the baseline assessment protocol of the parent study.

In-Person Screening Measures

Mental Status. The Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975) was administered in order to obtain an estimated mental status during screening. This test provides a brief screen covering the domains of orientation, attention/concentration, memory, language, and constructional ability. Participants with scores <24 were ineligible for the parent study, but remained eligible to complete the one-time assessment protocol.

Visual Function. (1) Letter acuity: Acuity was measured using the modified Bailey-Lovie chart (Ferris, Kassoff, Bresnick, & Bailey, 1982). Acuity was measured binocularly and was expressed in terms of log minimum angle resolvable using the recommended scoring system. (2) Contrast sensitivity: Contrast sensitivity was measured binocularly, using the Pelli-Robson Contrast Sensitivity Chart (Pelli, Robson, & Wilkins, 1988). Owsley and colleagues (1995) have delineated the minimum visual requirements necessary to perform the UFOV® task. A visual acuity of 20/60 or better ensures that participants will have the necessary visual acuity to perform all of the visual tests present in the battery. All participants met this criterion.

Useful Field of View—UFOV®. UFOV® measures the minimum display duration necessary for a participant to attend to multiple stimuli in the visual field. Stimuli are presented as white targets (2 cm by 1.5 cm) with an otherwise black background on a 17-inch computer monitor (i.e., the Visual Attention Analyzer). Participants view the monitor from a distance of approximately 60 cm. Each trial consists of 4 display screens: a fixation box, a test stimulus, a visual mask, and a response screen. Three types of test stimuli are presented. (1) Foveal targets are presented and the participant is required to identify the object presented inside the fixation box. (2) Foveal targets are presented simultaneously with peripheral targets and the participant must identify the foveal target and locate the peripheral target. Peripheral targets are presented 11 cm from the fixation box at one of eight radial locations (0, 45, 90, 135, 180, 225, 270, and 315 degrees). (3) Foveal targets are presented simultaneously with peripheral targets as above, with the addition of peripheral distractors. Distractor stimuli are triangles of the same size and luminance as the peripheral target and occupy all unused test locations, as well as uniformly filling the space between target locations.

These three subtests form the basis for the subtests of the UFOV® measure. Processing speed ability is assessed first with the foveal discrimination task and is determined by the minimum display duration at which the participant can correctly identify the foveal target correctly 75% of the time. The divided attention task (Subtest 2) requires participants to perform this central discrimination task and also to identify the location of a peripheral object appearing briefly in one of eight locations around the periphery of the screen. Again, the minimum display duration resulting in 75% correct performance of both the central identification task and the peripheral location task is determined. The selective attention task (Subtest 3) is similar to the divided attention task, with the exception that the peripheral object is embedded in a field of distractors. Once again, for this task the threshold duration for 75% correct performance is determined. Each of these measures may range from a minimum of 17 ms to a maximum of 500 ms. Display durations greater than 500 ms permit the participant to engage in unwanted eye movements. These three subtests may be combined into a single composite score, or analyzed individually.

Baseline Assessment / One-Time Assessment

All participants (N = 197) provided IRB-approved written informed consent. Based on the parent study eligibility criteria, participants were enrolled for baseline or one-time assessment. For the purposes of this paper, the protocol was identical. The assessment included variables regarding demographic information, cardiovascular function, cognition, mobility, and IADLs. In addition to the natural rest periods in moving from one task to the next, rest periods were available after each set of measures, and upon request.

Demographic Information

Data regarding age, gender, race (Caucasian or minority), and years of education were gathered via self-report. An established questionnaire was used to obtain information regarding current amount of tobacco use (Howard et al., 2005). Much research supports the hazardous effects of tobacco on cardiovascular health (Allan, 1996; Gorelick, 2005; Kane et al., 2004; Roberts, 1996; Stout, 2003). Therefore, the amount of tobacco smoked per day was controlled as in previous research (Elias, Wolf et al., 1993; Robbins, Elias, Elias, & Budge, 2005; Scherr, Hebert, Smith, & Evans, 1991; Van Boxtel et al., 1997). These demographic factors vary between individuals and must be considered when examining the impact of cardiovascular function on outcome variables. This is especially important when the outcome variables involve cognitive function, because many cardiovascular risk factors are also related to cognitive function (e.g., age).

Cardiovascular Function

High blood pressure is one of the most prominent independent risk factors for the development of cardiovascular pathology (Kannel, 1995; Vokanas, 1998). Resting blood pressure was measured by a trained technician, under the supervision of a cardiologist, using the CardioVascular Profiling Instrument (HDI/*PulseWave*™ CR-2000 Research CardioVascular Profiling System, Hypertension Diagnostics, Inc., 2007). For data analysis, the last two blood pressure measurements were averaged separately for both systolic blood pressure and diastolic blood pressure. On average, 3.28 measurements (range: 2 - 7) were taken for each participant.

There is no consensus in the literature regarding whether systolic blood pressure or diastolic blood pressure is most predictive of decreased cognitive function (Gorelick, 2005). Therefore, the averages of each of these variables were used to represent the latent variable "Cardiovascular Function."

Cognitive Function

Four cognitive measures were selected to provide a composite index of cognitive function. The sampled domains include divided attention, non-verbal reasoning, verbal memory, and executive function. Impairments in these areas of cognitive function have previously been associated with cardiovascular pathology. It is recognized that no test is a pure measure of a single domain and that performance on a single test is a minute sample of behavior that at best can only partially represent a given domain. It is further recognized that virtually all tests tap more than one domain.

Divided attention was measured by the Useful Field of View (UFOV®) Subtest 2. See description under "In-Person Screening Measures." As it would be unnecessary to test the participant with this measure twice, their performance on Subtest 2 during the in-person screening was used in these analyses.

Non-verbal reasoning was assessed by the Wechsler Abbreviated Scale of Intelligence (WASI) Matrix Reasoning Subtest. This subtest is a measure of spatial and nonverbal fluid reasoning (Psychological Corporation, 1999). In this task, participants look at a matrix that is missing a section and complete the matrix by saying the number of or pointing to one of five given response choices. Participants' scores represent the number of correct choices made out of 32.

Verbal memory was measured using the Hopkins Verbal Learning Test (HVLT; Brandt, 1991). The HVLT is a measure of word list learning and recall. A 12-word list is presented aurally. After presentation of the last word, the participant is asked to immediately write all words they can remember from the list. The same list is presented three times total. The total sum recalled across the three learning trials was used in these analyses.

Executive Function was estimated by the Controlled Oral Word Association Test (COWAT). The COWAT is a measure of verbal fluency and is widely used as a measure of the productivity and flexibility aspects of executive function (Benton & Hamsher, 1983; Lezak, 1995; Spreen & Strauss, 1998). In this test, participants attempt to generate as many words as possible within one minute that begin with the letter F. This is repeated for the letters A and S. The participant is instructed not to use proper nouns (e.g., Frank) or variations of words they have already provided. The total number of eligible words produced in one minute for each of the three letters is counted. Higher scores represent better executive function.

Outcome Measures – Measures of Everyday Activities

Life Space Assessment™. Life space was assessed using The University of Alabama at Birmingham (UAB) Study of Aging Life-Space Assessment™ (LSA™; Baker et al., 2003) which measures a person's spatial mobility, beginning with their bedroom and moving progressively farther into their life-space (i.e., outside home, beyond own property, beyond own neighborhood, etc.) The purpose of the LSA™ is to determine the extent of one's actual mobility during the preceding month. The LSA™ gathers mobility-related information regarding distance, frequency, and the degree of independence. Two-week test-retest reliability is high (r = .96; Baker et al.). The LSA™ is also significantly correlated with measures of physical performance, ADLs, self-reported IADL difficulty, depression, number of comorbid conditions, and self-reported health (Baker et al.).

Timed IADL Test. The Timed IADL Test involves laboratory measurement of five timed tasks that simulate everyday IADLs (Owsley et al., 2002). Tasks include: finding a telephone number for a given person in the telephone directory; finding and counting out correct change; finding and reading the ingredients on a can of food; finding two food items on a shelf; and finding and reading the directions on a medicine container. For each of the five tasks, there is a pre-set time limit of two minutes, with the exception of the telephone task (i.e., three minutes). Time in seconds required to complete each task is recorded. If the participant does not complete the task in time, testing for that particular task is terminated. Error codes are assigned for each task reflecting whether the task is (1) completed without error within the time limit, (2) completed with minor errors, or (3) not completed within the time limit or completed with major errors. For the tasks completed with minor errors, a time penalty is added. This penalty is equal to one standard deviation, based upon the data from the participants who completed the same item without error. Tasks not completed within the time limit are assigned the maximum value, as are those that are completed with major errors. The times for each of the tasks are transformed into z-scores, which are then summed to form a composite.

