Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Rachel H. Safeek Date

HIV and Aging: Low Leisure-Time Physical Activity Correlates with Diminished Physical Function among Older Persons Living with HIV

By

Rachel H. Safeek
Master of Public Health

Hubert Department of Global Health

_____

Carlos Del Rio, MD
Committee Chair

_____

Felipe Lobelo, MD, PhD
Committee Member

HIV and Aging: Low Leisure-Time Physical Activity Correlates with Diminished Physical Function in Older Persons Living with HIV

By

Rachel H. Safeek

Bachelor of Arts
Duke University
2013

Thesis Committee Chair: Carlos Del Rio, MD
Thesis Committee Member: Felipe Lobelo, MD, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
In partial fulfillment of the requirements for the degree of
Master of Public Health
in Global Health
2017

Abstract

HIV and Aging: Low Leisure-Time Physical Activity Correlates with Diminished Physical Function in Older Persons Living with HIV

By: Rachel H. Safeek

Background: Current WHO guidelines promoting early initiation of antiretroviral therapy (ART) has prolonged the lives of persons living with HIV/AIDS (PLWHA). Consequently, HIV and aging is a novel and growing field. As part of the continuum of care for PLWHA, there is a need to evaluate leisure-time physical activity (PA) to reduce risk of CVD and other secondary health outcomes.

Methods: Older PLWHA on ART with undetectable HIV-1 viral loads were recruited from a larger HIV and aging study, in which the 6-minute walk test (6MWT), 30 second chair stand test (30sec-CST), and grip strength measurements were performed. Participants wore waist-mounted activity monitors (Actigraph GT3X, Pensacola, FL) for one week, determining daily steps walked and kCals expended. Pearson correlation analyses were conducted between mean number of daily steps and kCals expended versus 6MWT, age, pulse, body mass index (BMI), current/nadir CD4 count, waist circumference (WC), and diastolic blood pressure (DBP). Linear regression models, adjusted for socio-demographic and clinical status variables, were performed to determine correlates of PA and physical function as outcomes.

Results: Twenty-one subjects (14 men; mean age 66 years, range 50-78 years; 11 white; 10 black; mean BMI 30 kg/m^2; mean WC 39.5 inches) participated. The mean number of daily steps was 3,995 (SD: 2,478), with 296.9 kCals expended daily. With 72% of the day spent sedentary, participants engaged in light-intensity PA 27% of the time. On average, 9 minutes were spent in daily moderate-to-vigorous PA (MVPA). Among participants, 95% had low 6MWT performance and 33% had low 30sec-CST scores and low grip strength. Daily mean number of steps($R= 0.65$; p-value=0.0009) and kCals ($R=0.57$; $p=0.0200$) had significant correlations with 6MWT. Linear regression models revealed DBP was a significant, independent correlate of grip strength, and 6MWT was a significant correlate of 30sec-CST and daily mean number of steps. Significant correlates of kCals were age, pulse, CD4 nadir, and 6MWT, while significant correlates of 6MWT included 30sec-CST and kCals.

Discussion: The findings suggest that older PLWHA are remarkably inactive with diminished physical function and fail to meet public health guidelines for mobility and PA, emphasizing a need for clinicians to promote ongoing PA in PLWHA.

HIV and Aging: Low Leisure-Time Physical Activity Correlates with Diminished Physical Function in Older Persons Living with HIV

By

Rachel H. Safeek

Bachelor of Arts
Duke University
2013

Thesis Committee Chair: Carlos Del Rio, MD
Thesis Committee Chair: Felipe Lobelo, MD, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
In partial fulfillment of the requirements for the degree of
Master of Public Health
in Global Health
2017

Acknowledgements

I would like to first thank the study PI, Dr. Mehri McKellar, for introducing me to the field of HIV and aging and including me for her work on this study, my first one as a clinical research coordinator. I would also like to thank the study participants for their time and efforts. Furthermore, I would like to express my gratitude toward Dr. Felipe Lobelo, whose expertise in the field of physical activity and epidemiology was an instrumental to guiding me through the writing process. I would also like to thank Dr. Carlos Del Rio for providing insights and expertise from an infectious disease perspective. I also would like to thank Dr. Katherine Hall for guiding my writing of the manuscript and overseeing all study procedures related to the accelerometer devices, including data collection with the ActiLife software. Thank you to Audrey and Tammy for their collaborative efforts on this project. Finally, I would like to thank my alma mater's Duke University and Emory University for forging a new collaboration for this manuscript to become a success. This work was supported by the Duke Pepper OAIC (OAIC grant number P30 AG028716), and the Duke Department of Medicine.

Table of Contents

Chapter I: Introduction

Context of Project

Since initial detection of HIV in the United States, much has changed regarding which issues Following the advent of highly active antiretroviral therapy (HAART), persons living with HIV/AIDS (PLWHA) have been afforded more options for control of their HIV. Recently, the World Health Organization (WHO) recommended the early initiation of antiretroviral therapy (ART) in all PLWHA upon initial diagnosis of HIV-1, despite disease progression status [1]. This recommendation has established a continuum of care for PLWHA that includes: 1) HIV testing and diagnosis, 2) linkage to care, 3) initiation of ART, and 4) achieving viral suppression from consistent use of ART [2].

In congruence with the continuum of care, public health initiatives for HIV have shifted toward encouraging HIV testing, including the WHO-recommended self-testing for HIV [3], thereby promoting early detection of HIV and early linkage of new HIV diagnoses to care and access to potent treatment. These initiatives have also impacted the number of persons diagnosed with HIV at an older age (50 or older), as older PLWHA who were previously undiagnosed for their HIV were also encouraged to under HIV testing under the new guidelines [4].

Increased identification of HIV, coupled with improved access to efficacious ART for HIV-1 and early initiation of ART after diagnosis, has controlled HIV-1 viral loads and improved health status for many PLWHA, who are living longer, healthier lives[5]. Consequently, as more people are living longer with HIV, the field of HIV and aging is emerging as a novel and growing field in HIV-related research.

Problem Statement

While HIV-related illnesses can be successfully treated with ART, there are ongoing and specific health issues associated with HIV and aging, including with long-term use of ART and development of co-morbidities associated with age. The ongoing and chronic health issues continue to pose threats for older PLWHA. As PLWHA are now living longer, there is a pressing need to expand the HIV continuum of care to include care and treatment of ongoing health issues that affect older PLWHA as they continue to age.

Several factors associated with the course of HIV progression and treatment predispose PLWHA to cardiovascular disease (CVD) and other co-morbidities. First, older age is associated with more rapid progression of HIV. Older PLWHA might undergo accelerated or premature aging, including shortening of telomere length, increasing rate of functional decline [6].

Secondly, use of HAART in HIV-positive persons has been linked to dyslipidemia, diabetes, and greater accumulation of fat in central regions of the body, increasing risk of CVD [7]. Furthermore, there is an overall observed increase of co-morbidities, including CVD, among HIV-positive persons, compared to healthy adults [8]. Development of co-morbidities can increase risk of drug-drug interactions between HAART regimens and treatment for other co-morbidities.

Prevention of HIV progression and development of co-morbidities in older PLWHA is necessary for promoting long term health. Therefore, there is a need to monitor lifestyle behaviors that can influence health outcomes, including leisure-time physical activity (PA).

Given the potential for PA to diminish risk for CVD and type 2 diabetes, in addition to promoting bone strength and overall health [9-11], engagement in PA is particularly necessary for older PLWHA for maintenance of independence and prevention of both falls and functional

decline. As PA is often overlooked in the course of HIV treatment for older PLWHA, there is a need for research that assesses daily levels of leisure-PA among older PLWHA, with subsequent action of developing PA-based initiatives for prevention of co-morbid conditions that pose risks for older PLWHA.

Purpose of Project

The objective of the study was to evaluate daily leisure-time PA among older PLWHA using accelerometry. A secondary objective of this study was to compare accelerometry data, obtained from outside of clinic, to in-clinic physical function measurements from the six-minute walk test. The 30 second chair stand, grip strength and other bio-clinical markers to evaluate any correlations between leisure-time PA and physical function. We hypothesize that energy expenditure and daily mean number of steps walked, as captured by the accelerometer, will positively correlate with better performance on physical function tests, including 6MWT and 30sec-CST. We also hypothesize that age, DBP, and waist circumference will inversely correlate with levels of physical activity.

