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Physical Activity and Cognitive Function in African American Older Adults Living With HIV

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Abstract

The purpose of the current study was to investigate the association between self-reported physical activity (minutes/week) and cognitive functioning in a sample of African American older adults living with HIV. A secondary analysis of baseline data collected from clinically stable African American older adults living with HIV (aged >50 years; $N = 124$) enrolled in the Rush Center of Excellence on Disparities in HIV and Aging study was conducted. Participants completed a battery of 19 cognitive function tests that were used to create summary scores of global cognition and five cognitive domains. Physical activity was measured using a modified self-report questionnaire derived from a national health survey. Average self-reported number of weekly minutes spent in light physical activity was 290.6 minutes and for moderate/vigorous physical activity was 314.67 minutes. Number of weekly minutes of light physical activity was significantly positively associated with visuospatial ability; however, no associations were found between moderate/vigorous physical activity and any cognitive domain. Contrary to expectations, our findings do not support a relationship between moderate/vigorous physical activity and cognitive function in African American older adults living with HIV.

The population of older adults living with HIV in the United States is rapidly growing. Due to the effi cacy of combination antiretroviral therapies (cART), HIV infection has transitioned from a fatal illness to a manageable chronic condition, leading to a concomitant increase in life expectancy (Heaton et al., 2010). Of the >1.2 million individuals living with HIV in the United States, more than one half are aged ≥50 years, with African Americans accounting for approximately 39% of these cases (Centers for Disease Control and Prevention [CDC], 2016, 2020).

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Although cART have decreased AIDS-related mortality, HIV-related comorbidities persist, such as HIV-associated neurocognitive disorders (HAND). HAND affect approximately 50% of persons living with HIV and encompass a spectrum of neurocognitive disorders, which include asymptomatic neurocognitive impairment (ANI), mild neurocognitive disorder (MND), and HIV-associated dementia (HAD) (Saylor et al., 2016). ANI includes mild dysfunction within at least two cognitive domains without observable functional impairment, whereas MND represents more advanced disease, encompassing mild to moderate dysfunction in two cognitive domains with observable functional impairment (Sanmarti et al., 2014). HAD involves moderate to severe neurocognitive impairment in at least two cognitive domains accompanied by marked interference with performance of activities of daily living (Sanmarti et al., 2014). A longitudinal study of cART-treated persons living with HIV found that the probability of exhibiting neurocognitive impairment on a standardized neuropsychological battery increased by 20% for each decade of life starting at the fifth decade (Coban et al., 2017).

HAND are associated with deficits in attention span, problem solving, reasoning skills, and slower speed in performing activities of daily living (Vance et al., 2013). Risk factors for HAND include low CD4+ T lymphocyte count, depression, diabetes, lower educational level, and higher viral load (Heaton et al., 2010; Sanmarti et al., 2014; Saylor & Sacktor, 2016). HAND are caused by the dissemination of HIV to the brain with subsequent activation of neurotoxic signaling pathways that alter brain function (Saylor & Sacktor, 2016). Most alarmingly, the effects of HAND are known to be exacerbated in older adults living with HIV (Rodriguez-Penney et al., 2013; Saylor & Sacktor, 2016), and studies have suggested that African American older adults are more susceptible to the adverse neurocognitive consequences of aging with HIV compared to White individuals (Cross et al., 2013; Heaton et al., 2015; Manly et al., 2011). Although reasons for the disparity between African American and White individuals are not fully understood, they may relate to the downstream effects of structural racism, such as lower educational attainment, less access to material and social resources, and higher exposure to neurotoxins (Weuve et al., 2018). Because HAND can significantly impact quality of life, everyday functioning, and self-care abilities needed to effectively manage HIV infection and its sequelae (Hinkin et al., 2004; Watkins & Treisman, 2015), interventions to ameliorate neurocognitive disorders in African American older adults living with HIV are urgently needed.