Statistical Procedures

Regarding sample size, Schumacker and Lomax (2004) suggest the sample size for Structural Equation Modeling (SEM) analyses be determined by the ratio of cases to measured variables (i.e., 10:1). The sample size (N = 197) exceeds the requirement to analyze the SEM containing 12 variables.

The specific aims of this research were (1) to investigate the effects of cardiovascular function on two measures of everyday activities — life space mobility and performance on a timed IADL task (Timed IADLs), (2) to evaluate the relationship between cardiovascular function and cognitive function, and (3) to determine whether the impact of cardiovascular function on everyday functioning is mediated by cognitive function while simultaneously controlling for other variables known to be associated with cardiovascular function, cognition, and everyday functioning. These aims were tested using SEM.

The SEM analyses were conducted in accordance with Anderson and Gerbing's (1988) algorithm. According to these guidelines, the first step in the SEM analysis involved the specification of a measurement model wherein latent variables were extracted from observed variables. This is important for two reasons. First, the measurement model confirms the stability of the latent variables and enables detection of potential unreliability in observed variables that could bias the results. Second, because the final, trimmed model is always nested within the measurement model, it cannot provide better fit to the data than the measurement model. Therefore, if the measurement model fits the data poorly, the findings from the final model are likely to be biased and unreliable. The measurement model step was followed by the specification of a causal model in which all hypothesized paths were tested. The final step in this process was the analysis of a trimmed model which involved a stepwise deletion of all non-significant paths in the causal model, beginning with the most non-significant, until only significant causal paths remained. It is from the final trimmed model that the data were interpreted.

To test the measurement model, latent variables were extracted for cardiovascular function (average systolic blood pressure and average diastolic blood pressure) and cognition (UFOV® Subtest 2, WASI Matrix Reasoning, HVLT, and COWAT). Next, a causal model was constructed to determine the effects of measured demographic variables (age, gender, race, years of education, number of cigarettes smoked per day), the latent variable "cardiovascular function," and the latent variable "cognition" on everyday functioning. A separate causal model was tested for each measure of everyday functioning (i.e., life space mobility and Timed IADLs).

All SEM analyses were performed using the LISREL 8.50 software system (Jöreskog & Sörbom, 2001). Maximum likelihood estimation was used for all model estimates, and the observed variance-covariance matrix was compared with the model-reproduced matrix using the standard chi-square goodness-of-fit test.

RESULTS

Baseline or one-time assessments were completed for 211 participants. Of those, two participants were missing data for the HVLT and one participant was missing data for the WASI Matrix Reasoning subtest. Linear imputation was used to replace these three values. Data regarding cardiovascular function were missing for 13 participants and all cognitive assessment data were missing for one participant; these cases were deleted from analysis, resulting in a final sample size of n = 197. Those excluded from analysis (n = 14) did not differ from the retained cases in terms of age, $F(1, 209) = 0.61$, $p = 0.43$; race, Fisher's Exact Test, $p = 0.37$; or number of cigarettes smoked per day, $F(1, 209) = 0.05$, $p = 0.83$. However, of the excluded cases, non-participants were more likely to be female, Fisher's Exact Test, $p = 0.02$; and have fewer years of education, $F(1, 209) = 4.01$, $p = 0.05$. General descriptive statistics for the final sample (n = 197) were calculated using SPSS 14.0 software (SPSS, Inc., 2005) and are displayed in Table 1. Simple summary information was used for many of the instruments, such as age, gender, years of education, number of cigarettes smoked per day, UFOV® subtest 2, WASI Matrix Reasoning, HVLT, COWAT, LSA™, and Timed IADL. Ethnicity was dichotomized as Caucasian (coded 1) or minority (coded 2; African American, n = 20; Indian, n = 1). The values presented for both systolic and diastolic blood pressures are the average of the last two readings. As previously mentioned, a composite score was calculated for Timed IADL performance.

In an effort to increase the variability of the sample, participants who did not qualify for the intervention study (i.e., the parent study) were recruited for a one-time assessment based on the same measures as the baseline assessment of the parent study. Comparisons of demographic, cognitive, and everyday function variables are presented in Table 2. In general, participants of minority race were more likely to qualify for the intervention study (i.e., they were more likely to demonstrate speed of processing decrements) Fisher's Exact Test, $p = 0.01$. Based on the qualification criteria, UFOV® performance differed significantly between those participants in the intervention (i.e., participants were required to have UFOV® decrements in order to be recruited into the parent study) and those who were not. No other significant differences were noted.

The correlation matrix for these variables was calculated using SPSS and is presented in Table 3. Standard Pearson's correlations were calculated between pairs of continuous variables; otherwise Spearman's correlations were estimated when one or both variables were measured dichotomously (i.e., race and gender).

As discussed in the Statistical Analysis Methods, two separate SEMs were conducted for each measure of everyday function (i.e., LSA™ and Timed IADLs). Reference variables were identified and specified for the latent variables that had two or more indicator variables. This procedure stabilizes the latent variable while providing a conservative solution by allowing the reference variable to remain in the model without removing its error variance. It also provides a means of easily interpreting the valence of the latent variable. All significant and non-significant paths between latent variables remained constant with or without the modified variable. The independence model tested the hypothesis that all variables are uncorrelated. A full causal model was then specified for each measure of everyday function (i.e., LSA™, Figure 1; Timed IADLs, Figure 2). Many of the paths in the model were non-significant, therefore trimmed models were created by step-wise deletion of the least significant path (based on lowest *t* value) and recalculating model fit. This was continued until only statistically significant paths remained in each model ($p < 0.05$).

Life Space Mobility SEM

For the model evaluating life space mobility (i.e., LSA™), the independence model was rejected, χ^2 (66, N = 197) = 593.34, $p < 0.001$. In general, models that fit the observed data well are associated with low chi-square statistics and a nonsignificant chi-square statistic indicates that there is no difference between the observed variance-covariance data and the data that can be accounted for on the basis of the model. However, it was expected that the chi-square goodness-of-fit statistic would be significant, because its significance is a function of sample size. Therefore, additional fit indices were examined to evaluate overall model fit irrespective of sample size. These are the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), the Parsimony Goodness-of-Fit Index (PGFI), the Normed Fit Index (NFI), the Parsimony Normed Fit Index (PNFI), and the Comparative Fit Index (CFI). These fit indices all range from zero to one, with higher scores (≥ 0.90) representing a better fit. As can be seen by the standard fit indices presented for the trimmed LSA™ model in Table 4 (e.g., GFI = 0.80, AGFI = 0.61), this model provided a poor fit to the observed data, χ^2 (40, N = 197) = 530.36, $p < 0.001$, indicating that the hypothesized relationships between the variables were incorrect. Figure 3 illustrates the fully trimmed model for LSA™, including path coefficients in standardized form.

Timed IADLs SEM

Likewise, the independence model for Timed IADLs was rejected, χ^2 (66, N = 197) = 787.13, $p < 0.001$. The standard fit indices (e.g., GFI = 0.79, AGFI = 0.55) in Table 5 indicate that the fully trimmed causal model provided a poor fit to the observed data, χ^2 (37, N = 197) = 496.05, $p < 0.001$, again indicating that the hypothesized relationships between the variables were incorrect. Figure 4 illustrates the fully trimmed model for Timed IADL performance, including path coefficients in standardized form.

The final trimmed models for both LSA™ and Timed IADLs (Figures 3 – 4) did not fit the data well and thus further interpretations are not relevant or reliable. The suggested modification indices were examined for each trimmed model; however, these suggested modifications did not fit the models conceptually and were disregarded.

Additional Analyses

Given the poor fit of the hypothesized causal models, and in an effort to better understand the data, several additional analyses were completed. Multiple regression analysis was used to evaluate (1) the effect of cardiovascular function on cognition, and (2) the effect of cardiovascular function and cognition on the measures of everyday function. Lastly, the sample was divided into two groups based on AHA criteria for hypertension status. Between-group comparisons of demographics, cognition, and everyday functional measures were conducted.