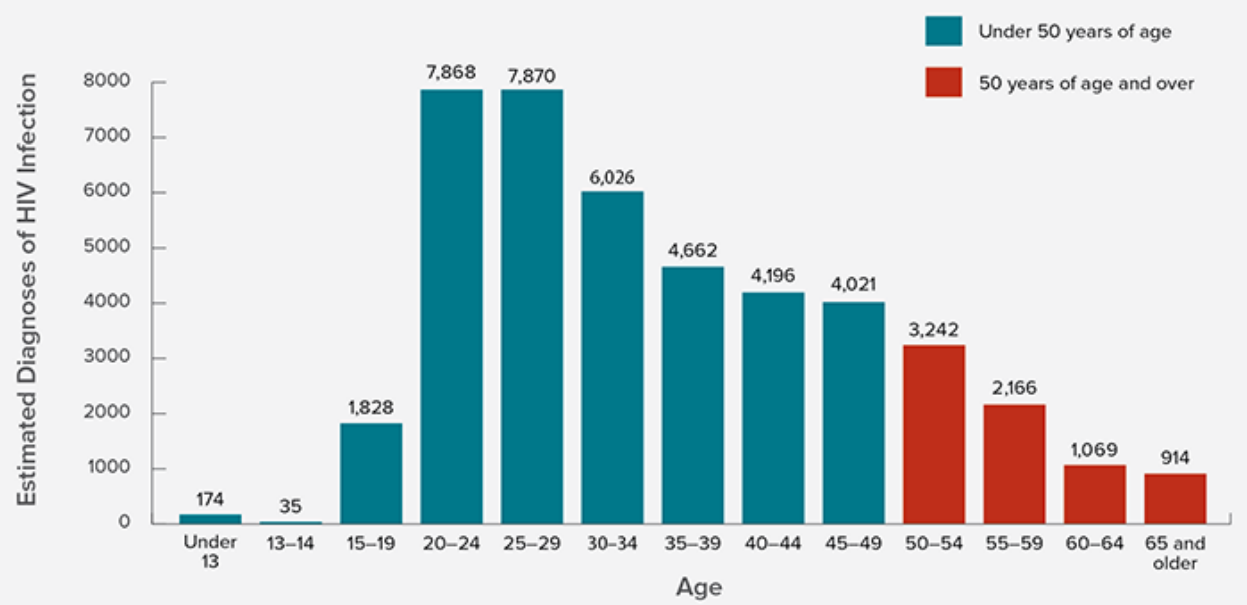
Chapter II: Literature Review

HIV and Aging

Following the World Health Organization's (WHO) recommendation for initiation of antiretroviral therapy (ART) in all PLWHA upon diagnosis [1], coupled with recent advocacy efforts focused on linking persons with positive HIV-1 antibody screenings to care, more persons with HIV are receiving earlier and appropriate treatment for their HIV and living longer. Consequently, HIV and aging is a novel and growing field in HIV-related research.

In 2013, it was estimated that 26% of all PLWHA in the United States were persons over the age of 55 [4]. This number is sure to increase as more PLWHA begin to age. Furthermore, more cases of HIV were discovered among older populations, following new public health initiatives that encourage HIV testing among all ages, in an effort to encourage earlier linkage to care and initiation of ART. In 2014, 17% of new diagnoses for HIV were among persons over age 50.

Figure A. Estimated Diagnoses of HIV Infection by Age [12].



As part of the continuum of care for persons living with HIV, there is a need to identify ongoing health issues associated with HIV and aging, including levels of PA and use of PA for prevention of co-morbid conditions that complicate HIV.

Background on Physical Activity

The Centers for Disease Control and Prevention (CDC) recommends 150 minutes (2.5 hours) of weekly moderate-to-vigorous physical activity (MVPA) for older adults, ages 50 and older [13]. Routine MVPA, for the CDC-recommended intervals, has been shown to diminish risk of cardiovascular disease (CVD) and type 2 diabetes [9-11]. Furthermore, increased physical activity (PA) among older adults is linked to prevention of cognitive impairment, Alzheimer's disease, dementia, depression, and functional decline linked to sarcopenia (muscle atrophy) and bone frailty, thereby promoting independence and enhanced quality of life among older adults [14-17].

The link between increased PA and improved health outcomes is especially indicated for prevention of immune function decline in aging populations, including prevention of age-related decline in T cell function and cytokine production [18], which is especially important for older immunosuppressed persons, including persons living with HIV; however, the CDC-recommended intervals for physical activity may be difficult to achieve for persons with chronic illness, like HIV, as they may also face considerable physical, mental, and emotional barriers to attaining optimal health outcomes[19].

Knowledge of PA Levels among PLWHA

Physical activity has been assessed in HIV-positive populations on a larger scale, but much focus has been paid to assessing PA among younger populations. One study conducted in

São Paulo, Brazil found that among adolescents with HIV, there was a high prevalence of sedentary lifestyles [20, 21]. Another study from Philadelphia, USA found that prevalence of obesity is high among adolescents living with HIV, indicating a need for PA interventions in this age group [16].

Gaps in Research for Older PLWHA

Currently, there is limited research addressing leisure-time PA among older PLWHA. Much of what is known about PA among older PLWHA has been obtained from accelerometry measurements or self-report questionnaires. One study has found that compared to healthy adults, persons with HIV have lower levels of measured PA, using validated accelerometry tools. The same study also found that persons with HIV overestimated their PA levels on self-reported questionnaires [23].

Accelerometry

Accelerometers, including the Actigraph, represent an ideal way to record PA. Accelerometers track number of steps and sense dynamic vibrations of movement, including capturing acceleration of movement and energy expenditure, measured in kCals. Accelerometers distinguish the intensity of movement, categorizing activity on four levels: 1) sedentary movement (sitting on the couch with minimal movement), 2) light movement (walking), 3) moderate movement (brisk walking; gardening), and 4) vigorous movement (running; dancing).

Given the direct and specific measurements that accelerometers can provide, they are considered the gold standard upon which PA is measured [24]. Unlike questionnaires that rely on self-report, accelerometry provides a validated, objective measure of PA levels and PA intensity by capturing minute-by-minute movements of persons wearing the monitor. Raw measurements of accelerometry are categorized into standardized counts per minute, which can then be

categorized as sedentary, light, or moderate-to-vigorous movement (MVPA). However, accelerometers are costly to purchase for individual patient use in large clinics.

Furthermore, the monitors themselves are cumbersome for daily wear around the waist. While modified versions of the accelerometer can be worn around the wrist, the most accurate measure of PA is produced from the waist, which can make daily wear cumbersome for many. Therefore, a waist-mounted accelerometer represents a deterrent for patients monitoring their daily activity levels.

PA Measurements from Self-Report Questionnaires

Another method for understanding PA levels in patients is through use of a self-report questionnaire. In the same study that found PLWHA have overall lower PA levels, compared to health populations, the study also demonstrated that older individuals with HIV overestimate their daily physical activity levels [23]. The ability for patients to over or underestimate their levels of PA often render bias estimations of PA from self-report assessments, making these tools unreliable.

Given the burden of cost and logistics for use of accelerometry on a wide-scale and the risk of biased data recorded through self-report questionnaires, there is a need to determine accurate measure of PA for use among physicians and other clinical practitioners. A systematic review of 45 studies found five consistent correlates of PA, including older age, lower number of CD4 cells, exposure to HAART, and presence of lipodystrophy [19]. Another study found that energy expenditure, as recorded from a three-day energy expenditure diary, significantly correlated with occupational physical activity, suggesting that PA at work might predict overall levels of PA.

Physical Function and HIV

Physical function has also been studied among PLWHA. Functional decline has been observed across all age groups among persons living with HIV receiving HAART, compared to healthy controls [25]. The same study found that previous history of CVD is strong predictor of physical function in persons living with HIV, indicating a need to prevent cardiometabolic risk factors in this group.

Another study found significant correlations between association of comorbid conditions, CD4 cell count and HIV viremia with self-reported ability of physical function, prompting a need to treat HIV and all associated HIV-related comorbidities. The study also found that aging was associated with functional decline, along with smoking, poor diet, and low levels of PA [26]. In another study of 324 participants, one of two HIV-positive participants on ART with undetectable viral loads displayed poor locomotor function, including poor lower limb muscle performance, highlighting the importance for ongoing physical function performance in older PLWHA [27].