Physical activity is a modifiable potential intervention for preventing, treating, and/or forestalling cognitive impairment among older adults living HIV (Dufour et al., 2013; Ortega et al., 2015; Quigley et al., 2019). Among people not living with HIV, physical activity has been associated with better overall mental health, mood, and health outcomes, including preserved cognition and brain volume (Barton & Pretty 2010; Bullitt et al., 2009; Chapman et al., 2013; Gregory et al., 2012). Mechanistic studies have found that physical activity is associated with improved firing of synaptic connections between neurons and increases in cerebral vasculature and hippocampal volume in the brain (Erickson et al., 2010). Most notably, physical activity has also been associated with delayed cognitive decline in older adults who are not living with HIV (Bherer et al., 2013). Evidence supports several mechanisms underlying this association, including decreased inflammation (Gregory et al., 2012) and increased release of growth factors (Rojas Vega et al., 2010) in the brain.

Previous studies have suggested that physical activity confers neuro-protective effects for older adults with and without HIV. Among uninfected older adults, physical activity has shown positive associations with attention and memory (Gothe, 2021; Hayes et al., 2015; Won et al., 2019), whereas positive associations have been found between physical activity and working memory, perceptual speed, and executive functioning in older adults living with HIV (Fazeli et al., 2014; Ortega et al., 2015).

Although previous studies of adults living with HIV of all ages have found that physical activity is associated with improved cognitive functioning (Dufour et al., 2013; Fazeli et al., 2015; Fazeli et al., 2014; Mapstone et al., 2013; Monroe et al., 2017; Ortega et al., 2015), these studies did not account for racial/ethnic differences that may influence the relationship between physical activity and cognitive function. This omission is significant because African American individuals overrepresent HIV infections among older adults.

To our knowledge, there have been no previous studies that specifically examined African American older adults living with HIV, a population that is disproportionately burdened by the disease, but for whom we know little about potentially modifiable risk factors for cognitive impairment. Therefore, the purpose of the current study was to examine the association of self-reported physical activity (minutes/week of light and moderate/vigorous physical activity) and cognitive functioning in a sample of African American older adults (aged >50 years) living with HIV.

METHOD

Participants and Procedures

We performed a secondary analysis of data collected from African American older adults living with HIV (aged >50 years) enrolled in the Rush Center of Excellence on Disparities in HIV and Aging (CEDHA) study. CEDHA is a collaborative research partnership within the Rush Alzheimer's Disease Center between the Ruth Rothstein Core Center and the University of Illinois at Chicago School of Public Health that was created to understand and eliminate racial disparities related to the consequences of aging with HIV. CEDHA recruited and enrolled a total of 177 adults living with HIV (124 African American, 53 White), and 195 controls not living with HIV.

Inclusion criteria for participants were: (a) documented HIV infection, (b) self-identified as African American, (c) age 50 to 80 years, (d) CD4+ >200 cells/mm^3 on cART or CD4+ >500 cells/mm^3 cART naïve, and (e) viral load ranging from undetectable to 50,000 copies. Exclusion criteria were illicit drug use in the past 3 months, prior stroke, or other neurodegenerative conditions (e.g., dementia, Parkinson's disease). Enrolled participants underwent annual evaluations of cognitive and motor function, psychosocial risk factors, and comorbidities. Moreover, biological specimens were collected annually and included serum, plasma, DNA, and viable lymphocytes. The analytic sample for the current study included only the African American CEDHA participants ($N = 124$), all of whom were enrolled between 2013 and 2014.

The setting was an outpatient HIV treatment center in the Midwest that provides clinical care to >5,000 patients with HIV, of whom 65% are African American (Ruth Rothstein Core Center). Recruitment of CEDHA participants included referrals from health care providers at outpatient clinics, posting of flyers, phone calls by research assistants, hosted talks by CEDHA personnel, and an ambassador program in which current CEDHA participants referred their friends. At the hosted talks, prospective participants were provided information about healthy aging, sexually transmitted infection prevention, and the CEDHA study. The ambassador program enlisted current CEDHA participants to share their experiences in the study with potential participants in the community.

After being screened for sampling criteria by trained research assistants, eligible participants were scheduled for another visit at one of the three testing locations. At this visit, a trained research assistant consented participants for the study and administered a structured interview, which contained questions on health characteristics, demographics, and self-reported physical activity questions, followed by a battery of neuropsychological tests. Following the completion of the questionnaires and battery of neuropsychological tests, a phlebotomist or RN obtained participants' blood specimens.