First, in order to investigate whether the variables associated with cardiovascular function (i.e., systolic and diastolic blood pressure, cigarettes smoked per day) affected cognitive performance, four separate multiple regressions were conducted for each outcome measure of cognitive function (i.e., UFOV® subtest 2, WASI Matrix Reasoning, HVLT, and COWAT; see Tables 6 – 9). Demographic variables (i.e., age, race, gender, and years of education) were controlled. *The results indicated that systolic blood pressure, diastolic blood pressure, and smoking status were not significantly associated with any of the measures of cognitive performance.* Slower divided attention, as measured by performance on the UFOV® subtest 2, was significantly associated with increased age ($\beta = 0.18$, SE = 1.71, t = 2.43, $p = 0.02$), minority race ($\beta = 0.20$, SE = 28.55, t = 2.89, $p = 0.004$), and fewer years of education ($\beta = -0.17$, SE = 3.30, t = -2.45, $p = 0.02$). Likewise, increased age ($\beta = -0.15$, SE = 0.09, t = -2.15, $p = 0.03$), minority race ($\beta = -0.30$, SE = 1.50, t = -4.59, $p < 0.001$), and fewer years of education ($\beta = 0.34$, SE = 0.17, t = 5.25, $p < 0.001$) were also associated with reduced accuracy on WASI Matrix Reasoning. Decreased immediate verbal memory (i.e., the HVLT) was associated with increased age ($\beta = -0.21$, SE = 0.07, t = -3.15, $p = 0.002$), minority race ($\beta = -0.25$, SE = 1.21, t = -4.02, $p < 0.001$), decreased education ($\beta = 0.24$, SE = 0.14, t = 3.90, $p < 0.0001$), and male gender ($\beta = -0.43$, SE = 0.75, t = -6.96, $p < 0.001$). Finally, fewer years of education ($\beta = -0.24$, SE = 0.31, t = 3.45, $p = 0.001$) and male gender ($\beta = -0.19$, SE = 1.65, t = -2.60, $p = 0.01$) were also significantly associated with poorer performance on the COWAT.

Second, two separate multiple regressions were conducted for each measure of everyday function (i.e., LSA™, Timed IADLs; see Tables 10 – 11) in order to evaluate the affect of demographic variables, cardiovascular variables, and cognitive function on each outcome measure. Again, demographic variables (i.e., age, race, gender, years of education) and cardiovascular function variables (i.e., systolic blood pressure, diastolic blood pressure, smoking status) were entered into the model, along with all four cognitive performance measures (i.e., UFOV®, WASI Matrix Reasoning, HVLT, COWAT). None of the measured variables significantly predicted LSA™. In order to address potential multi-colinearity concerns, the four cognitive variables were combined into a standardized composite score, but the cognitive composite score did not significantly predict LSA™.

Alternatively, slower performance on the Timed IADL measure, as indicated by a standardized composite score, was significantly associated with increased age ($\beta = 0.19$, $SE = 0.06$, $t = 3.03$, $p = 0.003$), minority race ($\beta = 0.19$, $SE = 0.97$, $t = 2.92$, $p = 0.004$), and decreased immediate verbal memory ($\beta = -0.35$, $SE = 0.06$, $t = -4.72$, $p < 0.001$), as measured by the HVLT. Follow-up analyses indicated that participants who performed more poorly on the HVLT were specifically more likely to require more time to read ingredients from cans of food, locate grocery items on a shelf, and read directions on medication containers.

Finally, in an attempt to more thoroughly evaluate the associations between cardiovascular function, cognition, and everyday activities, this generally healthy sample of older adults was divided into two groups based on hypertension criteria from the AHA (2008). Participants with an average systolic blood pressure reading of ≥ 140 mmHg (n = 84) or those with an average diastolic blood pressure reading of ≥ 90 mmHg (n = 4, all of whom also had elevated systolic blood pressure) were classified as hypertensive (n = 84).

These participants did not differ from the remaining sample (n = 113) on any demographic measure, except that those with hypertension had slightly fewer years of education, $F(1, 209) = 4.01$, $p < 0.05$. See Table 12.

Separate analyses of variance were conducted to compare the hypertensive group to the non-hypertensive group with respect to each of the four cognitive measures (i.e., UFOV® subtest 2, WASI Matrix Reasoning, HVLT, COWAT). Age, race, gender, years of education, and current cigarette use were controlled. No group differences were noted on any of the four cognitive measures. Again, to address possible issues of multicolinearity, the same analysis was conducted using a standardized composite of cognitive function, but no group differences resulted, $F(1, 190) = 1.56$, $p = 0.21$. Results are presented in Table 13.

Likewise, the demographic variables (age, race, gender, years of education, and current cigarette use) and the standardized cognitive composite were controlled in order to evaluate group differences with respect to the everyday functional measures (i.e., LSA™, Timed IADLs). No differences in everyday function were noted between those older adults with hypertension and those without. Results are presented in Table 14.

DISCUSSION

The purpose of this study was to determine whether cardiovascular health, as measured by blood pressure and cigarette consumption, is associated with cognitive function and everyday activities in older adults. The study sought to recruit a wide range of older adults who were relatively healthy in order to evaluate the proposed hypotheses. Specifically, it was hypothesized that (1) poorer cardiovascular function would be associated with poorer cognitive function; (2) poorer cardiovascular function would be associated with reduced life space mobility and slower performance on Timed IADLs; and (3) cardiovascular function would remain an independent predictor of life space mobility and Timed IADLs, even after controlling for demographic and cognitive differences.

As reported, the proposed relationships among these variables, as tested by SEM analyses, were not supported, meaning that the data from this sample were not consistent with the hypothesized relationships. In order to better understand the data, additional analyses (i.e., multiple regression, ANOVA) were conducted. Overall, no significant associations between cardiovascular health (i.e., blood pressure or cigarette smoking) and cognition resulted. These results are in contrast to numerous studies in the literature which have specifically linked hypertension, and even high blood pressure in normotensives, to decrements in cognitive performance (Elias, Robbins, et al., 1990; Harrington et al., 2000; Waldstein et al., 2005). In particular, hypertension is most frequently linked to decrements in the learning, memory, attention, abstract reasoning and other executive functions, as well as visual-spatial, perceptual and psychomotor abilities (see Waldstein et al., 2005). Decrements in speed and/or accuracy have also been noted in numerous domains involving reaction time, visual scanning, word and picture recognition, and spatial memory (Harrington et al., 2000).

However, some researchers have reported that blood pressure is not a significant contributor to cognitive performance in older adults. Van Boxtel and colleagues (1997) controlled for age, sex, and educational level and found no association between systolic or diastolic blood pressure and verbal memory or speed of information processing. Likewise, a longitudinal analysis by Hebert and colleagues (2004) that controlled for age, sex, education, and race indicated that neither systolic or diastolic blood pressure were associated with cognitive decline (i.e., immediate story memory, delayed story memory, the oral version of the Symbol-Digit Modalities Test, or the MMSE) over a six year period. Interestingly, André-Petersson and colleagues (2001) reported that mild hypertension (Stage 1; SBP 140-159 mmHg or DBP 90-99 mmHg) was associated with increased performance on measures of verbal and constructional ability.

It is difficult to determine whether the literature contains a pattern of results. For example, while some results link elevated diastolic blood pressure to decreased processing speed (Elias et al., 1990), other research reports no association (Van Boxtel et al., 1997). In general, there is evidence that increased blood pressure, even among those without hypertension, is associated with decreased cognitive performance. When decrements are reported, it does not seem to matter whether blood pressure was analyzed as a continuous variable or whether blood pressure measurements were used to categorize participants (e.g., hypertensive vs. normotensive). This is intuitive, but analyzing blood pressure as a continuous variable preserves more information about the data (i.e., specific systolic and diastolic values), avoids problems encountered when hypertension definitions change, and also provides more fine-grain information regarding the association(s) between blood pressure and the outcome variable(s).

As mentioned, performance decrements in the four cognitive domains measured in this study have been associated with impairments in activities of everyday life in other research (Kelly-Hayes, Jette, Wolf, D'Agostino, & Odell, 1992; Royall, Palmer, Chiodo, & Polk, 2005; Stuck et al., 1999). In this study, given that blood pressure was not associated with cognitive performance, it is also reasonable that no significant associations between blood pressure and everyday function were observed.