Six Minute Walk Test (6MWT)

Currently, there are validated physical performance measures adapted for use in clinical settings. One such measurement is the 6-minute walk test (6MWT), which requires participants to demonstrate the amount of distance he or she can comfortably walk over the course of six minutes. The test itself measures physical function and aerobic endurance, which may be a valuable indicator of PA levels within the home. Previous research has indicated that performance equivalent to 25th percentile or less among ages 50-59 for men is less than 545m, and less than 525m for women. Among ages 60-69, the 25th percentile of performance for men is

less than 525m and is less than 510m for women, and for ages 70-79, the 25th percentile of performance is less than 455m for men, and less than 460m for women [28].

30 Second Chair Stand (30sec-CST)

Another test of physical function is the 30 second chair stand test (30sec-CST), which prompts the patient to cross his arms in an "X" shape across his chest and from a seated position come to a complete stand and then return to a seated position. The test is scored based upon the number of times the patient can stand from his seated position in 30 seconds. If the patient is not able to stand without using his arms, he will receive a score of "0". The CDC characterizes below average scores for men ages 60-64 as below 14 stands, men ages 65-69 and ages 70-74 as below 12 stands, and men ages 75-79 as below 10 stands. For women between ages 60-64, the below average number of stands is below 12, ages 65-69 is below 11 stands, and ages 70-74 and 75-79 is below 10 stands [29].

Grip Strength

Grip strength is another measure of physical function that involves the use of a handgrip dynamometer. Isometric grip strength is then measured by asking the participant to squeeze the dynamometer, with grip strength measured in pounds. Grip strength below the 25th percentile for men ages 50-59 is less than 170lbs and for women is less than 115lbs, while for ages 60-69, the 25th percentile of grip strength for men is less than160 lbs. and for women less than 110 lbs. For men ages 70-79, the 25th percentile is below 125lbs, while for women it is below 75lbs [30].

Bio-Clinical Markers Associated with PA

Physical activity has been proven to decrease cardio-metabolic risk factors associated with CVD and reduce accumulation of central fat [8]. Given the protective effective of PA on fat redistribution syndromes associated with long-term use of HAART [31] waist circumference

may be another measurement that predicts leisure-time PA, as lower accumulation of central fat has been overserved among persons who engage in regular PA.

One study has also found that significant increases in PA levels, irrespective of age, yield significant decreases in waist circumference after 18 weeks [32]. Among men, a waist circumference of or exceeding 40 inches is associated with a higher risk of developing obesity-related conditions in men. In women, 35 inches is cited as the waist circumference at which non-pregnant women have a high risk of obesity-related conditions) [33].

Body Mass Index (BMI) is another measurement often associated with PA. A BMI greater than or equal to 25 kg/m^2 is categorized as overweight or obese [34]. Blood pressure is another measurement that might be affected by levels of PA. A blood pressure reading of 140/90 mmHg or greater is associated with hypertension, which poses considerable health risks for older PLWHA [35].

Significance

Currently, there is limited research addressing levels of PA among PLWHA. Given the link between older age and functional decline, it is necessary to promote ongoing health of older PLWHA, who might also experience exacerbated health issues, including accelerated aging and increased risk for co-morbid conditions, including CVD and type 2 diabetes. As HIV and aging emerges as a novel and growing field, there is a need to understand leisure-time PA levels among older PLWHA and determine specific recommendation and interventions to promote PA among this group, in order to promote independence and overall health in this population.

Chapter III: Manuscript

HIV and Aging: Low Leisure-Time Physical Activity Correlates with Diminished Physical Function in Older Persons Living with HIV

Rachel Safeek[1], Felipe Lobelo, MD[1], Ph.D., Katherine Hall[2], Ph.D., Carlos del Rio[1], MD, Audrey Lan[3], Tammy Chin[3], Miriam Morey[2], Ph.D, Mehri McKellar[3], MD

[1]Hubert Department of Global Health, Rollins School of Public Health, Emory, Atlanta GA

[2]Department of Medicine, Division of Geriatrics, Duke University Medical Center, Durham, North Carolina

[3]Division of Infectious Disease, Duke University Medical Center (DUMC), Durham, North Carolina

Author for Correspondence:

Rachel Safeek

Hubert Department of Global Health

Rollins school of Public Health

1518 Clifton Road NE

Atlanta, GA 30322

Contribution of Student

The student was active in all components of the project. As the lead study coordinator, the student recruited all study participants, obtained inform consent, and was active in the collection of all physical activity data, while overseeing all study procedures. After data collection, the student cleaned all data and performed all subsequent data analysis for her results in SAS. The student also analyzed data collected by the co-authors in a larger study for comparison with results for her study. The student created all tables and figures and was responsible for writing and preparing the manuscript for publication.

ABSTRACT:

Background: Current WHO guidelines promoting early initiation of antiretroviral therapy (ART) has prolonged the lives of persons living with HIV/AIDS (PLWHA). Consequently, HIV and aging is a novel and growing field. As part of the continuum of care for PLWHA, there is a need to evaluate leisure-time physical activity(PA) to reduce risk of CVD and other secondary health outcomes.
Methods: Older PLWHA on ART with undetectable HIV-1 viral loads were recruited from a larger HIV and aging study, in which the 6-minute walk test (6MWT), 30 second chair stand test (30sec-CST), and grip strength measurements were performed. Participants wore waist-mounted activity monitors (Actigraph GT3X, Pensacola, FL) for one week, determining daily steps walked and kCals expended. Pearson correlation analyses were conducted between mean number of daily steps and kCals expended versus 6MWT, age, pulse, body mass index (BMI), current/nadir CD4 count, waist circumference (WC), and diastolic blood pressure (DBP). Linear regression models, adjusted for socio-demographic and clinical status variables, were performed to determine correlates of PA and physical function as outcomes.
Results: Twenty-one subjects (14 men; mean age 66 years, range 50-78 years; 11 white; 10 black; mean BMI 30 kg/m^2; mean WC 39.5 inches) participated. The mean number of daily steps was 3,995 (SD: 2,478), with 296.9 kCals expended daily. With 72% of the day spent sedentary, participants engaged in light-intensity PA 27% of the time. On average, 9 minutes were spent in daily moderate-to-vigorous PA (MVPA). Among participants, 95% had low 6MWT performance and 33% had low 30sec-CST scores and low grip strength. Daily mean number of steps($R= 0.65$; p-value=0.0009) and kCals ($R=0.57$; $p=0.0200$) had significant correlations with 6MWT. Linear regression models revealed DBP was a significant, independent correlate of grip strength, and 6MWT was a significant correlate of 30sec-CST and daily mean number of steps. Significant correlates of kCals were age, pulse, CD4 nadir, and 6MWT, while significant correlates of 6MWT included 30sec-CST and kCals.
Discussion: The findings suggest that older PLWHA are remarkably inactive with diminished physical function and fail to meet public health guidelines for mobility and PA, emphasizing a need for clinicians to promote ongoing PA in PLWHA.

Introduction

Following the recent World Health Organization (WHO) guidelines promoting early initiation of highly active antiretroviral therapy (HAART) for all persons living with HIV/AIDS (PLWHA)[1], more PLWHA are gaining access to potent antiretroviral therapy (ART) for HIV-1. The push for early identification of HIV, coupled with improved access to ART has prolonged lives among PLWHA [2]. Consequently, HIV and aging is emerging as a novel field in HIV research.

Older PLWHA over age 55 accounted for 26% of all PLWHA in the United States in 2013, while 17% of new HIV diagnoses in 2014 were among persons over 50 [3]. As part of the continuum of care for PLWHA over age 50, there is a need to evaluate ongoing health issues associated with aging populations, including daily levels of leisure-time physical activity (PA) and physical function. Compared to healthy adults, older PLWHA are at increased risk for developing co-morbidities, including cardiovascular disease (CVD)[4], and can experience accelerated aging [5], which may result in premature functional decline. Furthermore, long-term use of HAART is linked to fat redistribution syndrome, leading to greater accumulation of central fat, which may also increase risk for CVD and other chronic conditions [6].

The Centers for Disease Control and Prevention (CDC) recommend 150 minutes (2.5 hours) of weekly moderate-to-vigorous physical activity (MVPA) for persons ages 50 and over [7]. Engaging in routine MVPA is linked to prevention of cardiovascular disease (CVD) and type 2 diabetes [8-10], as well as prevention of cognitive impairment, Alzheimer's disease, dementia, and depression. Furthermore, PA is associated with prevention of immune function decline [11], which is of particular importance for older PLWHA.

