Low Levels of Physical Activity Among Older Persons Living with HIV/AIDS Are Associated with Poor Physical Function

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Abstract

Antiretroviral therapy (ART) has prolonged lives of persons living with HIV/AIDS (PLWHA), resulting in greater incidence of aging-related diseases and disability. Physical activity (PA) is recommended for healthy aging, but little is known about PA in older PLWHA. The purpose of this study was to objectively assess PA levels in older PLWHA and the associations with physical function. Twenty-one PLWHA, ≥ 50 years old, on ART with undetectable HIV-1 viral loads, wore an accelerometer to assess PA, including number of steps, activity intensity, and energy expenditure over 7 days. A physical function performance battery assessing aerobic capacity, strength, and gait speed was also completed. Average age was 66, and 67% were male. An average of 3,442 (interquartile range: 4,613) steps were walked daily, with 254.9 kcals expended. Participants spent most waking hours (75%) sedentary, with minimal hours (24%) in light-intensity activity. Only 5 min per day (35 min per week), on average, were spent in moderate-to-vigorous physical activity (MVPA). Maximal gait speed and 6-min walk test significantly correlated ($p < .05$) with all PA outcomes. Usual gait speed significantly correlated with all PA outcomes, except for daily kcals and light-intensity activity. Greater PA was associated with better physical performance, while high sedentary time was associated with poorer performance. To our knowledge, this is the first study to objectively measure PA in older PLWHA. Our findings indicate that older PLWHA accumulate substantial sedentary time. Most (86%) do not achieve recommended MVPA levels. This activity profile was associated with poor physical function. Providers should promote PA among PLWHA.

Keywords: HIV, aging, physical function, physical activity, accelerometry

Introduction

WITH EARLY INITIATION of antiretroviral therapy (ART) being recommended for all persons living with HIV/AIDS (PLWHA),^{1,2} PLWHA are living near-normal life spans.^{3–9} Older PLWHA, ages 50 and older, accounted for nearly half (45%) of all PLWHA in the United States in 2014, and also accounted for 17% of new HIV diagnoses in that same year.¹⁰ Increased life expectancy, however, introduces new challenges with age-associated chronic conditions,

including cardiovascular disease (CVD),^{11–14} lung disease,^{14,15} and cancer,^{14–16} which have been shown to negatively affect physical function,¹⁷ the ability to perform everyday physical activities. These conditions appear at younger ages and at higher incidences among PLWHA.¹⁸ There is a large, robust body of literature showing that older PLWHA, even when virally suppressed on ART, exhibit diminished physical function, loss of independence, and overall increased morbidity when compared with age-matched HIV-negative references.^{19–24}

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Physical activity (PA), including small amounts of activity accrued through the day (e.g., household chores and recreational activities), or scheduled blocks of time for more strenuous activity (i.e., exercise), may be one way to promote health and mitigate the progression of functional decline^{25–28} in older PLWHA. The Centers for Disease Control and Prevention (CDC) recommends at least 150 min of weekly moderate-to-vigorous physical activity (MVPA) for persons ages 50 and older who are generally healthy, and encourages those with chronic conditions to be as physically active as possible.²⁹ In general, engaging in routine MVPA, such as jogging or running, walking, and cycling, is linked to prevention of CVD, metabolic disease, and type 2 diabetes.^{30–32} prevention of dementia and depression,³³ and among PLWHA, PA has been shown to mitigate chronic inflammation associated with HIV that can lead to development of HIV-associated, non-AIDS defining illnesses.^{34,35} Increased PA among older adults improves mobility and enhances quality of life by decreasing the rate of functional decline linked to sarcopenia and bone frailty,^{36–39} thereby promoting independence among older adults. PA in older populations is also associated with preservation of immune function, including T lymphocyte cell count and production of interleukin-2, which are typically impaired with older age.^{40,41}

Very little is known about PA engagement among older PLWHA. However, previous research has demonstrated that compared with age-matched HIV-negative controls, PLWHA are considerably less active.^{42,43} A recent meta-analysis of more than 24 studies⁴⁴ concluded that PA levels among PLWHA have not been adequately studied, and there is a lack of studies using objective measures. The bulk of the small literature on HIV and PA has been conducted in adolescent and young adult samples,^{44–46} and to our knowledge there are no published studies reporting PA levels in older PLWHA assessed with objective measurement tools. Given that measurements of PA and physical function are often based on self-report, more information on objectively measured PA participation among older PLWHA is needed to inform clinical behavioral health programs that are now becoming part of routine care for PLWHA.