In addition, cardiovascular health was not significantly related to Timed IADLs or life space mobility. This is in contrast to earlier research that linked hypertension to increased self-reported difficulty on ADLs (e.g., bathing, dressing), IADLs (e.g., shopping, managing money), and an in-laboratory physical function test (e.g., 10-foot timed walk, standing balance, grip strength; Wang et al., 2002). Importantly, the null finding reported herein may be because this sample was generally healthy (according to self-report). Therefore, more serious limitations in daily activities might not become apparent until cardiovascular disease, including coronary heart disease and chronic hypertension, becomes more chronic and severe (Wang et al., 2002).

There are several potential reasons for these null findings. Initially, this study intended to evaluate only those participants who were enrolled in the parent study. However, in an attempt to increase the variability of the sample, all who did not qualify for the intervention study during the in-person screening, yet had already passed the telephone screening, were recruited, as well. As can be seen in Table 2, a comparison of those enrolled and excluded from the parent study revealed that the two groups did not differ with respect to age, gender, years of education, smoking status, blood pressure, cognitive function, life space mobility, or performance on Timed IADLs. As expected, the two groups differed on speed-of-processing (UFOV® performance), given that this was one of the measures that determined parent study eligibility (i.e., some decrement was required for enrollment).

Eligibility also varied by race. Non-Caucasian participants were more likely to demonstrate UFOV® impairment and were thus significantly more likely to be enrolled in the parent study. This is generally consistent with results reported by Schwartz and colleagues (2004) who stated that African Americans performed significantly worse than Caucasian Americans across numerous cognitive measures, even when educational status, household income, household assets, occupational status, health-related behaviors, health conditions, and blood lead were controlled. Regardless, the composition of the entire sample was primarily Caucasian (n = 176 of N = 197). In summary, recruiting and enrolling those participants who did not qualify for the parent study did not increase the variability of the sample.

As mentioned, additional analyses, including multiple regressions and ANOVAs, were conducted. In general, the sample was too homogenous for significant differences related to cardiovascular health to emerge. This homogeneity is most likely the result of the stringent telephone screening criteria that all participants were required to meet. For example, all participants reported relatively good cardiovascular health, including no history of heart disease or MI, no history of coronary artery bypass graft surgery, and no uncontrolled hypertension. In addition, participants also endorsed having a relatively sedentary lifestyle, specifically they had not engaged in more than one hour of exercise per week during the past year. All participants denied having conditions known to have actual or potential cognitive impairment including Alzheimer's disease, diabetes mellitus (Gorelick, 2005), or current chemotherapy or radiation treatment for cancer (Kvale et al., submitted; Tannock et al., 2004). Further, participants were able and willing to travel to the assessment site and reported no physical impairments that would prevent potential exercise training, had they been enrolled in the parent study and randomized to exercise training. These restrictions clearly limited the range of the cardiovascular variables, and may also have limited the range of some of the cognitive and mobility variables of interest.

Interestingly, although the telephone screen was intended to exclude adults with uncontrolled hypertension, 42.6% of the total sample (N = 197) had blood pressure measurements during the assessment that met AHA criteria for hypertension. Equal rates of hypertension were found among men and women, which is consistent with other research. Overall, men are more likely to develop cardiovascular disease in middle age, but the incidence rate among women increases with age (Taylor & Simpson, 2000). However, in this sample, the hypertensive and non-hypertensive groups did not differ on race, which is in contrast to the majority of findings in the literature. African Americans are more likely than Caucasians to develop hypertension, and the condition is more likely to occur earlier and be more severe (AHA, 2008; Greenlund, Croft, & Mensah, 2004).

However, one significant difference was noted. Participants who were classified as hypertensive reported significantly fewer years of education (M = 14.48, SD = 2.36) than participants without hypertension (M = 14.96, SD = 2.38). Although this is consistent with data reported by van Boxtel and colleagues (1997), Waldstein and colleagues (2005), as well as the AHA (2008), it should be noted that the difference between the two groups in this sample is approximately one-half year of education and thus may not be clinically significant.

Although none of the predicted associations were significant, ANOVA comparisons based on hypertensive status concluded that most findings were in the expected direction. Consistent with other research, participants who met the AHA criteria for hypertension were more likely to demonstrate poorer performance in the cognitive domains of speed of processing (Cohen's d = 0.34, small-to-moderate effect size; power = 0.651; for example, Elias et al., 1990), non-verbal matrix reasoning (Cohen's d = 0.004, trivial effect size; power = 0.050; for example, Trojano et al., 2003), short-term verbal memory (Cohen's d = 0.08, trivial effect size; power = 0.084; for examples, Elias et al., 1995[a]; Elias et al., 1995[b]; Elias, Wolf et al., 1993; Trojano et al., 2003), and verbal fluency (Cohen's d = 0.14, small effect size; power = 0.154; for example, Trojano et al., 2003). Hypertensives also performed more slowly on Timed IADLs (Cohen's d = 0.08, trivial effect size; power = 0.089), which seems logical given their poorer performance on the cognitive measures. Unexpectedly, older adults with hypertension reported greater life space mobility (Cohen's d = 0.12, small effect size; power = 0.137) than those without hypertension. Although it is not possible to explain exactly why older adults with hypertension had a greater life space, possible reasons include more frequent travels for health-related reasons, such as visits to the physician's office or pharmacy.

Given these generally small effect sizes, power analyses (power = 0.80; Cohen, 1988), indicate that at minimum N = 274 participants would have been necessary to observe significant between-group differences on the UFOV®. The effect sizes for the other measures indicate that a sample sizes ranging from N = 2,044 (LSA™) to N = 1,746,368 (Matrix Reasoning) would have been necessary to observe significant group differences. In sum, it is reasonable that recruitment of a larger sample (N = 274 vs. N = 197) may have yielded significant results for the UFOV®, which had a small-to-moderate effect size. However, the other effect sizes were so minimal that a very large sample would be required in order to observe significant group differences. Finally, it is also possible that a wider sampling of the population would have yielded more pronounced group differences.

There are several limitations of this study, many of which have already been addressed. First, the exclusivity of the telephone screening criteria was so strict that the resulting sample was fairly homogenous (i.e., generally healthy, no neurological diseases, mobile, etc.). In an attempt to increase the variability of the sample, recruitment was expanded to include nearly all participants who presented at the in-person screening. Table 2 succinctly depicts the similarities between those who were enrolled in the parent study and those who were not. Therefore, although recruitment criteria were broadened, it did not have a significant impact on the variability of the sample. The participants, overall, were high functioning, healthy older adults and thus it was difficult to parse out meaningful differences that were related to cardiovascular health.

Second, the research protocol originally intended to gather objective data regarding cholesterol levels from all participants, but that component of the study was not

IRB-approved until data collection was nearly complete. The AHA and the American College of Cardiology (Grundy, Pasternak, Greenland, Smith, & Fuster, 1999) report that elevated cholesterol levels are a major independent risk factor for the development of cardiovascular disease and may also be associated with increased risk of vascular dementia (Gorelick, 2005). Therefore, it would have been interesting to evaluate if cholesterol levels are related to cognitive or functional performance in older adults without more serious cardiovascular disease.

Finally, participant medical history regarding hypertensive status is vague. The telephone screen excluded only participants with “uncontrolled high blood pressure,” thereby including those participants who endorsed 1) a previous diagnosis of high blood pressure that is now “under control” or 2) reported no previous diagnosis of high blood pressure. Assessing medical conditions in this way is common (Ball et al., 2002), but necessarily limits certain objective data. For example, data regarding chronicity and severity of hypertension, as well as data related to pharmacological treatment (i.e., formulation, dosage, duration, or compliance), were not obtained. Had this information been available, it may have been possible to identify more precisely any relationships between hypertension, cognition, and everyday activities.

As mentioned, this study was an addition to a large-scale intervention study with an inherently restricted sample. Perhaps the strong point of this study is that with this very select population, it can be concluded that cardiovascular health, as measured by smoking status and systolic and diastolic blood pressure, does not affect cognition, life space mobility, or performance on a timed measure of IADLs in generally healthy, community-dwelling, older adults.

CONCLUSION

Although the hypothesized relationships between cardiovascular function, cognition, and everyday activities were not significantly related, as demonstrated by the SEMs, further analyses indicated that many of the results were in the expected direction. For example, older adults with hypertension demonstrated slower speed of processing and performed more poorly on measures of non-verbal matrix reasoning, short-term verbal memory, and verbal fluency. In order to improve this study, and possibly demonstrate significant pathways of the hypothesized relationships, recruitment of a wider range of adults would be necessary.