Physical function, which can be measured through clinic-based exams, including the six-minute walk test (6MWT), 30 second chair stand test (30sec-CST), and grip strength, is also impacted by PA. Increased PA among older adults enhances quality of life by decreasing the rate of functional decline linked to sarcopenia (muscle atrophy) and bone frailty [12-15], thereby promoting independence among older adults.

While PA has been established as beneficial for older adults, little is known about levels of leisure-time PA among older PLWHA, with most studies focused on PA levels in younger adults with HIV and adolescents [16-18]; however, it is likely that achievement of the CDC-recommended intervals for PA will be difficult to attain for older PLHWA who also face considerable physical, mental, and emotional barriers to attaining optimal health outcomes[19].

Accelerometers, including the Actigraph, measure leisure-time PA by tracking number of steps, energy expenditure (kCals) and acceleration of movement using counts per minute (CPM) [20]. While they are considered the gold standard for accessing PA, they are often expensive and cumbersome to wear. Thus, PA is often assessed through self-report questionnaires. One study found, however, that older PLWHA overestimated their levels of PA on self-report questionnaires [21], indicating a need to accurately evaluate levels of PA among PLWHA.

Study Objectives

The objective of the study was to evaluate levels of daily leisure-time PA among older PLWA using accelerometry at home. A secondary objective of this study was to compare PA data obtained from accelerometry to measurements of physical function, as measured through the six-minute walk test, the 30 second chair stand, grip strength, and other bio-clinical markers to identify correlations between daily leisure-time PA levels measured from home and monitored

physical function measurements obtained in clinical settings. A correlation between in-clinic physical function tests and leisure-time PA obtained from the patient's home might indicate that clinical functional tests could be used to understand daily leisure-time PA levels among older PLWHA. We hypothesize that energy expenditure and daily mean number of steps walked, as captured by the accelerometer, will positively correlate with better performance on physical function tests, including 6MWT and 30sec-CST. We also hypothesize that age, DBP, and waist circumference will inversely correlate with levels of physical activity.

Methods

Study Population

This study represents a sub-study of a larger HIV and aging study conducted at the Duke University Infectious Disease Clinic in Durham, NC between 2012-2014, in which anthropometric data and physical function performance was measured. Between August -January 2015, 21 HIV-infected participants, ≥50 years old, were recruited. All participants were on antiretroviral therapy (ART) with undetectable plasma HIV-1 viral loads (≤ 50 copies /mL) for greater than 12 months prior to enrollment into the study. All participants were receiving ongoing care for their HIV from the Duke University Infectious Disease Clinic in Durham, NC.

Anthropometric and Clinical data

Anthropometric data, including weight, height, pulse (beats per minute), waist circumference (WC), and body mass index (BMI) were collected as part of the larger HIV and aging study. Basic clinical data, including disease history, smoking and drinking history, diastolic blood pressure (DBP), systolic blood pressure (SBP), current CD4 count, and nadir CD4 counts were obtained from patient medical record screenings. Specific disease history included history of

CVD, liver disease, pulmonary disease, renal disease, and HIV-Associate Non-AIDS (HANA) conditions.

Physical Function Data

All participants completed three physical function measures, while participating in the larger HIV and aging study in 2012-2014: (1) the 6MWT, (2) 30sec-CST, and (3) measure of grip strength. For the 6MWT, all participants were asked to walk up and down a hallway for a duration of six minutes. Their performance was measured by the amount of distance they walked over six minutes. For the 30sec-CST, all participants were asked to sit in a chair and cross their arms, forming an "X" over their chest. Participants were asked to raise their bodies from seated positions to a full standing position, without using their hands and arms for support. Performance was determined by the number of full standing positions a participant could complete after 30 seconds. Participants who could not stand without support of their arms were assigned a score of "0". An isometric grip strength test was also performed using a handgrip dynamometer. Each participant was instructed to squeeze the dynamometer as hard as possible with his or her dominant hand.

Study Procedures

As part of the sub-study, participants were mailed an activity monitor belt (Actigraph GT3X, Pensacola, FL) and a monitor log with instructions to wear the monitors around their waists. Participants were encouraged to wear their monitors for a minimum of 4 days, with an ideal wear time of 7 days, and could keep the monitor for up to 10 days. Participants were advised to avoid wearing the monitor while sleeping or during bathing, swimming, or engaging in any water-related activities. Each day participants recorded their number of hours wearing the

monitor. Upon completion of the 7-day period, participants mailed their activity monitor belts and logs back to the study team using a prepaid envelope.

Accelerometers were used to collect data on daily PA levels of participants, including daily number of steps and energy expenditure (kCals). The discriminatory nature of accelerometers to distinguish subtle movements during sedentary bouts with the monitor on and no movement while the monitor is not being worn, allows for activity measured to be categorized as sedentary versus light versus MVPA. Data on the accelerometer was downloaded using Actilife (v6.11.5) software. PA outcomes were generated including: average number of daily steps walked, energy expenditure measured in kCals, and percent sedentary time versus time spent engaging in light activity, i.e. brisk walking versus time spent in moderate to vigorous activity, i.e. running, dancing, gardening, and cycling.

Light	Moderate to vigorous
Walking	Running Dancing Gardening Cycling

All participants were mailed their daily mean number of steps walked with recommendations for how to improve their daily PA levels. The Duke University Institutional Review Board approved this study, and all supportive documents.

Cutoff for At-Risk Sociodemographic and Clinical Variables

Overweight and obesity among the participant pool was determined by a BMI measurement equal to or greater than 25 kg/m^2. Following CDC cut points, high waist circumference was determined as greater than 40 inches for men and greater than 35 inches for women [22]. High blood pressure was determined as a blood pressure greater than 140/90mmHg [23].

Cutoff for Low Performance on Physical Function Assessments

Using reference data from a study compiling data across seven countries, we established cutoffs for low performance on the 6MWT by estimating values below the 25th percentile of performance for men and women, stratified by age. For men ages 50-59, low 6MWT performance was defined as below 545m; for ages 60-69 low 6MWT performance was cut off at 525m; for ages 70-79 low 6MWT performance was cut off at 455m. For women, low 6MWT performance for ages 50-59 was 525m; for ages 60-69 low 6MWT performance was under 510m, and for ages 70-79, low 6MWT was 460m [24].

For 30sec-CST, we used low cutoffs outlined by the CDC indicating below average scores for men ages 60-64 as below 14 stands, men ages 65-69 and ages 70-74 as below 12 stands, and men ages 75-79 as below 10 stands. For women between ages 60-64, the below average number of stands is below 12, ages 65-69 is below 11 stands, and ages 70-74 and 75-79 is below 10 stands [25].

For grip strength, we converted measurements obtained in kilograms to pounds. As data was obtained only from the dominant hand, all values of grip strength were multiplied by 2, in order to compare our results to national reference data, which sums together measurements, in pounds, from both hands. We used cutoff points for low grip strength based the 25th percentile of mean grip strength values in pounds, for men and women, stratified by age [26]. For men ages 50-59, low grip strength was defined as below 170lbs; for ages 60-69, low grip strength was defined as below 160lbs; and for ages 70-79, low grip strength was defined as below 125lbs. For women ages 50-59, low grip strength was defined as below 115lbs; ages 60-69, low grip strength was defined as below 110lbs; and for women ages 70-79, low grip strength was defined as below 75lbs.

Cutoff Points for Physical Activity Levels

The ActiLife Software measures activity in counts per minute (CPM), which are established by summing the frequency and intensity of raw acceleration into standardized pockets. Sedentary activity was defined as less than 99 CPM. Light activity was defined as 100 to 1951 CPM. MVPA was defined as 1952 CPM or greater [27].

Statistical Analysis

Data were analyzed in SAS 9.4. Chi-squared tests were used to determine p-values across categorical physical activity data for men versus women, while t-tests were used to determine p-values across numeric variables. Pearson correlation analyses were used to assess accelerometry metrics, including daily mean number of steps and energy expenditure, in correlation with physical function performance on 6MWT, 30sec-CST, and grip strength. Pearson correlations were also used to assess correlation of accelerometry metrics with other continuous sociodemographic and clinical variables. Finally, linear regression analyses were used to determine predictive models for physical activity and physical function.