Measures

Demographics.—Age was determined from date of birth and date of enrollment. Sex was self-reported as male, female, or transgender. Education was self-reported as number of years of formal education.

Health Characteristics.—Health characteristics included: (a) measured body mass index (kg/m^2), and (b) number of years since HIV diagnosis. Total CD4+ T lymphocytes and viral load were obtained by medical chart review and used to describe the sample clinically but not included in the analyses.

Physical Activity.—Physical activity was measured using questions derived from the 1985 Health Interview Survey, which pertains to light, moderate, and vigorous activities (U.S. Department of Health and Human Services et al., 1988). Participants were asked if, in the past 14 days, they participated in six different light (<3.0 metabolic equivalents of task [METS]), moderate (3.0 to 5.9 METS), and vigorous (≥6.0 METS) physical activities based on the Compendium of Physical Activity (Ainsworth et al., 2011). Activities included: (1) walking for exercise (METS 4.3), (2) lifestyle walking (e.g., to the store, to visit someone, to go to church) (METS 2.5), (3) gardening or yard work (METS 4.8), (4) calisthenics or general exercise (METS 3.5), (5) bicycling (METS 7.5), and/or (6) swimming or water exercises (METS 5.5). For each activity, participants who responded *yes* were asked: (1) the number of occasions in the past 2 weeks they did the activity, and (2) the average number of minutes they spent doing the activity per occasion. For each activity, number of occasions was multiplied by number of minutes and divided by two to obtain the number of minutes spent in physical activity in 1 week. The numbers of weekly minutes for all activities were summed to yield a single score for moderate/vigorous physical activity. In addition, there was one open-ended question that asked participants to include any other exercise, sport, or physical activity in which they participated over the past 14 days. Two researchers

(N.W., J.W.) coded the METS of the activities. If METS were ≥3.0, the weekly minutes were calculated and included in the analysis (Ainsworth et al., 2011). Examples of reported activities that met the METS criteria included kickboxing and gardening, whereas activities that did not meet the METS criteria included arts and crafts, painting, and gambling. For the current study, we examined the number of minutes per week spent in light physical activity and number of minutes per week spent in moderate/vigorous physical activity.

Cognitive Function.—Cognitive function was measured using a validated battery of 19 neuropsychological tests that were administered by trained research assistants and selected to assess a broad range of cognitive abilities in aging, as previously described (Wilson et al., 2005) (Table 1). Prior factor analysis has shown that these 19 tests comprise five cognitive domains: (1) episodic memory (seven tests), (2) semantic memory (i.e., long-term memory related to general knowledge) (three tests), (3) working memory (three tests), (4) perceptual speed (four tests), and (5) visuospatial ability (two tests) (Wilson et al., 2002). To create each cognitive domain, individual tests were converted to z scores, using the baseline mean and standard deviation from the entire cohort, and z scores for all tests in a given domain were averaged, as previously described (Wilson et al., 2002). Similarly, a global cognition score was calculated by converting all test scores to z scores and averaging them.

Data Analysis

All analyses were performed using SPSS version 22.0. Descriptive statistics and frequency distributions were performed to describe study variables and to identify missing data and outliers. Spearman's correlation coefficients were computed to explore the relationships among cognitive function, physical activity, health characteristics, and demographic variables. A regression analysis was performed to estimate the relationship between scores in each cognitive function domain and physical activity category while controlling for demographics (age, sex, education), body mass index, and number of years living with HIV.

RESULTS

Background Characteristics and Physical Activity

Table 2 and Table 3 summarize participants' background characteristics and physical activity data, respectively. The majority of the 124 participants were male (75%), had a mean age of 59 years, and an educational level of 12.6 years. Mean years since HIV diagnosis was 16 years and mean CD4+ T lymphocyte count was 609.5 cells/mm^3 (range = 500 to 1,500). Most participants were overweight or obese (61%). Self-reported number of weekly minutes spent on light physical activity was 290.6, whereas moderate/vigorous physical activity was 314.67 (Table 3). Walking and lifestyle walking were the most prevalent forms of physical activity, followed by calisthenics/general exercise. Gardening/yard work, bicycling, swimming, and other moderate/vigorous physical activity were performed by <75% of participants.