As discussed, this sample was intentionally limited to adults without serious cardiovascular disease, and those previously diagnosed with hypertension indicated that their blood pressure was controlled with medications. In the future, it would be useful to recruit a more heterogeneous sample with regard to cardiovascular health. Doing so may have two potential implications. First, it would increase the likelihood of determining whether the four cognitive measures and two everyday function measures are sensitive to cardiovascular health. Specifically, it is possible that performance on the cognitive and everyday function measures used in this study is unrelated to cardiovascular health, and thus even older adults with more serious cardiovascular disease would not demonstrate impairment on these measures. Second, if these measures are related to cardiovascular health, a more diverse sample might reveal at what performance levels association(s) are apparent. Given the rate at which the population is aging, in conjunction with the prevalence rates of cardiovascular disease, more research is needed regarding the relationships between aging, cardiovascular health, cognition, and everyday activities.

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Table 1 Sample Characteristics

Variable	*N* *(197)*	%	*M*	*SD*	Range
Gender					
Female	102	51.8			
Male	95	48.2			
Ethnicity					
Caucasian	176	89.3			
Minority	21	10.7			
Age in years			74.94	5.44	65.24 – 96.44
Years of education			14.75	2.63	7.00 – 20.00
Number of cigarettes per day			0.61	4.81	0 – 60.00
Systolic BP (mmHg)			138.54	19.08	98.00 – 198.50
Diastolic BP (mmHg)			71.93	9.59	47.00 – 97.50
UFOV® subtest 2 (msec; possible range 17 – 500)			168.15	125.18	17 – 500
Matrix Reasoning (# correct; possible range 0 – 32)			17.92	7.02	3 – 28
HVLT (# correct; possible range 0 – 36)			25.87	6.03	4 – 36
COWAT (FAS total words)			33.31	11.55	1 – 69
LSA™ (raw score; possible range 0 – 120)			92.74	17.49	44.00 – 120.00
Timed IADL composite (z-score of performance time)			0.00	4.61	-4.87 – 25.88

Notes. BP = blood pressure; UFOV® = Useful Field of View test; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test; LSA™ = Life Space Assessment™; IADL = Instrumental Activities of Daily Living

Table 2 Participant Characteristics Based on Parent Study Eligibility

Variable	Eligible (n = 107)	Not Eligible (n = 90)	F or χ^2	p or *FET*
Gender			0.03	0.86
Female, *n (%)*	56 (52.3)	46 (51.1)		
Male, *n (%)*	51 (47.7)	44 (48.9)		
Ethnicity			-	0.01**
Caucasian, *n (%)*	90 (84.1)	86 (95.6)		
Minority, *n (%)*	17 (15.9)	4 (4.4)		
	M (SD)	*M (SD)*		
Age in years	75.43 (5.24)	74.36 (5.65)	1.90	0.17
Years of education	14.46 (2.43)	15.10 (2.82)	2.95	0.09
Number of cigarettes per day	0.19 (1.36)	1.11 (6.94)	1.81	0.18
Systolic BP (mmHg)	139.87 (20.14)	136.95 (17.71)	1.15	.29
Diastolic BP (mmHg)	72.34 (9.38)	71.43 (9.87)	0.44	0.51
UFOV® subtest 2 (msec; possible range 17 – 500)	244.48 (105.60)	77.40 (76.80)	155.89	<0.01**
WASI Matrix Reasoning (# correct; possible range 0 – 32)	17.36 (6.96)	18.58 (7.07)	1.46	0.23
HVLT (# correct; possible range 0 – 36)	25.30 (5.83)	26.54 (6.22)	2.10	0.15
COWAT (FAS total words)	33.38 (12.53)	33.22 (10.33)	0.01	0.92
LSA™ (raw score; possible range 0 – 120)	91.15 (17.70)	94.63 (17.14)	1.95	0.16
Timed IADL composite (z-score of performance time)	0.27 (4.45)	-0.34 (4.79)	0.90	0.34

Notes. FET = Fisher's Exact Test; UFOV® = Useful Field of View; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test (FAS version); LSA™ = Life Space Assessment™; IADL = Instrumental Activities of Daily Living; $*p < .05$; $**p < .01$.

Table 3 <u>Correlation Matrix Using Defined Variables From SPSS</u>

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender (o)	1.00											
2. Ethnicity (o)	-0.14	1.00										
3. Age (c)	0.04	-0.16*	1.00									
4. Years of Education (c)	0.10	-0.01	-0.14*	1.00								
5. Cigarettes per day (c)	-0.05	0.13	-0.04	0.01	1.00							
6. Systolic BP (c)	-0.03	0.14	0.10	-0.03	0.003	1.00						
7. Diastolic BP (c)	0.05	0.18*	-0.17*	0.04	-0.06	.69**	1.00					
8. UFOV® subtest 2 (c)	0.04	0.16*	0.20**	-0.20**	-0.07	0.11	0.03	1.00				
9. Matrix Reasoning (c)	-0.04	-0.27**	-0.17*	0.36**	0.02	-0.04	0.01	-0.21**	1.00			
10. HVLT (c)	-0.41**	-0.17*	-0.23**	0.23**	0.06	-0.05	-0.06	-0.26**	0.37**	1.00		
11. COWAT (c)	-0.19**	-0.05	0.03	0.22**	-0.01	-0.05	-0.10	-0.02	0.23**	0.31**	1.00	
12. LSA™ (c)	0.09	-0.01	-0.05	0.14	-0.002	0.10	0.11	-0.06	0.07	0.06	0.10	1.00
13. Timed IADL (c)	0.23**	0.20**	0.32**	-0.24**	-0.03	0.06	-0.06	0.24**	-0.37**	-0.52**	-0.23**	-0.01

Notes. (c) = continuous variable; (o) = ordinal variable; BP = blood pressure; UFOV® = Useful Field of View; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test; LSA™ = Life Space Assessment™; IADL = Instrumental Activities of Daily Living. *$p < .05$; **$p < .01$.

Table 4 Fit Measures of Causal and Trimmed Models for Life Space Assessment™

	χ^2 (df)	GFI	AGFI	PGFI	NFI	CFI	PNFI
Full Causal model	521.63 (34)	0.81	0.55	0.35	0.12	0.08	0.06
Trimmed model	530.36 (40)	0.80	0.61	0.41	0.11	0.07	0.06

Notes. GFI = goodness-of-fit; AGFI = adjusted goodness-of-fit index; PGFI = parsimony goodness-of-fit index; NFI = normed fit index; comparative fit index; PNFI = parsimony normed fit index.

Table 5 Fit Measures of Causal and Trimmed Models for Timed IADL

	χ^2 (df)	GFI	AGFI	PGFI	NFI	CFI	PNFI
Full Causal model	490.00 (34)	0.79	0.52	0.35	0.38	0.37	0.19
Trimmed model	496.05 (37)	0.79	0.55	0.37	0.37	0.36	0.21

Notes. GFI = goodness-of-fit; AGFI = adjusted goodness-of-fit index; PGFI = parsimony goodness-of-fit index; NFI = normed fit index; comparative fit index; PNFI = parsimony normed fit index.

Table 6 Multiple Regression Analysis for Variables Predicting UFOV® Subtest 2

Variable	B	SE B	β
Age	4.14	1.71	0.18*
Ethnicity	82.37	28.55	0.20**
Gender	24.89	17.63	0.10
Years of education	-8.09	3.30	-0.17*
Cigarette use	-1.63	1.79	-0.06
Systolic BP	0.71	0.66	0.11
Diastolic BP	-0.73	1.34	-0.06

Notes. N = 197; UFOV® = Useful Field of View; BP = blood pressure; $*p < .05$; $**p < .01$.

Table 7 Multiple Regression Analysis for Variables Predicting Matrix Reasoning

Variable	B	SE B	β
Age	-0.19	0.09	-0.15*
Ethnicity	-6.86	1.50	-0.30**
Gender	-1.59	0.92	-0.11
Years of education	0.91	0.17	0.34**
Cigarette use	0.02	0.09	0.01
Systolic BP	-0.01	0.04	-0.03
Diastolic BP	0.04	0.07	0.06

Notes. N = 197; BP = blood pressure; *$p < .05$; **$p < .01$.