Results

There were 21 PLWHA enrolled in the study; 14 (67%) were male. Eleven participants (52%) were white, while 10 were black. The mean age was 66 years old (range: 51-78). A majority had a history of smoking (52%) and alcohol use (52%). Mean duration of HIV was 15.93 years. All participants had undetectable HIV-1 viral loads (<50 copies/mL of blood). The mean CD4 count was 631.52 cells/mm^3, while the mean CD4 nadir count was 185.48 cells/mm^3.

Among the 21 participants, 81% had a history of cardiovascular disease, including hypertension, hyperlipidemia, arrhythmia, or coronary artery disease; 29% had history of cancer; 33% had a history of liver disease, including viral Hepatitis B or C; 29% had history of

pulmonary disease, including asthma, COPD, emphysema, or tuberculosis; 24% had a history of renal disease; and 57% had a history of HIV-Associated Non-AIDS (HANA) conditions, including PCP, CMV, candidiasis, and shingles.

Most participants (81%) were overweight or obese with mean BMI of 29.26 kg/m^2 (range: 17.43-40.17 kg/m^2). Nearly half (47%) had a high waist circumference, while 40% were hypertensive (Table 1).

From participation in a larger HIV and aging study, average distance walked on the 6MWT was 371.66m, with 95% or participants walking distances below the 25^{th} percentile of performance standards. Average 30sec-CST score was 12, with 52% of participants having lower scores than the CDC-reported averages. Finally, mean grip strength was 141lbs, with 33% of participants having below average grip strength, as reported by the CDC (Table2).

Overall, all participants met their encouraged wear time of at least one week, with a mean of 7.86 days of wear time (men: 8.21 day versus women 7.14 days). Men walked more steps per day than women (men 4078 steps versus women 3826) and expended more kCals (men: 309.24 kCals versus women: 272.17 kCals). Overall, participants walked a mean of 3,994 (SD: 2477.74) steps per day.

The majority (72%) of waking hours was spent sedentary (men: 71.50% versus women: 71.70%). Among time spent physically active, participants engaged in light-to-moderate physical activity, including walking, only a quarter (27%) of waking hours. Remarkably, participants spent a mean of only 9.22 minutes per day, approximately 1.09% of waking hours, engaged in MVPA, including running, dancing, and jogging (men: 8.96 minutes versus women: 10.29 minutes). There were no statistically significant PA differences between men and women

participating in our study (Table 3). None of the participants met the CDC recommendation for 150 minutes of MVPA per week.

Pearson correlations analysis showed that distance walked during the 6MWT significantly and strongly correlated with daily mean number of steps taken (R= 0.67038; p-value=0.0009) (Figure 1). Pearson correlations analysis also revealed a similar strong, significant correlation with distance walked during the 6MWT and physical activity- related energy expenditure, as measured in kCals (R=0.520327; p-value: 0.0200) (Figure 2). Steps walked and kCals expended did not significantly correlate with performance on the 30sec-CST and grip strength. Mean number of daily steps and kCals expended did not correlate with BMI, CD4 nadir, current CD4 count, DBP, or WC

Linear regression models revealed that age, resting pulse, CD4 nadir, and distance walked on the 6MWT were all independent correlates of kCals expended. DBP was a significant, independent correlate of grip strength, while 6MWT was a significant, independent correlate of 30sec-CST and daily mean number of steps. Significant correlates of 6MWT included 30sec-CST and kCals expended (Table 4).

Discussion

Following the advent of HAART, successful linkage of PLWHA to care, and HIV treatment guidelines that promote earlier treatment after an HIV diagnosis, PLWHA are living longer and healthier lives. In 2013, PLWHA age 55 and older accounted for 26% of all cases of HIV in the United States [3], and this number is sure to increase over time.

As PLWHA are beginning to live longer lives on HAART, HIV and aging is a relatively new and expanding field, and HIV and aging studies are a necessary component of

understanding ongoing health issues as part of continuum of care for PLWHA. This HIV and aging study sought to determine levels of PA among PLWHA and understand the link between PA and physical function among older PLWHA.

Our study suggests that older PLWHA are remarkably inactive with 72% (10.15 hours) of daily waking hours spent sedentary. Compared to a national average of 8 hours per day (60% of waking hours) spent sedentary among older adults ages 60-85 [28], our cohort was considerably less active. Only 1% (9.22 minutes) were spent engaged in MVPA. We identified that older PLWHA were engaged in a weekly mean of 64.54 minutes of moderate to vigorous activity weekly, less than 50% of the CDC goal of 150 minutes per week. These data indicate that persons enrolled in our study failed to meet national public health guidelines for mobility and physical activity behavior. This is clinically significant, given the link between a sedentary lifestyle and functional decline.

Our data also revealed a significant, strong positive correlation between daily mean number of steps and distance walked during the 6MWT, suggesting a link between daily ambulatory activity, as measured through daily mean number of steps, and aerobic endurance, as measured through the 6MWT. A strong positive link between daily kCals expended and distance walked during the 6MWT was also observed. These correlations suggest that physical performance metrics, including 6MWT, are strong, accurate predictors of leisure-time PA levels, and could be utilized by healthcare providers as standard measurement for assessing in older PLWHA.

There are several limitations that should be considered for this study. While the GT3X Actigraph monitor has been validated for persons in all age groups, the monitor has not been validated specifically among older adults with HIV [29]. As a pilot study, our sample size

(N=21) is low, introducing a possibility of low statistical power. The study should be repeated in a larger cohort to further understand differences across gender, race, and correlations of physical activity outputs with physical function. Furthermore, the use of the monitors for a one-week period might introduce the Hawthorne effect, in which participants may have consciously chosen to engage in more physical activity than usual, in an effort to improve their PA measures for social desirability.

Our findings indicate that older PLWHA are failing to meet public health recommendations for daily PA, emphasizing a need for clinicians to routinely encourage PA among PLWHA and recommend ongoing options for engaging in PA. Our results suggest that performance on the 6MWT might be indicative of leisure-time PA among PLWHA, and clinicians could rely on this validated measurement of aerobic endurance to understand leisure-time PA in clinic, rather than relying on self-report questionnaires or requiring patients to wear accelerometers at home.

Furthermore, there is a greater public health need to implement and develop programs that promote PA among older PLWHA. Encouragement of PA and availability of PA-related programs for older PLWHA is essential for reducing risk of CVD and mortality in aging populations.

References

1. World Health Organization. Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV, 2015.
2. Palella Jr FJ, Delaney KM, Moorman AC, Loveless MO, Fuhrer J, Satten GA, Aschman DJ, Holmberg SD. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. New England Journal of Medicine. 1998 Mar 26;338(13):853-60.
3. HIV Among People Aged 50 and Over. Centers for Disease Control and Prevention. February 2017.
4. Friis-Møller N, Weber R, Reiss P, Thiébaut R, Kirk O, Monforte AD, Pradier C, Morfeldt L, Mateu S, Law M, El-Sadr W. Cardiovascular disease risk factors in HIV patients–association with antiretroviral therapy. Results from the DAD study. Aids. 2003 May 23;17(8):1179-93.
5. Phillips AN, Lee CA, Elford J, Webster A, Janossy G, Timms A, Bofill M, Kernoff PB. More rapid progression to AIDS in older HIV-infected people: the role of CD4+ T-cell counts. JAIDS Journal of Acquired Immune Deficiency Syndromes. 1991 Oct 1;4(10):970-5.
6. Florindo AA, Rosario Dias de Oliveira Latorre MD, Jaime PC, Segurado AA. Leisure time physical activity prevents accumulation of central fat in HIV/AIDS subjects on highly active antiretroviral therapy. International journal of STD & AIDS. 2007 Oct 1;18(10):692-6.
7. How much physical activity do older adults need? Physical Activity is Essential to Healthy Aging. Centers for Disease and Prevention. 17 June 2014.
8. The Benefits of Physical Activity. Physical Activity and Health. Centers for Disease and Prevention. 14 June 2015.
9. Bassuk, Shari S., and JoAnn E. Manson. "Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease." *Journal of applied physiology* 99.3 (2005): 1193-1204.
10. Haennel, Robert G., and Francine Lemire. "Physical activity to prevent cardiovascular disease. How much is enough?" *Canadian Family Physician*48.1 (2002): 65-71.
11. Venkatraman, J. T., and G. Fernandes. "Exercise, immunity and aging." *Aging Clinical and Experimental Research* 9.1-2 (1997): 42-56.
12. Laurin, Danielle, et al. "Physical activity and risk of cognitive impairment and dementia in elderly persons." *Archives of neurology* 58.3 (2001): 498-504.
13. Penedo, Frank J., and Jason R. Dahn. "Exercise and well-being: a review of mental and physical health benefits associated with physica2l activity." *Current opinion in psychiatry* 18.2 (2005): 189-193.