The principal objective of this study was to examine PA participation in older PLWHA using accelerometry, the gold standard for activity assessment. A secondary objective of this study was to examine the associations between activity metrics derived from the accelerometer (including number of steps, time spent in sedentary, light-, and moderate-intensity activity, and activity-related energy expenditure) and performance-based measurements of physical function. Identification of significant relationships between objectively measured PA and physical function performance measures may help in the design of future interventions among older PLWHA.

Materials and Methods

Study population

This study represents a substudy of a larger HIV and aging trial conducted at the Duke University Infectious Disease Clinic in Durham, North Carolina, between 2012 and 2014, in which anthropometric data and physical function were measured.¹⁹ Twenty-five PLWHA ≥ 50 years old were recruited for this ancillary study between August 2014 and January 2015. Four participants were later withdrawn from

the study due to insufficient accelerometer data, leaving 21 participants for data analysis. As per the eligibility criteria in the overall study, participants had to be age 50 or older and on successful ART with undetectable plasma HIV-1 viral loads (<50 copies/mL) for 12 months before enrollment. Exclusion criteria for the overall study included medical problems, such as active unstable angina, myocardial infarction within 6 months of enrollment, history of ventricular tachycardia, uncontrolled hypertension (diastolic blood pressure >120 mmHg), history of stroke or any neurological conditions that might impact physical function within 6 months of enrollment, active substance abuse, dementia or behavioral disorders, severe hearing or vision loss, and chronic pain that could impact physical function or movement.

Anthropometric and clinical data

Anthropometric data, including weight, height, waist circumference, and hip circumference, were collected as part of the larger study using validated protocols. Body mass index (BMI) was calculated using weight and height. Historical clinical data, including length of time with HIV diagnosis (HIV duration), smoking history (measured in pack-years), current CD4 count, and nadir CD4 counts, were obtained from patient medical record screenings. A comorbidity index (range: 0–5) was created by summing the number of comorbidities that included CVD (hypertension, hyperlipidemia, arrhythmia, or coronary artery disease), renal disease, liver disease (viral hepatitis B or C), cancer, and pulmonary disease (asthma, chronic obstructive pulmonary disease, emphysema, or tuberculosis).

Physical function

All participants completed a validated physical function performance battery in clinic using four validated functional assessments: the 6-minute walk test (6MWT), 30-second chair stand test (30 sec-CST), grip strength, and 2.4 m walk. The 6MWT, an estimate of aerobic capacity,⁴⁷ instructs participants to walk as far as possible over the course of 6 min and has been shown to have a moderate correlation with aerobic capacity in PLWHA.⁴⁸ A loop track was set up in a hallway at the clinic using two cones. The 30 sec-CST, which can test leg strength and endurance,⁴⁹ requires participants to stand all the way up and down from a chair with their arms crossed as many times as possible in 30 s. Maximal grip strength, predictive of mortality,⁵⁰ was measured using a Jamar handheld dynamometer. Two trials were performed on the dominant hand, and the best score was used for analyses. The 2.4 m walk test, which is a measure of gait speed,⁵¹ was performed twice at both a usual pace and maximal pace. The participant's time to walk 2.4 m was recorded for each trial and the fastest time was used to calculate both usual and maximal gait speed (in m/s).

Physical activity

Participants enrolled in the larger HIV and aging study¹⁹ were contacted in order of recent enrollment to participate in this ancillary study and wear an accelerometer. All participants were contacted by phone and provided verbal consent to participate in the study. Participants who provided verbal consent were mailed a triaxial accelerometer (ActiGraph GT3X, Pensacola, FL) via the United States Postal Service,

along with a paper log to record wear time and instructions for wearing the monitor. The accelerometer was initialized in the laboratory before being mailed out and was set to start sampling data 3 days later, to account for the 2-day average delivery time. Participants were encouraged to wear the monitor at the waist for 7 consecutive days during waking hours and instructed to mail back the accelerometer and log using a prepaid envelope provided by the study team.