Table 8 Multiple Regression Analysis for Variables Predicting HVLT Total Recall

Variable	B	SE B	β
Age	-0.23	0.07	-0.21**
Ethnicity	-4.88	1.21	-0.25**
Gender	-5.21	0.75	-0.43**
Years of education	0.55	0.14	0.24**
Cigarette use	0.09	0.08	0.07
Systolic BP	-0.001	0.03	-0.003
Diastolic BP	-0.01	0.06	-0.02

Notes. N = 197; HVLT = Hopkins Verbal Learning Test; BP = blood pressure; *$p < .05$; **$p < .01$.

Table 9 Multiple Regression Analysis for Variables Predicting COWAT

Variable	B	SE B	β
Age	0.10	0.16	0.05
Ethnicity	-2.25	2.68	-0.06
Gender	-4.30	1.65	-0.19*
Years of education	1.07	0.31	0.24**
Cigarette use	-0.02	0.17	-0.01
Systolic BP	0.01	0.06	0.02
Diastolic BP	-0.11	0.13	-0.09

Notes. N = 197; COWAT = Controlled Oral Word Association Test (FAS version); BP = blood pressure; *$p < .05$; **$p < .01$.

Table 10 Multiple Regression Analysis for Variables Predicting LSA™

Variable	B	SE B	β
Age	-0.09	0.26	-0.03
Ethnicity	-0.38	4.58	-0.01
Gender	4.05	2.92	0.12
Years of education	0.55	0.54	0.08
Cigarette use	-0.04	0.26	-0.01
Systolic BP	0.08	0.10	0.09
Diastolic BP	0.08	0.20	0.04
UFOV® Subtest 2	-0.01	0.01	-0.04
WASI Matrix Reasoning	-0.02	0.21	-0.01
HVLT Total Recall	0.15	0.27	0.05
COWAT	0.14	0.12	0.09

Notes. N = 197; LSA™ = Life Space Assessment™; BP = blood pressure; UFOV® = Useful Field of View®; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test (FAS version); *$p < .05$; **$p < .01$.

Table 11 Multiple Regression Analysis for Variables Predicting Timed IADL

Variable	B	SE B	β
Age	0.17	0.06	0.20**
Ethnicity	2.82	0.97	0.19**
Gender	0.27	0.62	0.03
Years of education	-0.11	0.11	-0.06
Cigarette use	-0.01	0.06	-0.01
Systolic BP	0.02	0.02	0.09
Diastolic BP	-0.07	0.04	-0.15
UFOV® Subtest 2	0.001	0.002	0.04
WASI Matrix Reasoning	-0.06	0.05	-0.10
HVLT Total Recall	-.27	0.06	-0.35**
COWAT	-.04	0.03	-0.09

Notes. N = 197; IADL = Instrumental Activities of Daily Living; BP = blood pressure; UFOV® = Useful Field of View®; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test (FAS version); *p < .05; **p < .01.

Table 12 Participant Characteristics of Hypertensives and Non-Hypertensives

Variable	Htn (n = 84)	Non-Htn (n = 113)	*F*	*p* or *FET*
Gender			-	0.89
Female, *n (%)*	44 (52.4)	58 (51.3)		
Male, *n (%)*	40 (47.6)	55 (48.7)		
Ethnicity			-	0.07
Caucasian, *n (%)*	71 (84.5)	105 (92.9)		
Minority, *n (%)*	13 (15.5)	8 (7.1)		
	M (SD)	*M (SD)*		
Age in years	75.40 (5.57)	74.60 (5.35)	0.614	0.43
Years of education	14.48 (2.36)	14.96 (2.80)	4.011	0.05*
Number of cigarettes per day	0.95 (6.70)	0.35 (2.65)	0.046	0.83
Systolic BP (mmHg)	156.13 (13.48)	125.47 (9.90)	338.82	<0.01**
Diastolic BP (mmHg)	77.98 (8.20)	67.43 (7.95)	82.71	<0.01**

Notes. Htn = hypertension; FET = Fisher's Exact Test; BP = blood pressure; *$p < .05$; **$p < .01$.

Table 13 Cognitive Comparisons of Hypertensives and Non-Hypertensives

Variable	Htn n = 84 M (SD)	Non-Htn n = 113 M (SD)	F	*P*
UFOV® subtest 2 (msec; possible range 17 – 500)	192.69 (139.68)	149.90 (110.35)	2.37	0.13
WASI Matrix Reasoning (# correct; possible range 0 – 32)	17.90 (7.31)	17.93 (6.83)	3.50	0.06
HVLT (# correct; possible range 0 – 36)	25.59 (6.75)	26.07 (5.45)	0.97	0.33
COWAT (FAS total words)	32.42 (10.87)	33.97 (12.04)	0.04	0.85
Standardized Cognitive Composite	0.07 (2.41)	-.05 (2.04)	1.56	0.21

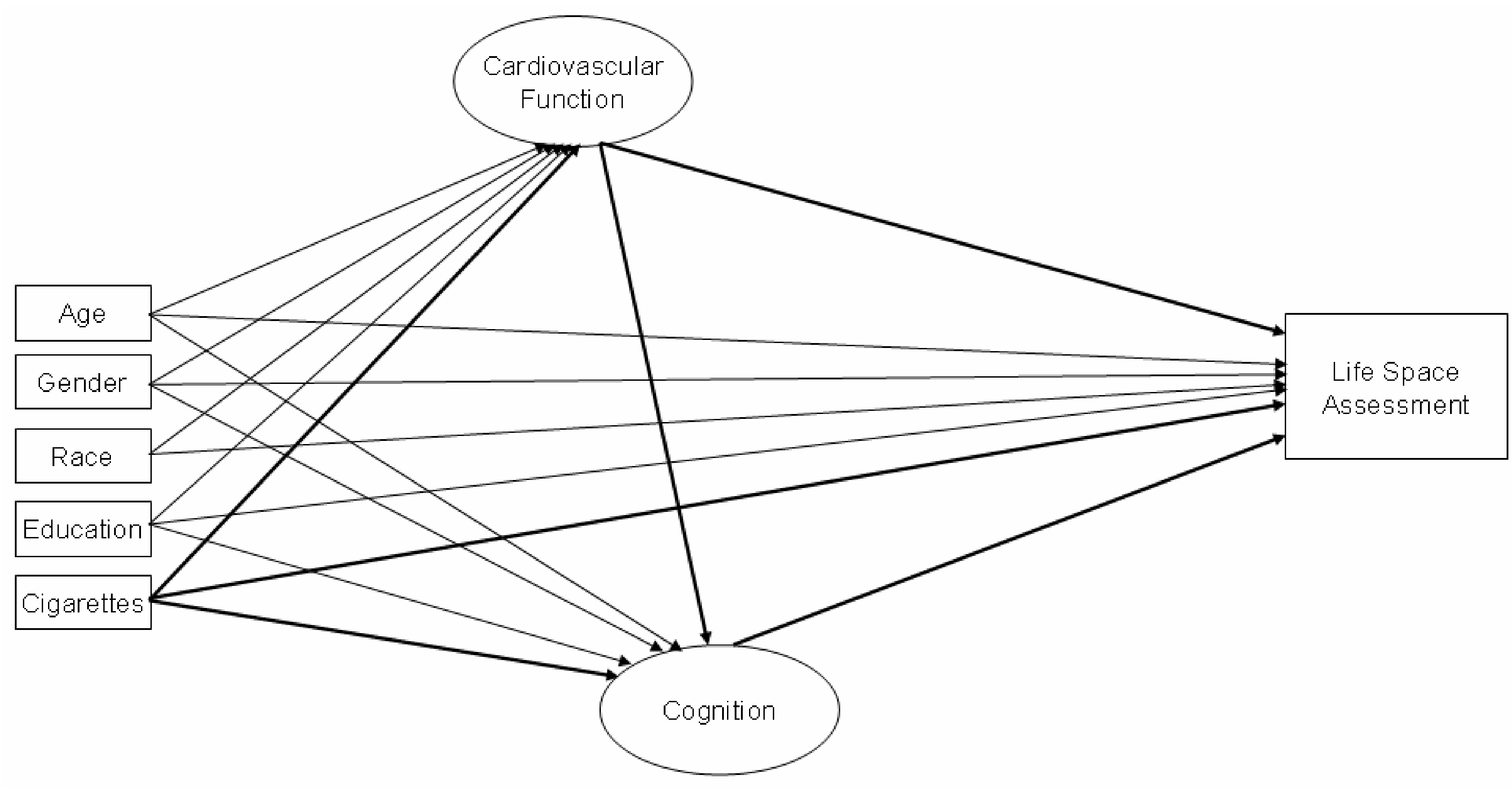
Notes. Controlling for age, gender, race, years of education, cigarette use, and systolic and diastolic blood pressure. Htn = hypertension; UFOV® = Useful Field of View test; HVLT = Hopkins Verbal Learning Test; COWAT = Controlled Oral Word Association Test. *$p < .05$; **$p < .01$.