14. Taylor, A. H., et al. "Physical activity and older adults: a review of health benefits and the effectiveness of interventions." *Journal of sports sciences*22.8 (2004): 703-725.
15. Roubenoff, Ronenn. "Physical activity, inflammation, and muscle loss. *"Nutrition reviews* 65.suppl 3 (2007): S208-S212.
16. Florindo AA, Latorre MD, Santos EC, Negrão CE, Azevedo LF, Segurado AA. Validity and reliability of the Baecke questionnaire for the evaluation of habitual physical activity among people living with HIV/AIDS. Cadernos de Saúde Pública. 2006 Mar;22(3):535-41.
17. Tanaka LF, da Silva AM, de Oliveira Konstantyner TC, Peres SV, de Sousa Marques HH. High prevalence of physical inactivity among adolescents living with HIV/AIDS. Revista Paulista de Pediatria (English Edition). 2015 Sep 30;33(3):326-31.
18. Amorosa V, Synnestvedt M, Gross R, Friedman H, MacGregor RR, Gudonis D, Frank I, Tebas P. A tale of 2 epidemics: the intersection between obesity and HIV infection in Philadelphia. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2005 Aug 15;39(5):557-61.
19. Vancampfort D, Mugisha J, Richards J, De Hert M, Probst M, Stubbs B. Physical activity correlates in people living with HIV/AIDS: a systematic review of 45 studies. Disability and Rehabilitation. 2017 Mar 21:1-2.
20. Ward DS, Evenson KR, Vaughn A, Rodgers AB, Troiano RP. Accelerometer use in physical activity: best practices and research recommendations. Medicine and science in sports and exercise. 2005 Nov;37(11 Suppl):S582-8.
21. Ramírez-Marrero FA, Rivera-Brown AM, Nazario CM, Rodríguez-Orengo JF, Smit E, Smith BA. Self-reported physical activity in Hispanic adults living with HIV: comparison with accelerometer and pedometer. Journal of the Association of Nurses in AIDS Care. 2008 Aug 31;19(4):283-94.
22. How to Measure and Interpret Weight Status. Assessing Your Weight. Centers for Disease and Prevention National Center for Injury Control and Prevent. 17 May 2015.
23. Know Your Numbers. Understanding Blood Pressure Readings. American Heart Association. October 2016.
24. Casanova C, Celli BR, Barria P, Casas A, Cote C, De Torres JP, Jardim J, Lopez MV, Marin JM, De Oca MM, Pinto-Plata V. The 6-min walk distance in healthy subjects: reference standards from seven countries. European Respiratory Journal. 2011 Jan 1;37(1):150-6.
25. 30-Second Chair Stand Test. Centers for Disease and Prevention National Center for Injury Control and Prevent. 2015.
26. Perna FM, Coa K, Troiano RP, Lawman HG, Wang CY, Li Y, Moser RP, Ciccolo JT, Comstock BA, Kraemer WJ. Muscular Grip Strength Estimates of the US Population From the National Health and Nutrition Examination Survey 2011–2012. The Journal of Strength & Conditioning Research. 2016 Mar 1;30(3):867-74.

27. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. Medicine and science in sports and exercise. 1998 May;30(5):777-81.
28. Matthews, Charles E., et al. "Amount of time spent in sedentary behaviors in the United States, 2003–2004." *American journal of epidemiology* 167.7 (2008): 875-881.
29. Sasaki JE, John D, Freedson PS. Validation and comparison of ActiGraph activity monitors. Journal of Science and Medicine in Sport. 2011 Sep 30;14(5):411-6.

Tables and Figures

Table 1. Sociodemographic and Clinical Data

Characteristics*	**Overall**	**Men**	**Women**	**p-value**
Age in years, mean (SD)	66.05(6.34)	65.67(6.07)	66.80(7.30)	0.7104
Race, n (%)				
White	11 (52.38)	7 (50.00)	3 (42.86)	
Black	10 (47.62)	7 (50.00)	4 (57.14)	0.7574
Lifestyle History, n (%)				
Smoking ever	11 (52.38)	7 (50.00)	4 (57.14)	0.4003
Alcohol use ever	11 (52.38)	8 (57.14)	3 (42.86)	0.5366
History of Disease, n (%)				
CVD	17 (80.95)	12 (85.71)	5 (71.43)	0.4319
Cancer	6 (28.57)	4 (28.57)	2 (28.57)	1.000
Liver disease	7 (33.33)	6 (42.86)	1 (14.29)	0.1904
Pulmonary disease	6 (28.57)	3 (21.43)	3 (42.86)	0.3055
Renal disease	5 (23.81)	4 (28.57)	1 (14.29)	0.4687
HANA disease	12 (57.14)	7 (50.00)	5 (71.43)	0.3496
HIV data, mean (SD)				
Years living with HIV	15.93 (7.64)	13.67 (8.19)	20.44 (3.91)	0.0540
CD4 cells (cells/mm^3)	631.52 (370.16)	515.21 (296.04)	864.14 (414.90)	0.0381
CD4 nadir (cells/mm^3)	185.48 (243.96)	170.57 (247.15)	215.94 (253.94)	0.7027
BMI (kg/m^2), mean (SD)	29.26 (6.05)	28.44(5.46)	30.90 (7.25)	0.3927
Obese/Overweight, n (%)**	17 (80.95)	11 (78.57)	6 (85.71)	0.6944
WC (in.), mean (SD)	39.58 (5.64)	39.23 (5.12)	40.33 (7.12)	0.7038
High WC, n (%)‡	9 (47.37)	4 (30.77)	5 (83.33)	0.0329
Blood pressure, mean (SD)	79.60 (17.92)	79.69 (5.51)	79.43 (15.04)	0.9760
Pulse (bpm)	130.60 (17.34)	133.34 (15.34)	125.71 (20.95)	0.3693
SBP (mmHg)	74.20 (11.01)	79.54 (7.69)	64.29 (9.45)	0.0010
DBP (mmHg)	8 (40.00)	5 (38.46)	3 (42.86)	0.8482
Hypertensive, n (%)‡‡				
Total, n (%)	21 (100.00)	14 (66.67)	7 (33.33)	0.1266

**Data are n (column percentage)*

**BMI ≥ 25 kg/m^2

‡ WC greater than 35 in. for women; WC greater than 40 in. for men

‡‡Blood pressure greater than 140/90 mmHg

Table 2. Physical Function Data

Physical Function Test	**Overall (N= 21)**	**Men (n=14)**	**Women (n=7)**	**p-value**
6MWT (meters), mean (SD)	371.66 (78.37)	374.20 (80.33)	366.50 (80.28)	0.8380
Low 6MWT, n (%)€	20 (95.24)	14 (100.00)	6 (85.71)	0.1437
30sec-CST score, mean (SD)	12.76 (4.57)	13.14 (4.83)	12.00 (4.24)	0.6020
Low 30sec-CST score, n (%)€€	7 (33.33)	4 (28.57)	3 (42.86)	0.5127
Grip Strength (lbs.), mean (SD)	140.59 (37.55)	159.34 (29.35)	103.09 (19.32)	0.0002
Low grip strength, n (%)¥	7 (33.33)	5 (35.71)	2 (28.57)	0.7434

€ Performance equivalent to 25th percentile or less. Ages 50-59: men <545m, women <525m; ages 60-69: men 525m, women 510m; and for ages 70-79: men 455m, women 460m.
€€ Low scores by age and gender. Ages 60-66: men<14, women <12; ages 65-69: men <12, women <11; ages 70-74: men <12 men, women <10; ages 75-70: men <11, women <10
¥ Performance equivalent to 25th percentile or less. Ages 50-59: men <170lbs, women <115lbs; ages 60-69: men 160lbs, women 110lbs; and for ages 70-79: men 125lbs, women 75lbs.