Data from the accelerometer were downloaded and processed with ActiLife software (v6.11.5), which uses cut points or thresholds to characterize activity-level intensity. We examined five activity parameters using the Sasaki et al.⁵² and Troiano et al.⁵³ scoring algorithms: (1) average daily number of steps, (2) activity-related energy expenditure (kcal), (3) time spent in sedentary activity (defined as ≤ 100 counts per minute), (4) time spent in light-intensity activity (defined as 100–2,019 counts per minute), and (5) time spent in MVPA (defined as $\geq 2,020$ counts per minute). To be included in the analysis, the participant had to wear the accelerometer ≥ 10 h per day for 4 or more days. Of the 25 individuals who were given an accelerometer, 4 were excluded from analyses due to insufficient wear time, resulting in 21 files that were retained for subsequent analysis.

The Duke University Institutional Review Board approved this study.

Statistical analyses

All statistical analyses were performed using SAS 9.4 (Cary, NC) or IBM SPSS Statistics v. 21.0. Descriptive data of the PA and physical function variables are presented as the median with interquartile ranges (IQRs). The associations between PA variables and physical function measures were examined using bivariate Pearson correlation analyses, with $p < .05$ set as the significance level.

Results

Demographic and clinical characteristics

Anthropometric and clinical characteristics for the 21 PLWHA enrolled in the study who completed all measures are presented in Table 1. Average age was 66 years (range: 51–78), and 67% were male; just over half (52%) of the sample was white. The mean duration with diagnosed HIV infection was 15.93 years. All participants had undetectable HIV-1 viral loads (<50 copies/mL) as per inclusion criteria. Nearly all participants (90%) had a CD4 nadir count of <200 cells/mm³. The mean comorbidity index score was 1.95 (standard deviation [SD]: 1.12).

Most participants (81%) were either overweight or obese, with a BMI ranging from 17.43 to 40.17 kg/m². Most participants (86%) had a higher than recommended waist to hip ratio, with a mean of 0.94 (SD: 0.05). Half of participants (50%) had a history of smoking, with a mean of 14.07 pack-years smoked.

Physical activity

PA outcomes are reported in Table 2. Participants wore their monitors for an average 7 days, and averaged 15 h per day of wear time. Participants walked an average of 3,441.89 (IQR: 4,612.81) steps per day. Activity-related expenditure approximated 245.86 kcal per day.

TABLE 1. SAMPLE DEMOGRAPHICS AND CLINICAL CHARACTERISTICS

Characteristics	Overall (n=21)
Age in years, mean (SD)	66.05 (6.34)
Age range in years	51–78
Race, n (%)	
White	11 (52.38)
Black	10 (47.62)
Gender, n (%)	
Men	14 (66.67)
Smoking in pack-years, mean (SD)	14.07 (26.39)
Comorbidity index (range 0–5), mean (SD)	1.95 (1.11)
BMI (kg/m ²), mean (SD), n (%) ≥ 30 kg/m ²	29.26 (6.05)
Waist to hip ratio, mean (SD)	
Men	0.94 (0.05)
Women	0.93 (0.05)
HIV data, mean (SD)	
Length of time with HIV diagnosis (years)	15.93 (7.64)
Current CD4 count (cells/mm ³)	631.52 (370.16)
CD4 nadir (cells/mm ³)	185.48 (243.96)

BMI, body mass index; SD, standard deviation.

Three-quarters of the day (75% of waking hours) were spent in sedentary activities, with the remaining time (24%) spent mostly in light-intensity activity (Fig. 1). On average, participants spent only 5 min per day, $<1\%$ of waking hours, engaging in moderate-intensity activities. There were no statistically significant differences between men and women on any of the PA variables.