Table 14 Comparison of Everyday Functional Measures between Hypertensives and Non-Hypertensives

Variable	Htn n = 84 M (SD)	Non-Htn n = 113 M (SD)	F	*p*
LSA™ (raw score; possible range 0 – 120)	93.98 (16.80)	91.82 (18.01)	1.07	0.30
Timed IADL composite (z-score of performance time)	0.22 (4.90)	-0.17 (4.39)	0.07	0.79

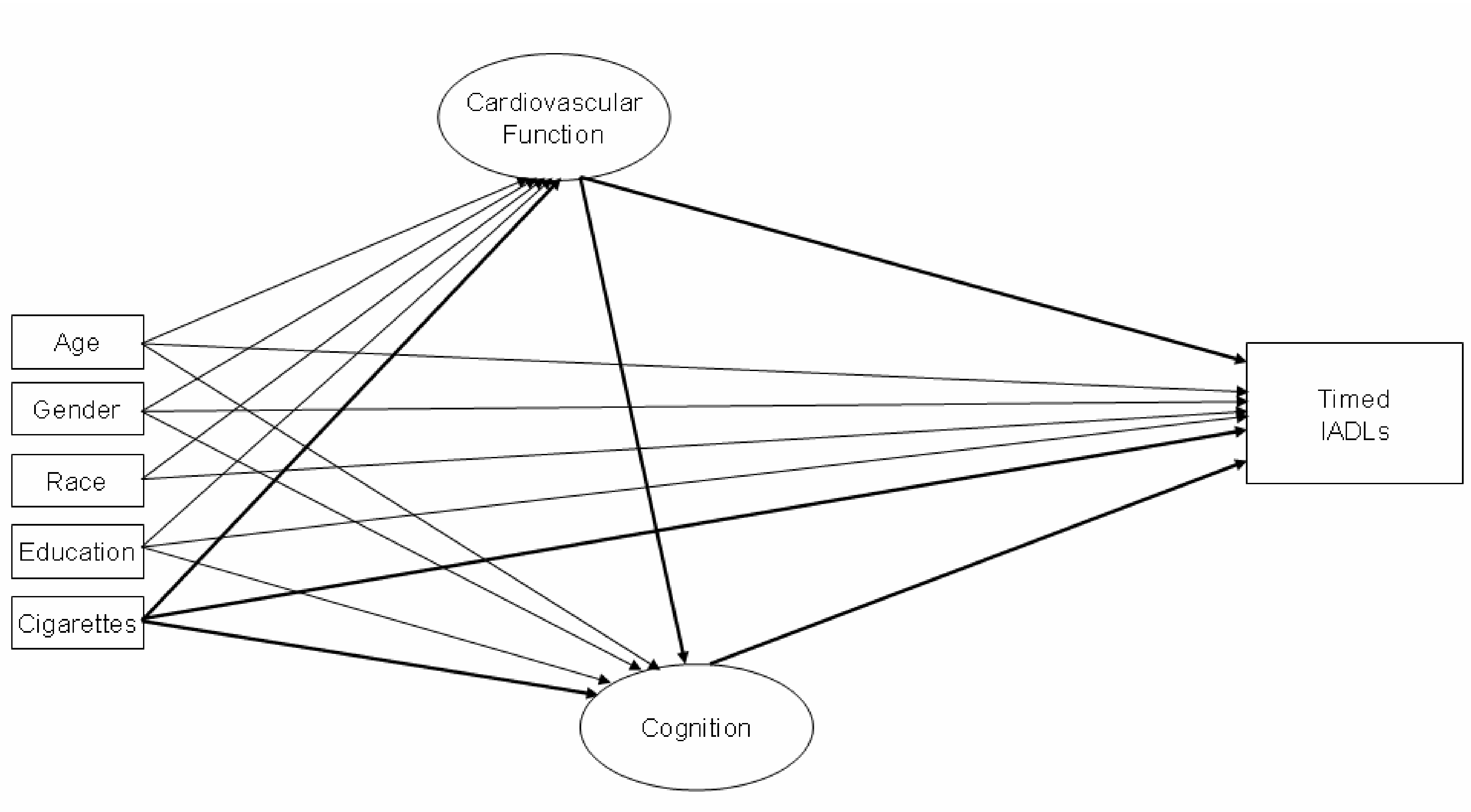
Notes. Controlling for age, gender, race, years of education, cigarette use, systolic and diastolic blood pressure, and cognitive function. Htn = hypertension; LSA™ = Life Space Assessment™; IADL = Instrumental Activities of Daily Living.

Figure 1 Proposed Causal Model of Factors that Contribute to Life Space Mobility



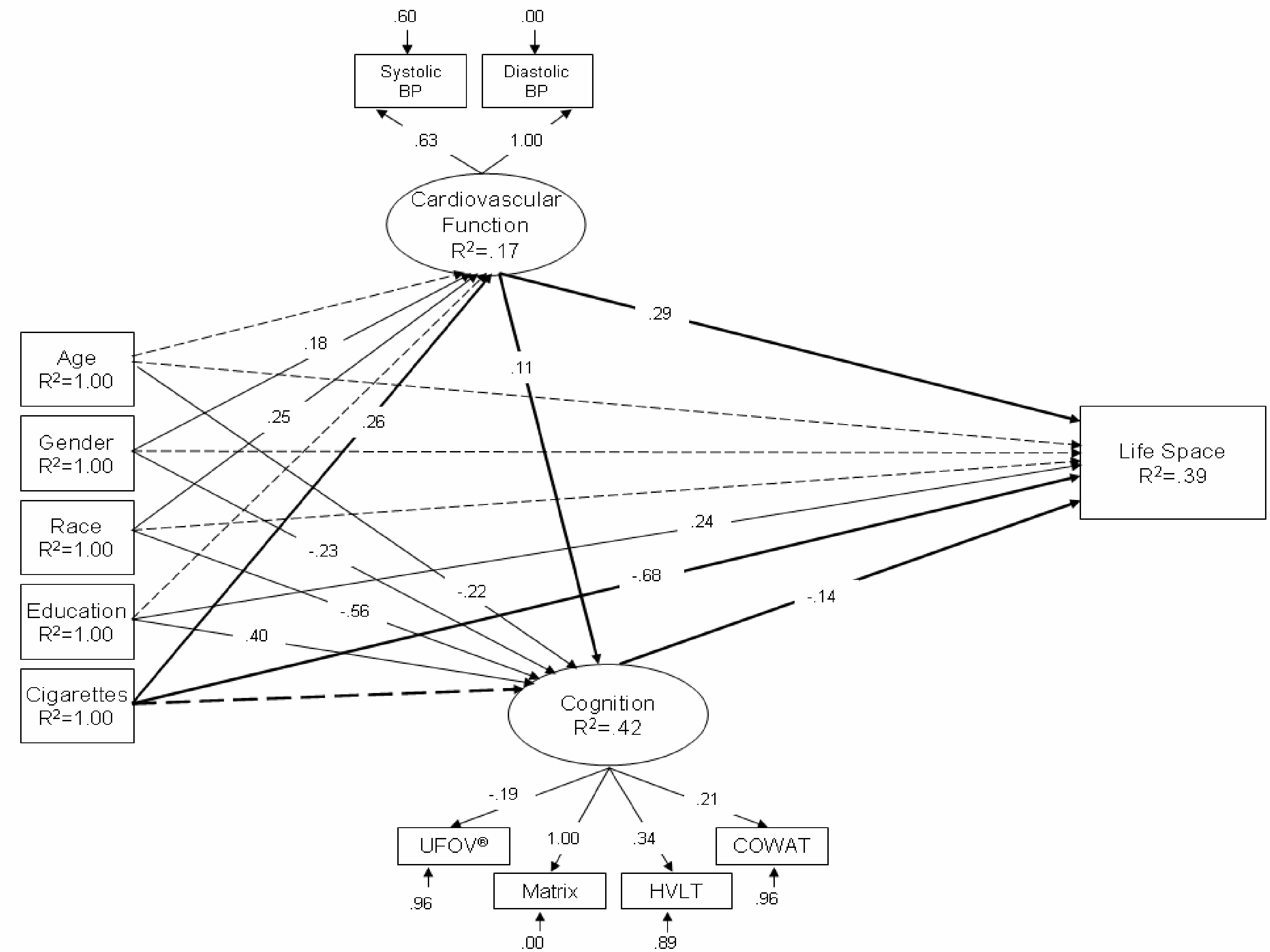
Notes. Thick lines represent primary paths of interest. Thin lines represent causal paths of demographic variables.