Table 3. Accelerometry Data

Accelerometry Output*	**Overall (N= 21)**	**Men (n=14)**	**Women (n=7)**
Mean Number of Days Monitor Worn	7.86(2.51)	8.21(2.94)	7.14(1.21)
Daily Mean Steps, n (SD)	3994.54 (2477.74)	4078.77 (2483.82)	3826.08 (2564.70)
Energy Expenditure (kCals), mean (SD)	296.88 (184.97)	309.24 (193.47)	272.17 (178.56)
Daily Physical Activity, Sedentary (%)¥¥	71.57%(11.40)	71.50%(12.26)	71.70%(10.37)
Daily Physical Activity, Light Intensity (%)Ω	27.33%(10.38)	27.43%(11.36)	27.14%(8.90)
Daily Physical Activity, Moderate/Vigorous Intensity (%)◊	1.09%(1.54)	1.06%(1.57)	1.16%(1.58)
Daily MVPA (minutes), mean (SD)	9.22(12.12)	8.69(11.86)	10.29(13.53)

*All p-values less than 0.05
¥¥ 0-99 CPM
Ω 100-1951 CPM
◊1952-9498 CPM

Table 4. Linear Regression Models

Dependent Variables	**Adjusted R^2**	**Age^{Ø}** ß (p-value)	**pulse^{Ø}** ß (p-value)	**nadir^{Ø}** ß (p-value)	**6MWT^{Ø}** ß (p-value)	**30sec-CST^{Ø}** ß (p-value)	**kcals^{Ø}** ß (p-value)	**DBP^{Ø}** ß (p-value)
steps	0.4204				6.46023 0.0009			
kcals	0.6768	-13.5147 0.0060	-3.32256 0.00481	-0.24721 0.0343	0.36875 0.0019			
6MWT	0.6737					38.29597 <0.0001	0.17956 0.0061	
30sec-CST	0.5250				0.01317 0.001			
Grip strength	0.375							0.50512 0.00024

Ø Independent Variables

Figure 1. Correlation of Mean Number of Daily Steps with Distance Walked in Meters During the 6 Minute Walk Test

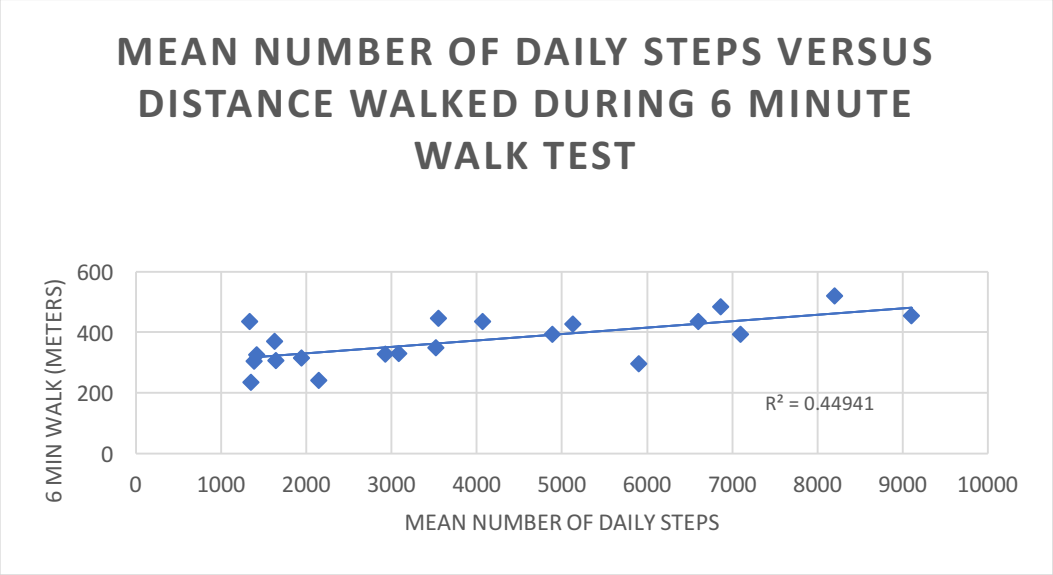
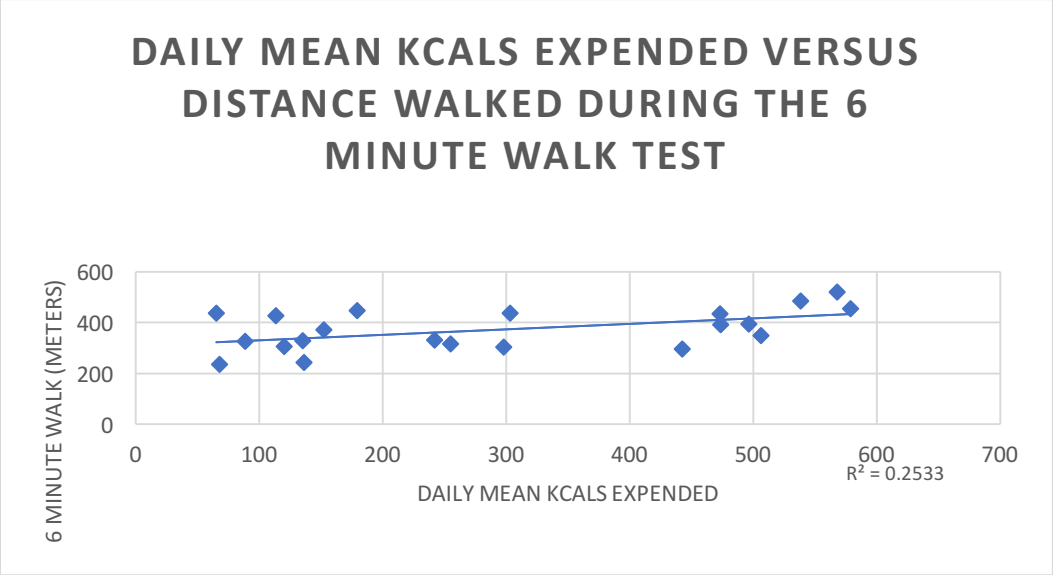


Figure 2. Correlations of Daily Mean kCals Expended with Distance Walked in Meters During the 6 Minute Walk Test



Chapter IV: Public Health Implications

The findings from the study indicate that older PLWHA are currently failing to meet public health guidelines for PA and physical function. The data emphasize a need for structural change, initiated through both clinical practice and guidance, as well as HIV-related policy and guidelines:

(1) Education and encouragement of PA among older PLWHA should be part of standard clinical practice for all older adults, but especially for older PLWHA.

Our study found that 72% (10.15 hours) of daily waking hours were spent sedentary, with none of the participants in our study met the current CDC guidelines recommending 150 mins of MVPA per week. Compared to national data among all older adults, in which an average of 60% of waking hours were spent sedentary [36] , older PLWHA are considerably less active. The findings suggest a pressing need for clinicians to educated patients about the importance of PA and continually promote PA during follow-up care visits for HIV.

(2) Ongoing Assessments of PA in Older PLWHA should also be incorporated into clinical practice.

In addition to encouraging PA among older PLWHA, there is also a need for clinicians to regularly ask patients about their levels of PA within the home. If possible, clinicians should actively monitor PA by using validated questionnaires or accelerometry, when possible, to accurately monitor changes in PA and offer further recommendations for behavioral change.

(3) Performance on the 6MWT might indicate levels of leisure-time PA.

One challenge with monitoring PA levels is a lack of accuracy from self-report questionnaires. While accelerometry could be used to provide a more accurate measurement of daily leisure-time PA, accelerometers are often expensive and cumbersome to wear. In our study, we found a significant, strong positive correlations between daily mean number of steps walked and distance walked during the 6MWT, as well as a significant correlation between daily kCals expended and distance walked during the 6MWT. This link between daily ambulatory activity, as measured through daily mean number of steps, and aerobic endurance, as measured through the 6MWT, with levels of daily leisure-time PA suggests that physicians can indirectly measure leisure-time PA in clinic using the 6MWT.

(4) There is a need to develop programs that promote PA in Older PLWHA.

The findings indicate a larger public health need to address PA among older adults overall. Culturally competent health promotion campaigns should be enacted to educate older adults about the importance of PA and encourage positive behavior change. Further, PA-based programs should be designed and implemented to allow options for older adults to become more active. Such programs might include community-led or group-based programs aimed specifically toward adults over the age of 50 that offer incentives to participants for being physically actively.

(5) As PLWHA age, there is need to expand the Continuum of Care for HIV.