Physical function

Physical function outcomes for the larger HIV and aging study have been reported elsewhere.¹⁹ Scores for this subset

TABLE 2. PHYSICAL ACTIVITY AND PHYSICAL FUNCTION

Physical activity	Median (IQR)
No. of days monitor worn (range)	7.00 (1.00)
Steps/day	3,441.89 (4,612.81)
Weekly MVPA (minutes)	35.00 (63.94)
Daily activity-related energy expenditure (kcal)	254.86 (345.58)
Daily time spent in sedentary activity (hours)	10.82 (3.27)
Daily time spent in light activity (hours)	3.69 (2.72)
Daily time spent in MVPA (minutes)	5.00 (9.13)
Physical function	
6MWT (m)	392.60 (1,212.30)
30 sec-CST (no. of stands)	14.00 (6.00)
Grip strength (kg)	
Men	38.00 (9.75)
Women	25.00 (2.50)
Gait speed (usual pace; m/s)	1.13 (1.02)
Gait speed (maximal pace; m/s)	1.63 (0.49)

30 sec-CST, 30-second chair stand test; 6MWT, 6-minute walk test; IQR, interquartile range; MVPA, moderate-to-vigorous physical activity.

FIG. 1. Daily activity by intensity (%). MVPA, moderate-to-vigorous physical activity.

of 21 participants are reported in Table 2. Average distance walked in the 6MWT was 392.60 m (IQR: 1,212.30). The average number of chair stands completed for the 30 sec-CST was 14 (IQR: 6). Average grip strength for men was 38.0 kg (IQR: 9.75), while average grip strength for women was 25.0 kg (IQR: 2.5). Average usual walking speed in this sample was 1.13 m/s (IQR: 1.02) and maximal walking speed 1.63 m/s (IQR: 0.49).

Associations between PA and physical function

The matrix reporting correlations between PA variables and physical function tests is shown in Table 3. The 6MWT and maximal gait speed were significantly associated ($p < .05$) with all of the PA outcomes. Significant associations were found between usual gait speed and all PA outcomes, with the exception of daily kcals and light-intensity activity. In all cases, greater PA was associated with better physical function, while accumulating more inactivity/sedentary time was associated with poorer outcomes. No significant associations were observed for the CST or grip strength and any of the activity variables.

Discussion

As PLWHA live longer, aging-related disease management becomes a growing concern, and their HIV care will

now require a more comprehensive review of their health. This will require a paradigm shift from a treatment-only model to a model grounded in health promotion. To date, little is known about behaviors that promote healthy aging, including PA, in this growing but understudied population. In this study, we examined levels of PA among older PLWHA with undetectable HIV-1 viral loads. We also explored the link between PA and physical function. Our sample demonstrated very low levels of PA participation, with the majority of waking time spent in sedentary and low-intensity activities. This activity profile was associated with poor physical function, an important clinical outcome associated with quality of life.^{36–39} To our knowledge, this is the first study to measure PA using accelerometry among older PLWHA; these results contribute important data to the emerging field of HIV and aging by providing new information about health behaviors in older PLWHA.

Our findings indicate that older PLWHA fall far short of public health guidelines for health-promoting PA participation. On average, participants engaged in only 35 min per week of MVPA, which is <25% of the CDC-recommended goal of at least 150 min per week for persons older than 50.²⁹ Most (86%) did not achieve the CDC-recommended MVPA goal. Furthermore, none of the participants reached the CDC-recommended standard of 10,000 steps per day for generally healthy persons. Although there are no specific PA recommendations for PLWHA, evidence suggests that regular PA can improve cardiorespiratory health, quality of life, depression, and HIV-related clinical outcomes in PLWHA.^{26,34,35}

We also observed very high rates of inactivity/sedentary behavior in this sample. The average time spent in sedentary behaviors during waking hours was 10.82 h per day, representing three-quarters of daily waking hours. The rest of their awake time was spent in light-intensity activities (24%, 3.69 h). The average daily step count in this sample was 3,442 steps, largely accrued through light-intensity activities, providing further evidence of a low-activity profile in this sample. Total daily step counts of this magnitude are low and consistent with step counts among older adults with chronic diseases.⁵⁴ Prolonged inactivity is associated with numerous negative health outcomes, including functional decline, increased chronic disease, and increased mortality,^{30–32} exacerbated among PLWHA through earlier onset and higher incidence of chronic conditions compared with HIV-negative controls.¹⁸