Cognitive Function, Health Characteristics, and Physical Activity

Participants' mean z scores for the five cognitive domains, as well as the global cognition score, are shown in Table 4. Demographic and health characteristics were significantly correlated with cognitive function, as shown in Table A (available in the online version of this article). Age showed a significant positive correlation with episodic memory, whereas years of education also showed a significant positive correlation with all cognitive domains and global cognition. That is, as age increased there was an increase in episodic memory, and as years of education increased there was an increase in all other cognitive domains. Years since HIV diagnosis showed a significant negative correlation with perceptual speed, working memory, and global cognition. That is, the greater the number of years since HIV diagnosis, the lower the scores for perceptual speed, working memory, and global cognition. Moderate/vigorous physical activity showed no significant correlations with any cognitive domains; however, light physical activity was found to be positively correlated with visuospatial ability. As the number of minutes spent in light physical activity increased, visuospatial ability improved for this cohort. Furthermore, light physical activity was significantly negatively correlated with viral load, which means that as the number of light physical activity minutes increased, viral load decreased for participants. In separate linear regression models with each cognitive domain as the outcome while controlling for age, sex, education, body mass index, and number of years living with HIV, light and moderate/vigorous physical activity were not significantly associated with any of the cognitive domains (Table B, available in the online version of this article).

DISCUSSION

To our knowledge, the current study is the first to examine the association of physical activity and cognitive function in a cohort of African American older adults living with HIV, a group that is disproportionately affected by HIV/AIDS. In this study, we found an association between light physical activity and visuospatial ability; however, participation in moderate/vigorous physical activity was found to be unrelated to all cognitive domains. Moreover, participants demonstrated negative z scores on semantic memory, working memory, perceptual speed, and visuospatial ability domains, as well as global cognition.

We did not find any associations between moderate/vigorous physical activity and cognitive domain performance. A possible explanation is that our sample was recruited from persons who were active clients in a large university-based HIV outpatient clinic. Accordingly, their HIV infection was well-managed, as evidenced by their viral suppression and relatively preserved CD4+ T lymphocyte counts. It is likely that comorbid conditions that are associated with cognitive impairment, such as hypertension and diabetes, were also well-managed. Thus, participants' engagement in health care may have reduced their risk for cognitive decline and obscured any protective effects of physical activity on cognitive function. We found one association between light physical activity and visuospatial memory. Given the absence of other significant associations, this was likely a spurious finding.

The mean self-reported number of weekly moderate/vigorous physical activity minutes reported by participants exceeded the CDC recommendation of 150 minutes of moderate intensity or 75 minutes of vigorous intensity physical activity per week (U.S. Department of Health and Human Services, 2018). The high physical activity levels may relate to recruitment of participants from a large Midwestern city with a high walkability score (Boyle et al., 2014). In addition, the majority of participants reported using public transportation as a means to navigate, and a prior study found a positive association between public transit use and physical activity (Saelens et al., 2014). We cannot rule out the possibility that participants overestimated their physical activity levels given the errors inherent in self-report measures of physical activity (Van Holle et al., 2014).

IMPLICATIONS FOR NURSING PRACTICE AND RESEARCH

Results of the current study expand on the current knowledge regarding physical activity and cognitive function in older adults living with HIV. Although we did not find an association between physical activity and cognitive function, a large body of literature supports beneficial effects of physical activity on parameters of cardiovascular and metabolic health in persons living with HIV (Jankowski et al., 2020; Ozemek et al., 2020; Willig et al., 2020). Accordingly, nurses should encourage older adults living with HIV to engage in regular physical activity. One method for encouraging physical activity is to include it as a vital sign in clients' medical records (Lobelo et al., 2018), as emerging evidence suggests that health care providers' assessment and monitoring of physical activity is associated with increased activity levels (Sanchez et al., 2015). In addition, nurses can guide clients in the use of a physical activity diary tracker, accelerometer, or other wearable technology to promote self-monitoring of physical activity.