The current HIV Continuum of Care follows treatment of PLWHA from early diagnosis, to linkage to care and ART initiation, to achieved viral suppression. As more persons are adhering

to their ART regimens and reaching undetectable HIV-1 viral loads, there is an urgent need to extend the continuum of care to address ongoing health issues linked to HIV, including development of co-morbid conditions, drug-drug interactions, and accelerated aging among older PLWHA. Preventing the onset of co-morbidities will be linked to effective monitoring of lifestyle and behavioral factors, including PA levels, physical function, smoking, alcohol use, etc.

Conclusion

Low PA in older adults can accelerate functional decline and lead to development of chronic illness, including CVD and type 2 diabetes. While PA should be encouraged among all older adults, PLWHA are disproportionately less active than persons who are HIV-negative. Given the socio-demographic and clinical barriers that PLWHA face, PA should be encouraged among older PLWHA. This will require public health initiatives that educate older adults about PA and health, in addition to PA-based programs for older persons. Clinicians should so encourage PA as part of their standard follow-up visits with older PLWHA.

References

1. World Health Organization. Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV, 2015.
2. Understanding the HIV Continuum of Care. Centers for Disease Control and Prevention. July 2016.
3. World Health Organization. WHO Recommends HIV Self-Testing. December 2016.
4. HIV Among People Aged 50 and Over. Centers for Disease Control and Prevention. February 2017.
5. Palella Jr FJ, Delaney KM, Moorman AC, Loveless MO, Fuhrer J, Satten GA, Aschman DJ, Holmberg SD. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. New England Journal of Medicine. 1998 Mar 26;338(13):853-60.
6. Phillips AN, Lee CA, Elford J, Webster A, Janossy G, Timms A, Bofill M, Kernoff PB. More rapid progression to AIDS in older HIV-infected people: the role of CD4+ T-cell counts. JAIDS Journal of Acquired Immune Deficiency Syndromes. 1991 Oct 1;4(10):970-5.
7. Friis-Møller N, Weber R, Reiss P, Thiébaut R, Kirk O, Monforte AD, Pradier C, Morfeldt L, Mateu S, Law M, El-Sadr W. Cardiovascular disease risk factors in HIV patients–association with antiretroviral therapy. Results from the DAD study. Aids. 2003 May 23;17(8):1179-93.
8. Cannon CP. Cardiovascular disease and modifiable cardiometabolic risk factors. Clinical cornerstone. 2007 Jan 1;8(3):11-28.
9. The Benefits of Physical Activity. Physical Activity and Health. Centers for Disease and Prevention. 14 June 2015.
10. Bassuk, Shari S., and JoAnn E. Manson. "Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease." *Journal of applied physiology* 99.3 (2005): 1193-1204.
11. Haennel, Robert G., and Francine Lemire. "Physical activity to prevent cardiovascular disease. How much is enough?" *Canadian Family Physician*48.1 (2002): 65-71.
12. HIV Among People Aged 50 and Over. [Internet]. Centers for Disease Control; 2017 [updated 2017 February 2017]. [Figure], Estimated Diagnoses of HIV Infection by Age. Available from: https://www.cdc.gov/hiv/group/age/olderamericans/
13. How much physical activity do older adults need? Physical Activity is Essential to Healthy Aging. Centers for Disease and Prevention. 17 June 2014.
14. Laurin, Danielle, et al. "Physical activity and risk of cognitive impairment and dementia in elderly persons." *Archives of neurology* 58.3 (2001): 498-504.
15. Penedo, Frank J., and Jason R. Dahn. "Exercise and well-being: a review of mental and physical health benefits associated with physica2l activity." *Current opinion in psychiatry* 18.2 (2005): 189-193.
16. Taylor, A. H., et al. "Physical activity and older adults: a review of health benefits and the effectiveness of interventions." *Journal of sports sciences*22.8 (2004): 703-725.
17. Roubenoff, Ronenn. "Physical activity, inflammation, and muscle loss. *"Nutrition reviews* 65.suppl 3 (2007): S208-S212.
18. Venkatraman, J. T., and G. Fernandes. "Exercise, immunity and aging." *Aging Clinical and Experimental Research* 9.1-2 (1997): 42-56.

19. Vancampfort D, Mugisha J, Richards J, De Hert M, Probst M, Stubbs B. Physical activity correlates in people living with HIV/AIDS: a systematic review of 45 studies. Disability and Rehabilitation. 2017 Mar 21:1-2.
20. Florindo AA, Latorre MD, Santos EC, Negrão CE, Azevedo LF, Segurado AA. Validity and reliability of the Baecke questionnaire for the evaluation of habitual physical activity among people living with HIV/AIDS. Cadernos de Saúde Pública. 2006 Mar;22(3):535-41.
21. Tanaka LF, da Silva AM, de Oliveira Konstantyner TC, Peres SV, de Sousa Marques HH. High prevalence of physical inactivity among adolescents living with HIV/AIDS. Revista Paulista de Pediatria (English Edition). 2015 Sep 30;33(3):326-31.
22. Amorosa V, Synnestvedt M, Gross R, Friedman H, MacGregor RR, Gudonis D, Frank I, Tebas P. A tale of 2 epidemics: the intersection between obesity and HIV infection in Philadelphia. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2005 Aug 15;39(5):557-61.
23. Ramírez-Marrero FA, Rivera-Brown AM, Nazario CM, Rodríguez-Orengo JF, Smit E, Smith BA. Self-reported physical activity in Hispanic adults living with HIV: comparison with accelerometer and pedometer. Journal of the Association of Nurses in AIDS Care. 2008 Aug 31;19(4):283-94.
24. Ward DS, Evenson KR, Vaughn A, Rodgers AB, Troiano RP. Accelerometer use in physical activity: best practices and research recommendations. Medicine and science in sports and exercise. 2005 Nov;37(11 Suppl):S582-8.
25. Oursler, Krisann K., et al. "Association of age and comorbidity with physical function in HIV-infected and uninfected patients: results from the Veterans Aging Cohort Study." *AIDS patient care and STDs* 25.1 (2011): 13-20.
26. Oursler KK, Goulet JL, Leaf DA, Akingicil A, Katzel LI, Justice A, Crystal S. "Association of comorbidity with physical disability in older HIV-infected adults". AIDS Patient Care & STDs. 2006 Nov 1;20(11):782-91.
27. Richert L, Dehail P, Mercié P, Dauchy FA, Bruyand M, Greib C, Dabis F, Bonnet F, Chêne G, Groupe d'Epidémiologie Clinique du SIDA en Aquitaine (GECSA. High frequency of poor locomotor performance in HIV-infected patients. Aids. 2011 Mar 27;25(6):797-805.
28. Casanova C, Celli BR, Barria P, Casas A, Cote C, De Torres JP, Jardim J, Lopez MV, Marin JM, De Oca MM, Pinto-Plata V. The 6-min walk distance in healthy subjects: reference standards from seven countries. European Respiratory Journal. 2011 Jan 1;37(1):150-6.
29. 30-Second Chair Stand Test. Centers for Disease and Prevention National Center for Injury Control and Prevent. 2015.
30. Perna FM, Coa K, Troiano RP, Lawman HG, Wang CY, Li Y, Moser RP, Ciccolo JT, Comstock BA, Kraemer WJ. Muscular Grip Strength Estimates of the US Population From the National Health and Nutrition Examination Survey 2011–2012. The Journal of Strength & Conditioning Research. 2016 Mar 1;30(3):867-74.
31. Florindo AA, Rosario Dias de Oliveira Latorre MD, Jaime PC, Segurado AA. Leisure time physical activity prevents accumulation of central fat in HIV/AIDS subjects on highly active antiretroviral therapy. International journal of STD & AIDS. 2007 Oct 1;18(10):692-6.

32. Jaggers JR, Sneed JM, Lobelo RF, Hand GA, Dudgeon WD, Prasad VK, Burgess S, Blair SN. Results of a nine-month home-based physical activity intervention for people living with HIV. International Journal of Clinical Trials. 2016 Aug 6;3(3):106-19.
33. How to Measure and Interpret Weight Status. Assessing Your Weight. Centers for Disease and Prevention National Center for Injury Control and Prevent. 17 May 2015.
34. Know Your Numbers. Understanding Blood Pressure Readings. American Heart Association. October 2016.
35. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. Medicine and science in sports and exercise. 1998 May;30(5):777-81.
36. Matthews, Charles E., et al. "Amount of time spent in sedentary behaviors in the United States, 2003–2004." *American journal of epidemiology* 167.7 (2008): 875-881.