Figure 2 Proposed Causal Model of Factors that Contribute to Timed IADLs



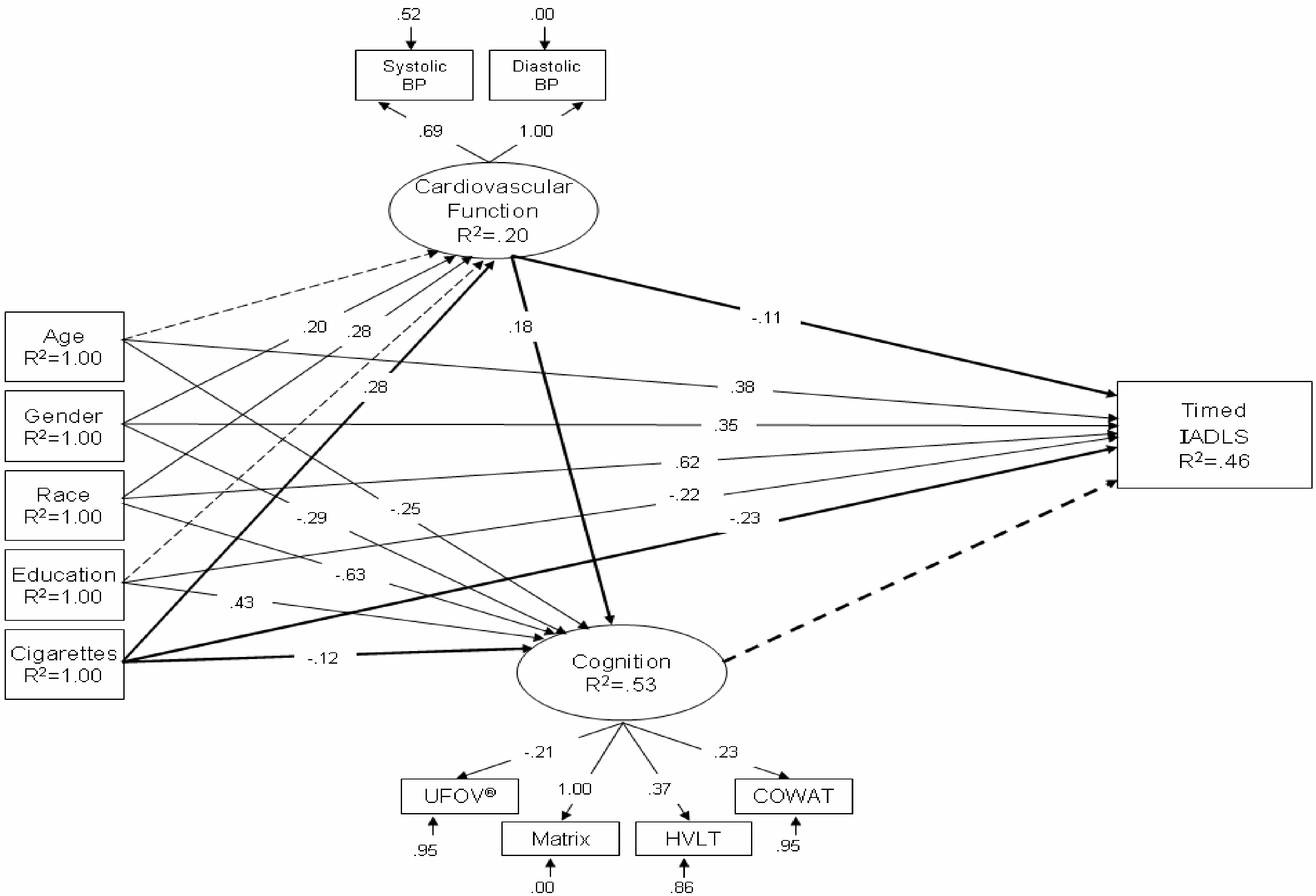
Notes. Thick lines represent primary paths of interest. Thin lines represent causal paths of demographic variables.

Figure 3 Trimmed Causal Model of Life Space Mobility



Notes. Standardized solution. All solid lines represent significant effects ($p \leq .05$); bold lines represent paths of study interest; broken lines indicate non-significant pat of interest.

Figure 4 Trimmed Causal Model of Timed IADLs



Notes. Standardized solution. All solid lines represent significant effects ($p \leq .05$); bold lines represent paths of study interest; broken lines indicate non-significant pat of interest.

APPENDIX

OMB No. 0990-0263
Approved for use through 11/30/2008

Protection of Human Subjects
Assurance Identification/IRB Certification/Declaration of Exemption
(Common Rule)

Policy: Research activities involving human subjects may not be conducted or supported by the Departments and Agencies adopting the Common Rule (56FR28003, June 18, 1991) unless the activities are exempt from or approved in accordance with the Common Rule. See section 101(b) of the Common Rule for exemptions. Institutions submitting applications or proposals for support must submit certification of appropriate Institutional Review Board (IRB) review and approval to the Department or Agency in accordance with the Common Rule.

Institutions must have an assurance of compliance that applies to the research to be conducted and should submit certification of IRB review and approval with each application or proposal unless otherwise advised by the Department or Agency.

1. Request Type	2. Type of Mechanism	3. Name of Federal Department or Agency and, if known, Application or Proposal Identification No.
[ ] ORIGINAL [X] CONTINUATION [ ] EXEMPTION	[ ] GRANT [ ] CONTRACT [ ] FELLOWSHIP [ ] COOPERATIVE AGREEMENT [ ] OTHER:______	

4. Title of Application or Activity	5. Name of Principal Investigator, Program Director, Fellow, or Other
Cardiovascular Function and Everyday Mobility in Older Adults (Improvement of Visual Processing in Older Adults)	VIAMONTE, SARAH M

6. Assurance Status of this Project *(Respond to one of the following)*

[X] This Assurance, on file with Department of Health and Human Services, covers this activity:
Assurance Identification No. FWA00005960______, the expiration date 09/19/2010 IRB Registration No. IRB00000196

[ ] This Assurance, on file with *(agency/dept)*______, covers this activity.
Assurance No.______, the expiration date______ IRB Registration/Identification No.______ *(if applicable)*

[ ] No assurance has been filed for this institution. This institution declares that it will provide an Assurance and Certification of IRB review and approval upon request.

[ ] Exemption Status: Human subjects are involved, but this activity qualifies for exemption under Section 101(b), paragraph______.

7. Certification of IRB Review (Respond to one of the following IF you have an Assurance on file)

[X] This activity has been reviewed and approved by the IRB in accordance with the Common Rule and any other governing regulations.
by: [ ] Full IRB Review on (date of IRB meeting) ______ or [X] Expedited Review on (date) 2-26-08
[ ] If less than one year approval, provide expiration date ______

[ ] This activity contains multiple projects, some of which have not been reviewed. The IRB has granted approval on condition that all projects covered by the Common Rule will be reviewed and approved before they are initiated and that appropriate further certification will be submitted.

8. Comments
Protocol subject to Annual continuing review.
HIPAA Waiver Approved?: No

Title X070419001
Cardiovascular Function and Everyday Mobility in Older Adults (Improvement of Visual Processing in Older Adults)

IRB Approval Issued: 2-26-08

9. The official signing below certifies that the information provided above is correct and that, as required, future reviews will be performed until study closure and certification will be provided.	10. Name and Address of Institution
11. Phone No. *(with area code)* (205) 934-3789 12. Fax No. *(with area code)* (205) 934-1301 13. Email: smoore@uab.edu	University of Alabama at Birmingham 701 20th Street South Birmingham, AL 35294
14. Name of Official Marilyn Doss, M.A.	15. Title Vice Chair, IRB
16. Signature Marilyn Doss	17. Date 2-26-08

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