The results of our study provide further evidence of the association between inactivity and poor physical function in

TABLE 3. ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND PHYSICAL FUNCTION

	6MWT (m)	30 sec-CST (no. of stands)	Grip strength (kg)	Gait speed—usual pace (m/s)	Gait speed—maximal pace (m/s)
Avg. daily steps	0.67**	0.30	−0.02	0.56**	0.64**
Avg. daily kcals expended from activity	0.52*	0.16	0.12	0.43	0.52*
Avg. daily sedentary activity	−0.65*	−0.25	0.15	−0.53*	−0.44*
Avg. daily light-intensity activity	0.44*	0.24	0.15	0.25	0.53*
Avg. daily MVPA	0.61**	0.16	−0.20	0.53*	0.50*

Pearson correlation results.

* $p < .05$; ** $p < .01$.

Avg, average.

older PLWHA. For tests of aerobic capacity and gait speed, greater PA was associated with better physical function, while accumulating more inactivity/sedentary time was associated with lower aerobic capacity and slower gait speed. In our sample, the average usual gait speed was 1.13 m/s, which is below the minimum necessary speed needed to safely cross the street.⁵⁵ No significant associations were observed for the chair stand or grip strength tests and any of the activity variables, countering other studies in older HIV-negative persons that have demonstrated a negative association between these two measures and increased sedentary time.⁵⁶ Other physiological or biological factors, such as inflammation, telomere shortening, mitochondrial dysfunction, or obesity, may be at play here, impacting muscle strength or contributing to sarcopenia.

Our findings contribute to a small, although growing, literature reporting low levels of PA in PLWHA and provide further evidence of a link between PA and functional parameters in older HIV-infected individuals. As a pilot study, our sample size makes it difficult to generalize results and limits our ability to run more comprehensive analyses due to low statistical power. This study should be repeated in a larger, national cohort to further understand differences across gender, race, and geography in terms of correlations of PA outputs with physical function. Like other cross-sectional studies, we cannot draw conclusions about the temporal ordering of the HIV-PA-physical function relationship, and relatedly, the role that the HIV virus or ART plays in these pathways. The lack of quality epidemiologic and intervention studies in this area is striking, and needs to be the focus of future research.

As an additional consideration, PLWHA face unique socioeconomic, emotional, and access to healthcare barriers to PA participation.^{57,58} Culturally tailored health promotion programs may be needed to educate older PLWHA about the importance of PA for health promotion and functional independence. There is growing awareness among public health professionals that reducing sedentary time is a meaningful (and more realistic) goal for public health interventions, and this certainly seems the case for this sample of older PLWHA. Supervised exercise programs have shown improvements in emotional health, BMI, and fatigue in PLWHA,^{59,60} but issues of sustained lifestyle changes and accessibility arise from gym-focused programs. Home-based programs offer a more accessible option. One study using a 9-month home-based intervention to promote PA among PLWHA showed that only minimal improvements in PA participation were made⁶¹; however, another study using a home-based pedometer walking program with an educational component did improve PA participation.⁶² Counseling programs that incorporate an understanding of motivations for PA have been shown to improve physical function and depression among older PLWHA,²⁶ and could be considered an added component of PA intervention programs.

While PA should be encouraged among all older adults, our findings indicate a pressing need to promote PA among older PLWHA, who are insufficiently active and demonstrate impaired physical function. Future studies with adequate sample size and robust study designs are needed to more accurately describe the activity profile of older PLWHA and determine the impact of PA on clinical physical function outcomes, the results of which could be used to inform public

health programs and clinical interventions to promote PA. Our findings suggest the need for a paradigm shift in the care of older PLWHA, from a focus solely on treatment to overall health promotion, which emphasizes secondary disease prevention through healthy lifestyle.

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Author Disclosure Statement

The authors have no conflicts of interest to report.

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