Future studies of physical activity and cognitive function in African American older adults living with HIV should include populations that are at higher risk for cognitive impairment than the well-managed participants in the current study. These populations could include individuals with housing or food insecurity, or those who live in rural areas where HIV care may not be available. Future studies should include objective measures of physical activity to control for bias inherent in self-report of behaviors and incorporate longitudinal designs to determine the effects of physical activity for delaying or preventing age-related cognitive decline.

LIMITATIONS

The current study had several limitations. First, a cross-sectional design was used, which precluded causal inference. Second, diagnostic criteria data for HAND were not collected, thus we cannot rule out that individual participants had impairment that affected their recall of physical activity. Third, this study cohort included only African American older adults who reside in a city with a high walkability score with access to reliable public transportation, thus limiting generalizability of findings to other populations and geographic areas. Finally, physical activity was measured by self-report, which may have led to an overestimation of physical activity levels.

CONCLUSION

The purpose of the current study was to investigate the association of self-reported low and moderate/vigorous physical activity and cognitive functioning in a cohort of African American older adults living with HIV. Moderate/vigorous physical activity was not correlated with any cognitive domain scores, possibly due to the cohort's high level of health care engagement and subsequent control of HIV infection and associated comorbidities. Studies in cohorts who are medically underserved are needed to extend these findings.

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Table A.: Spearman's Correlations Among Demographics, Health Characteristics, Cognitive Function Domains, and Physical Activity (PA) (N = 124)

Demographics	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**
1. Age	----													
2. Education	0.09	----												
3. Body Mass Index	−0.03	−0.11	----											
4. Years Since HIV Diagnosis	−0.02	0.14	0.06	----										
5. CD4 Count	0.05	−0.08	0.09	0.06	----									
6. Viral Load	0.52	0.16	−0.14	0.41	0.48	----								
7. Episodic Memory	**0.17** *	**0.22** **	0.03	−0.11	0.12	−0.05	----							
8. Visuospatial Ability	−0.07	**0.22** **	0.03	−0.06	0.01	0.57	0.24 *	----						
9. Perceptual Speed	−0.17	**0.27** **	−0.12	**-0.22** *	0.08	−0.09	0.43 **	0.32 **	----					
10. Semantic Memory	0.07	**0.34** **	−0.05	−0.10	0.10	0.33	0.37 **	0.39 **	0.58 **	----				
11. Working Mernory	0.00	**0.24** **	0.00	**-0.20** *	−0.03	0.16	0.33 **	0.36 **	0.44 **	0.44 **	----			
12. Global Cognition	0.02	**0.36** **	−0.02	**-0.19** *	0.08	0.24	0.76 **	0.54 **	0.78 **	0.72 **	0.68 **	----		
13. Moderate/ Vigorous PA (minutes week)	0.14	−0.07	**-0.24** **	0.02	−0.03	0.07	−0.04	0.08	−0.04	0.14	0.02	−0.01	-----	
14. Light PA (minutes week)	0.20	−0.02	−0.05	−0.15	0.02	**-0.81** *	0.01	**0.22** *	0.12	0.02	0.11	0.11	**0.34** *	----

* $p \leq 0.05$;

** $p \leq 0.01$.

Table B.: Summary of Regression Analysis (N = 124)

	Episodic Memory	Visuospatial Ability	Perceptual Speed	Semantic Memory	Working Memory	Global Cognition
Variable	−1.63	−1.33	1.12	−1.76	−1.25	−1.00
Age	0.01	−0.01	−0.03	0.01	0.01	−0.00
Sex	−0.13	0.33	−0.02	0.20	0.11	0.03
Education	**0.08** *	0.07	**0.10** *	**0.10** *	0.09	**0.09** *
Body Mass Index	0.01	0.02	−0.02	0.00	0.03	0.00
Years Since HIV Diagnosis	−0.01	−0.01	−0.02	−0.02	−0.02	−0.02
Moderate/ Vigorous PA (min, week)	−5.89	0.00	8.19	0.00	0.00	8.34
Light PA (min/ week)	0.00	−3.91	0.00	0.00	0.00	7.70
R^2	0.14	0.00	0.20	0.19	0.11	0.20

Note. PA = physical activity.

* $p \leq 0.05$.

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TABLE 1

Neuropsychological Tests

Assessment Tool Name	Measured Cognitive Domain
Word List Memory	Episodic memory
Word List Recall	Episodic memory
Word List Recognition	Episodic memory
Immediate Recall of Story A from Logical Memory Subtest of Wechsler Memory Scale-Revised	Episodic memory
Immediate Recall of the East Boston Story	Episodic memory
Delayed Recall of the East Boston Story	Episodic memory
Verbal Fluency	Semantic memory
Boston Naming	Semantic memory
Subset of Items from Wide Range Achievement Test	Semantic memory
Digit Span (Forward) Subtests of the Wechsler Memory Scale-Revised	Working memory
Digit Span (Backward) Subtests of the Wechsler Memory Scale-Revised	Working memory
Digit Ordering	Working memory
Symbol Digit Modalities Test	Perceptual speed
Number Comparison	Perceptual speed
Stroop Coloring Naming	Perceptual speed
Stroop Coloring Reading	Perceptual speed
Judgment of Line Orientation	Visuospatial ability
Standard Progressive Matrices	Visuospatial ability

TABLE 2

Demographics and Health Characteristics (*N* = 124)

Variable	***n* (%)**
Age (years)	
50 to 54	32 (26)
55 to 59	34 (27)
60 to 64	37 (30)
≥65	21 (17)
Sex[a]	
Male	92 (75)
Female	31 (25)
Body mass index (kg/m^2)[a]	
Underweight (<18.5)	2 (2)
Normal weight (≥18.5 to <25)	46 (37)
Overweight (≥25 to <30)	51 (42)
Obese (≥30)	23 (19)
	Mean (*SD*) (Range)
Age (years)	59 (5.5) (50 to 73)
Education (years)	12.6 (2.4) (7 to 19)
Body mass index (kg/m^2)	26.5 (5.4) (16.6 to 46.4)
Years since HIV diagnosis	16.4 (7.5) (1 to 16)
CD4+ T lymphocyte count (cells/mm^3)	609.5 (263.9) (219 to 1,446)
Viral load	413.6 (853.6) (42 to 2,512)

[a]Sample size <124 due to missing data.

TABLE 3

Moderate/Vigorous Physical Activity (Minutes/Week) (*N* = 124)

Moderate/Vigorous Physical Activity	Mean (*SD*) (Range)	Median (IQR)
Walking	183.3 (264.7) (0 to 1,260)	68.8 (0–236)
Lifestyle walking	290.6 (349.7) (0 to 1,680)	180 (50.6–420)
Gardening/yard work	19.3 (90) (0 to 900)	0 (0–0)
Calisthenics/general exercise	76.8 (215.7) (0 to 1,680)	0 (0–85)
Bicycling	33.8 (176.02) (0 to 1,680)	0 (0–0)
Swimming/water exercises	2 (13.5) (0 to 120)	0 (0–0)
Other moderate/vigorous physical activity	42.3 (158.4) (0 to 1,080)	0 (0–0)
Total light physical activity	290.6 (349.7) (0 to 1,680)	180 (50.6–420)
Total moderate/vigorous physical activity	314.67 (480.4) (0 to 1,680)	140 (15–420)

Note. IQR = interquartile range.

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TABLE 4

Cognitive Domain z Scores (*N* = 124)

Cognitive Domain	**Mean (*SD*) (Range)**
Episodic memory	0.06 (0.60) (−1.47 to 1.23)
Semantic memory	−0.14 (0.72) (−1.8 to 1.56)
Working memory	−0.04 (0.80) (−1.5 to 2.16)
Perceptual speed	−0.17 (0.77) (−1.79 to 1.84)
Visuospatial ability	−0.14 (0.81) (−2.03 to 1.71)
Global cognition	−0.05 (0.51) (−1.15 to 1.22)